Hornsea Offshore Wind Farm
Project One

Environmental Statement
Volume 5 – Offshore Annexes

Chapter 5.5.1
Ornithology Technical Report

PINS Document Reference: 7.5.5.1

APFP Regulation 5(2)(a)

July 2013

smartwind.co.uk

Copyright © 2013

All pre-existing rights reserved.

SMart Wind Limited

Hornsea Offshore Wind Farm

Project One – Environmental Statement

Volume 5

Annex 5.5.1 – Ornithology Technical Report

Liability

This report has been prepared by RPS with all reasonable skill, care and diligence within the terms of their contracts with SMart Wind Ltd or their subcontractor to RPS placed under RPS' contract with SMart Wind Ltd as the case may be.

Document release and authorisation record	
PINS Document Reference	7.5.5.1
Report number	UK04-050200-REP-0040
Date	July 2013
Client name	SMart Wind Limited
Client contact(s)	Chris Jenner Penny Pickett Rachael Mills Rosemary Tingle Liam Leahy Ditte Bilde Sheelagh Guilmartin

SMart Wind Limited
11th Floor
140 London Wall
London
EC2Y 5DN

Tel 0207 7765500

Email info@smartwind.co.uk

Table of Contents

1 Introduction 8
1.1 Context 8
1.2 Purpose and Scope of the Report 8
1.3 Hornsea Survey Area 9
1.4 Relevant Legislation 9
1.5 Consultation with Key Stakeholders 9
2 Methods 11
2.1 Boat Based Surveys 11
2.2 Data Processing 14
2.3 Defining Population Importance and Sensitivity Levels 15
3 Baseline Characterisation 15
3.1 Seabirds in the Wider Southern North Sea 15
3.2 Raw Counts of Seabirds in the Hornsea Survey Area in Years 1 and 2 19
3.3 Flight Height of Birds 22
3.4 Overview of Species Sensitivity 23
3.5 Designated Sites 24
3.6 Non-Seabird Species 25
3.7 Seabird Species Accounts 27
4 Summary 127
References 134
Appendix A – Survey Data and Displacement Matrices 136
Appendix B – Distribution and Density Maps 180
Appendix C – Population Estimates and Collision Rate Report 285
Appendix D – APEM Migratory Collision Modelling 407

Table of Figures

Figure 2.1 Hornsea ornithology study area showing Hornsea Zone and Subzone 1 transects 12
Figure 2.2 Survey effort in the Hornsea Survey Area in relation to Sea State during Year 1 13
Figure 2.3 Survey effort in the Hornsea Survey Area in relation to Sea State during Year 2 14
Figure 3.1 Marine natural areas around England, as identified by Jones *et al.* (2004). 16
Figure 3.2 Areas for analysis of seabird distribution in Stone *et al.* (1995). 17
Figure 3.3 Map of the Dutch continental shelf showing location of important bird areas (from Geelhoed *et al.* 2011) 18
Figure 3.4 Temporal variation in raw counts of red-throated diver in the Hornsea Zone survey area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.) 29
Figure 3.5 Spatial distribution of red-throated diver sightings in the Hornsea Survey Area 29
Figure 3.6 Temporal variation in raw counts on black-throated diver in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 30
Figure 3.7 Spatial distribution of black-throated diver sightings in the Hornsea Survey Area 30
Figure 3.8 Spatial distribution of grebe sightings in the Hornsea Survey Area. 31
Figure 3.9 Fulmar foraging range in relation to Project One and the Hornsea Zone. 32
Figure 3.10 Temporal variation in distance-adjusted counts of fulmar in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.) 33
Figure 3.11 Temporal variation in distance-adjusted counts of fulmar in Subzone 1 plus 4 km buffer. 33
Figure 3.12 Temporal variation in distance-adjusted counts of fulmar in Subzone 1. 35
Figure 3.13 Temporal variation in mean density of fulmar in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 35
Figure 3.14 A comparison of temporal variation in density of fulmar in the Hornsea Survey Area and wider figures from Stone *et al*. (1995). 36
Figure 3.15 Flight direction of fulmar in the Hornsea Survey Area in Years 1 and 2. 36
Figure 3.16 Temporal variation in distance-adjusted counts of sooty shearwater in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for

Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 39

Figure 3.17 Temporal variation in distance-adjusted counts of sooty shearwater in Subzone 1 and 4 km buffer. 39

Figure 3.18 Temporal variation in distance-adjusted counts of sooty shearwater in Subzone 1.. 39

Figure 3.19 Temporal variation in mean density of sooty shearwater in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 39

Figure 3.20 Temporal variation in raw counts of Manx shearwater in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 40

Figure 3.21 Temporal variation in mean abundance of Manx shearwater in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 41

Figure 3.22 Spatial distribution of Balearic shearwater, storm petrel and Leach's petrel in the Hornsea Survey Area. 41

Figure 3.23 Gannet foraging ranges from SPAs in relation to the Hornsea Survey Area. Note Northern Isles SPAs (beyond maximum foraging range) not shown on map. 44

Figure 3.24 Temporal variation in distance-adjusted counts of gannet in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 47

Figure 3.25 Temporal variation in distance-adjusted counts of gannet in Subzone 1 and 4 km buffer 47

Figure 3.26 Temporal variation in distance-adjusted counts of gannet in Subzone 1. 47

Figure 3.27 Temporal variation in mean gannet density in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 48

Figure 3.28 A comparison of temporal variation in density of gannet in the Hornsea Survey Area and wider figures from Stone *et al*. (1995). 48

Figure 3.29 Flight direction of gannets in the Hornsea Survey Area in Years 1 and 2. 48

Figure 3.30 Spatial distribution of cormorant and shag in the Hornsea Survey Area. 51

Figure 3.31 Spatial distribution of eider sightings in the Hornsea Survey Area. 52

Figure 3.32 Temporal variation in raw counts of common scoter in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.) 53

Figure 3.33 Temporal variation in mean abundance of common scoter in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 54

Figure 3.34 Spatial distribution of Grey phalarope sightings in the Hornsea Survey Area between September and January, Years 1 and 2. 54

Figure 3.35 Temporal variation in raw counts of pomarine skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 55

Figure 3.36 Spatial distribution of pomarine skua sightings in the Hornsea Survey Area. 55

Figure 3.37 Spatial distribution of long-tailed skuas in the Hornsea Survey Area. 56

Figure 3.38 Temporal variation in raw counts of Arctic skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 57

Figure 3.39 Temporal variation in mean abundance of Arctic skuas in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 58

Figure 3.40 Arctic skua foraging range in relation to Project One and the Hornsea Zone. 59

Figure 3.41 Temporal variation in raw counts of great skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 61

Figure 3.42 Temporal variation in mean abundance of great skuas in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 61

Figure 3.43 Great skua foraging range in relation to Project One and the Hornsea Zone. 62

Figure 3.44 Temporal variation in distance-adjusted counts of little gull in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 65

Figure 3.45 Temporal variation in distance-adjusted counts of little gull in Subzone 1 and 4 km buffer. 65

Figure 3.46 Temporal distribution of mean density of little gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 65

Figure 3.47 A comparison of temporal variation in density of little gull in the Hornsea Survey Area and wider figures from Stone *et al*. (1995). 66

Figure 3.48 Flight direction of little gulls in the Hornsea Survey Area, Years 1 and 2. 66

Figure 3.49 Spatial distribution of Sabine's gull sightings in the Hornsea Survey Area..... 67

Figure 3.50 Temporal variation in raw counts of black-headed gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 68

Figure 3.51 Temporal variation in mean abundance of black-headed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 68

Figure 3.52 Temporal variation in raw counts of common gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 69

Figure 3.53 Temporal variation in mean abundance of common gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 69

Figure 3.54 Lesser black-backed gull foraging range in relation to Project One and the Hornsea Zone. 72

Figure 3.55 Temporal variation in distance-adjusted counts of lesser black-backed gull in Subzone 1 and 4 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 73

Figure 3.56 Temporal variation in distance-adjusted counts of lesser black-backed gull in Subzone 1..... 73

Figure 3.57 Temporal variation in mean densities of lesser black-backed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 73

Figure 3.58 Flight direction of lesser black-backed gulls in the Hornsea Survey Area between April and August, Years 1 and 2..... 74

Figure 3.59 Herring gull foraging range in relation to Project One and the Hornsea Zone..... 77

Figure 3.60 Temporal variation in distance-adjusted counts of herring gull in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 78

Figure 3.61 Temporal variation in distance-adjusted counts of herring gull in Subzone 1 and 4 km buffer..... 78

Figure 3.62 Temporal variation in distance-adjusted counts of herring gull in Subzone 1..... 78

Figure 3.63 Temporal variation in mean density of herring gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively)..... 79

Figure 3.64 Flight direction of herring gulls in the Hornsea Survey Area in Years 1 and 2. 79

Figure 3.65 Great black-backed gull foraging range in relation to Project One and the Hornsea Zone.....82

Figure 3.66 Temporal variation in distance-adjusted counts of great black-backed gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 83

Figure 3.67 Temporal variation in distance adjusted counts of great black-backed gull in Subzone 1 and 4 km buffer.....83

Figure 3.68 Temporal variation in distance adjusted counts of great black-backed gull in Subzone 1.....83

Figure 3.69 Temporal variation in mean densities of great black-backed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).....84

Figure 3.70 A comparison of temporal variation in density of great black-backed gull in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).....84

Figure 3.71 Flight direction of great black-backed gulls in the Hornsea Survey Area in Years 1 and 2.....84

Figure 3.72 Kittiwake foraging ranges from SPAs in relation to the Hornsea Survey Area.Note Northern Isles SPAs not shown on map.....88

Figure 3.73 Temporal variation in distance-adjusted counts of kittiwake in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 90

Figure 3.74 Temporal variation in distance-adjusted counts of kittiwake in Subzone 1 and 4 km buffer.....90

Figure 3.75 Temporal variation in distance-adjusted counts of kittiwake in Subzone 1.....90

Figure 3.76 Temporal variation in mean estimated density of kittiwake in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.).....91

Figure 3.77 A comparison of temporal variation in density of kittiwake in the Hornsea Survey Area and wider figures from Stone *et al.* (1995).....91

Figure 3.78 Flight direction of kittiwake in the Hornsea Survey Area in Years 1 and 2. 92

Figure 3.79 Spatial distribution of Sandwich tern and little tern sightings in the Hornsea Survey Area. 95

Figure 3.80 Common tern foraging range in relation to Project One and the Hornsea Zone. .97

Figure 3.81 Temporal variation in raw counts of common tern in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).....98

Figure 3.82 Temporal variation in raw counts of common tern in Subzone 1 and 4 km buffer…… 98

Figure 3.83 Temporal variation in raw counts of common tern in Subzone 1. 98

Figure 3.84 Temporal variation in estimated density of common tern in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 99

Figure 3.85 A comparison of temporal variation in density of common tern in the Hornsea Survey Area and wider 'commic tern' figures from Stone *et al*. (1995). 99

Figure 3.86 Flight direction of common terns in the Hornsea Survey Area between August and October, Years 1 and 2. 100

Figure 3.87 Temporal variation in mean abundance of Arctic tern in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 101

Figure 3.88 Arctic tern foraging range in relation to Project One and the Hornsea Zone. 102

Figure 3.89 Guillemot foraging ranges from SPAs in relation to the Hornsea Survey Area. 105

Figure 3.90 Temporal variation in distance-adjusted counts of guillemot in the Hornsea Zone plus 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 108

Figure 3.91 Temporal variation in distance-adjusted counts of guillemot in Subzone 1 and 4 km buffer. 108

Figure 3.92 Temporal variation in distance-adjusted counts of guillemot in Subzone 1. 108

Figure 3.93 Temporal variation in mean estimated density of guillemot in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 109

Figure 3.94 A comparison of temporal variation in density of guillemot in the Hornsea Survey Area and wider figures from Stone *et al*. (1995). 110

Figure 3.95 Flight direction of guillemot in the Hornsea Survey Area in Years 1 and 2. 110

Figure 3.96 Razorbill foraging ranges from SPAs in relation to the Hornsea Survey Area. 112

Figure 3.97 Temporal variation in distance-adjusted counts of razorbill in the Hornsea Zone plus 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 114

Figure 3.98 Temporal variation in distance-adjusted counts of razorbill in Subzone 1 plus 4 km buffer. 114

Figure 3.99 Temporal variation in distance-adjusted counts of razorbill in Subzone 1. 115

Figure 3.100 Temporal variation in mean estimated densities of razorbill in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 115

Figure 3.101 A comparison of temporal variation in densities of razorbill in the Hornsea Survey Area and wider figures from Stone *et al*. (1995). 116

Figure 3.102 Flight direction of razorbills in the Hornsea Survey Area in Years 1 and 2. 116

Figure 3.103 Temporal variation in distance-adjusted counts of little auk in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 117

Figure 3.104 Temporal variation in distance-adjusted counts of little auk in Subzone 1 plus 4 km buffer. 117

Figure 3.105 Temporal variation in distance-adjusted counts of little auk in Subzone 1. 118

Figure 3.106 Temporal variation in mean estimated densities of little auk in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 120

Figure 3.107 Temporal variation in distance-adjusted counts of puffin in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 122

Figure 3.108 Temporal variation in distance-adjusted counts of puffin in Subzone 1 and 4 km buffer. 122

Figure 3.109 Puffin foraging ranges from SPAs in relation to the Hornsea Survey Area. 123

Figure 3.110 Temporal variation in distance-adjusted counts of puffin in Subzone 1. 125

Figure 3.111 Temporal variation in mean estimated density of puffin in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively). 125

Figure 3.112 A comparison of temporal variation in density of puffin in the Hornsea Survey Area and wider figures from Stone *et al*., 1995. 126

Figure 3.113 Flight direction of puffins in the Hornsea Survey Area in Years 1 and 2. 126

Table of Tables

Table 1.1 Consultation summary, where relevant to this Technical Annex. 10
Table 2.1 Survey effort for the Hornsea Survey Areas in Years 1 and 2..... 11
Table 2.2 Breakdown of survey effort for the Hornsea Zone and 10 km buffer in Year 2.... 13
Table 3.1 Comparison of seabird numbers recorded on surveys in Subzone 1 and the Hornsea Zone in Years 1 and 2 (raw numbers, all Sea States). 20
Table 3.2 Flight heights of birds in the Hornsea Survey Area in Years 1 and 2. 22
Table 3.3 Summary of seabird sensitivities to offshore wind farms (Langston, 2010)..... 23
Table 3.4 Qualifying SPA species within mean maximum foraging range of the Hornsea Zone (JNCC Seabird Monitoring Programme 2012). 24
Table 3.5 SPA species within theoretical mean maximum or maximum foraging range of the Hornsea Zone and Subzone 1. 25
Table 3.6 Comparison of non-seabird numbers recorded on surveys in Subzone 1 and the Hornsea Zone in Years 1 and 2 (Raw numbers, all Sea States)..... 26
Table 3.7 Estimated numbers of fulmars in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer in Years 1 and 2..... 34
Table 3.8 North Sea fulmar densities from Stone *et al.* (1995). 35
Table 3.9 Fulmar foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 37
Table 3.10 Estimated numbers of sooty shearwaters in Subzone 1, Subzone 1 and 4 km buffer, and the Hornsea Zone and 10 km buffer in Years 1 and 2..... 38
Table 3.11 SPAs for gannets on the UK east coast in the breeding season..... 43
Table 3.12 Estimated numbers of gannets in Subzone 1, Subzone 1 and 4 km buffer, and the Hornsea Zone and 10 km buffer in Years 1 and 2..... 46
Table 3.13 North Sea gannet densities from Stone *et al*. (1995). 47
Table 3.14 Gannet foraging behaviour in the Hornsea Survey Area in Years 1 and 2..... 49
Table 3.15 Age breakdown of gannets recorded in Years 1 and 2. 49
Table 3.16 SPAs for cormorants on the UK east coast in the breeding season..... 50
Table 3.17 SPAs for cormorants on the UK east coast in the non-breeding season..... 50
Table 3.18 SPAs for shags on the UK east coast in the breeding season 52
Table 3.19 SPAs for eiders on the UK east coast in the non-breeding season..... 52
Table 3.20 SPAs for common scoter on the UK east coast in the non-breeding season. 53
Table 3.21 SPAs for Arctic skua on the UK east coast in the breeding season. 57
Table 3.22 North Sea Arctic skua densities from Stone *et al*. (1995)..... 58
Table 3.23 SPAs for great skuas on the UK east coast in the breeding season 60
Table 3.24 North Sea great skua densities from Stone *et al*. (1995)..... 61
Table 3.25 Estimated numbers of little gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Year 1 and Year 2..... 64
Table 3.26 North Sea little gull densities from Stone *et al*. (1995). 65
Table 3.27 Little gull foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 66
Table 3.28 SPAs for black-headed gull on the UK east coast in the breeding season.....67
Table 3.29 Estimated numbers of lesser black-backed gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer in Years 1 and 2.....71
Table 3.30 Age breakdown of lesser black-backed gulls recorded in Years 1 and 2. 74
Table 3.31 SPAs for herring gull on the UK east coast in the breeding season.....75
Table 3.32 Estimated numbers of herring gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer, in Years 1 and 2.....76
Table 3.33 Estimated numbers of great black-backed gulls in Subzone 1, 4 km buffer and Hornsea Zone and 10 km buffer in Years 1 and 2. 81
Table 3.34 North Sea great black-backed gull densities from Stone *et al*. (1995). 83
Table 3.35 Great black-backed gull foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 85
Table 3.36 SPAs for kittiwake on the UK east coast in the breeding season.....87
Table 3.37 Estimated numbers of kittiwakes in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Year 1 and 2. 89
Table 3.38 North Sea kittiwake densities from Stone *et al*. (1995).....91
Table 3.39 Kittiwake foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 92
Table 3.40 Age breakdown of kittiwakes recorded on surveys in Years 1 and 2. 92
Table 3.41 North Sea 'large gull' densities from Stone *et al*. (1995). 93
Table 3.42 North Sea 'unidentified gull' densities from Stone *et al.* (1995).....94
Table 3.43 SPAs for Sandwich tern on the UK east coast in the breeding season.....94
Table 3.44 Estimated numbers of common terns in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2. 96
Table 3.45 North Sea 'commic tern' densities from Stone *et al*. (1995). 99
Table 3.46 Common tern foraging behaviour in the Hornsea Survey Area.....100
Table 3.47 SPAs for Arctic tern on the UK east coast in the breeding season. 101
Table 3.48 Arctic tern foraging behaviour in the Hornsea Survey Area in Years 1 and 2. ...103
Table 3.49 SPAs for guillemot on the UK east coast in the breeding season. 106
Table 3.50 Estimated numbers of guillemots in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2. 107
Table 3.51 North Sea guillemot densities from Stone *et al*. (1995).....109
Table 3.52 Guillemot foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 110
Table 3.53 Estimated numbers of razorbills in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2. 113
Table 3.54 North Sea razorbill densities from Stone *et al.* (1995).....115

Table 3.55 Razorbill foraging behaviour in the Hornsea Survey Area in Years 1 and 2..... 116
Table 3.56 Estimated numbers of little auks in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2. 119
Table 3.57 Little auk foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 120
Table 3.58 SPAs for puffin on the UK east coast in the breeding season. 121
Table 3.59 Estimated numbers of puffins in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2. 124
Table 3.60 North Sea puffin densities from Stone *et al*. (1995)..... 125
Table 3.61 Puffin foraging behaviour in the Hornsea Survey Area in Years 1 and 2. 126
Table 3.62 North Sea 'unidentified guillemot/razorbill' densities from Stone *et al*. (1995)... 127
Table 4.1 A summary of the conservation importance and peak populations of all species recorded in Subzone 1 and the 4 km buffer in relation to national and regional thresholds..... 129

Acronyms

Acronym	Full term
BTO	British Trust for Ornithology
EIA	Environmental Impact Assessment
ESAS	European Seabirds at Sea
IPC	Infrastructure Planning Commission
JNCC	Joint Nature Conservation Committee
NE	Natural England
NNR	National Nature Reserves
PBR	Potential Biological Removal
PCH	Potential Collision Height
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
SMP	Seabird Monitoring Programme
SOSS	Strategic Ornithological Support Services
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
WeBS	Wetland Bird Survey
ZoC	Zone Characterisation

1 INTRODUCTION

1.1 Context

1.1.1 The purpose of this Ornithology technical report is to provide a detailed baseline characterisation of birds within and around the Project One ornithology study area.

1.1.2 Bird surveys were undertaken to collect data for an ornithological characterisation of Subzone 1 and the wider Hornsea Survey Area and to provide a baseline against which to assess potential impacts of the proposed development. Two years of survey work were undertaken. Year 1 covered March 2010 to February 2011, while Year 2 covered March 2011 to February 2012.

1.1.3 An overview of the baseline, together with the impact assessment, cumulative and transboundary impact assessment are provided within the Environmental Statement, Volume 2, Chapter 5: Ornithology. Details of the ornithology study area, legislation and guidance, consultation, data sources, methodology for data collection are also included within Volume 2, Chapter 5: Ornithology.

1.1.4 It is recommended that the Ornithology chapter (Volume 2, Chapter 5: Ornithology) is read in conjunction with this Technical Annex.

1.2 Purpose and Scope of the Report

1.2.1 This Technical Annex presents an outline of the study methodology, together with baseline results from the site-specific boat-based surveys which were designed to best inform the ornithological characterisation of Project One site and surrounding Subzone 1 and Hornsea Zone. This Technical Annex therefore:

- Collates all ornithological data gathered to date for the Project One application and provides a baseline description of the ornithological interests within the Subzone 1 and Hornsea Zone survey areas; and
- Establishes the ornithological importance of the proposed Project One site for breeding, wintering and migratory birds by analysing boat-based survey data, and any other data sources from the wider area.

1.2.2 In relation to nature conservation importance, three key potential impacts on the seabird assemblage during the construction, operation and decommissioning of Project One have been identified:

- The potential for the project to adversely affect seabirds of highest conservation concern, listed on Annex 1 of the EU Birds Directive (2009/147/EC, the codified version - updated to incorporate the original act and all amendments of Council Directive (79/409/EEC), and/or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended);
- The potential for the project to adversely affect qualifying ornithological features of nearby designated sites; Natura 2000 sites (Special Protection Areas (SPAs)), sites of national value (Sites of Special Scientific Interest (SSSIs)), and internationally designated sites (Ramsar); and
- The potential for the project to adversely affect other species in internationally-, nationally- or regionally-important numbers in winter, during migration, or whilst commuting locally between foraging and breeding grounds.

1.2.3 The layout of this report is as follows:

- Section 1 provides an introduction to the project, in relation to ornithological aspects presented in this report. It also defines key concepts used throughout the report, relating to the survey areas, as well as relevant legislation and consultation;
- Section 2 provides an overview of the methodologies used to gather, analyse and present baseline data, as well as the rationale behind and procedures used to define population importance and sensitivity for each key species; and
- Section 3 presents the results gathered from desk-based studies and boat-based surveys to characterise the baseline environment. Information is provided on raw counts of all species recorded within Subzone 1 and the Hornsea Zone, as well as their corresponding flight height distribution. An overview of each key species' sensitivity is then presented, based on a literature review.

1.2.4 The following subsections contain individual Species Accounts for each key species, in which survey results are presented, as well as trends in spatial, seasonal or inter-annual variation, and considerations regarding the relative importance of the Subzone 1 to the species' background populations in a wider spatial context.

1.2.5 Section 4 then takes all the presented information to summarise which species should be considered for impact assessment, based on the importance of the populations recorded during the baseline period.

1.2.6 In addition, Appendix A presents detailed information and results that are provided more concisely in the text, including survey effort in relation to Sea State and monthly species counts, mean peak population estimates for key species and displacement matrices that are considered further in Volume 2, Chapter 5: Ornithology. Also included in Appendix B are density maps for each species where data was sufficient and abundance maps for those species which had too few records to apply a Distance adjustment.

1.2.7 Appendix C provides detailed results of population estimates and collision modelling carried out using baseline data, and Appendix D presents the methods and results of the APEM migratory collision modelling for key seabird and non-seabird migratory species.

1.3 Hornsea Survey Area

1.3.1 A broad scale Zone Characterisation (ZoC) was commissioned by SMart Wind across the Hornsea Survey Area. From the ZoC study, the ornithological survey area areas for Project One were defined as:

- Hornsea Subzone 1 with a 4 km buffer; and
- The larger Hornsea Zone with a 10 km buffer.

1.3.2 A series of transects, two kilometres apart, running north to south across Subzone 1 and the 4 km buffer were surveyed by boat each month, and provide a robust study design to capture data on seabird numbers and distribution within, and in the vicinity of, Project One. This is presented in Figure 2.1.

1.3.3 Furthermore, a series of transects six kilometres apart, running north to south across the Hornsea Survey Area (including Subzone 1) were surveyed each month during boat-based surveys. This wider area is useful for providing a wider context for determining changes in distribution and abundance within and between years and increases the probability of capturing migratory movements for relatively rare species as well.

1.3.4 Species recorded within Subzone 1 or the 4 km buffer that are a designated feature of any SPA along the east coast of the UK from Hermaness (Shetland Islands) to Foreness Point (Kent), have also been considered.

1.4 Relevant Legislation

1.4.1 This section provides a brief introduction to the relevant international conventions, European directives and relevant UK legislation.

1.4.2 Within the European Union, the key legislative measures providing for the protection of birds are the Birds Directive, and Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive). In addition, the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention) may be relevant as Ramsar sites are generally protected in the UK through designations as SPAs and SSSIs.

1.4.3 Articles 2 and 3 of the Birds Directive aim to maintain the populations of all wild bird species across their natural range and encourage various activities, which promote this. Article 4 of the Birds Directive allows for the designation of SPAs for rare and vulnerable species listed in Annex I of the Birds Directive, as well as for regularly occurring migratory species, especially wetland species of international significance. The Birds Directive satisfies the commitments of the European Community under the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention).

1.4.4 SPAs designated under the Birds Directive (together with Special Areas of Conservation designated under the Habitats Directive) form part of the network of Natura 2000 sites.

1.4.5 The Habitats and Birds Directives have been transposed into UK legislation through the Conservation of Habitats and Species Regulations 2010 and the Offshore Marine Conservation (Natural Habitats, andc.) Regulations 2007 (together the 'Habitats Regulations'). These Regulations allow for the designation of SPAs and set out a mechanism for the protection of those sites.

1.4.6 The Wildlife and Countryside Act 1981 (as amended) implements the Birds Directive in the UK. The Act provides protection for wild birds by making it an offence to kill, injure, or take any wild bird or take, damage or destroy the nest or eggs of a wild bird, as well as disturb breeding birds listed on Schedule 1 of the Act. The Act also provides for the designation of Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR) in the UK.

1.5 Consultation with Key Stakeholders

1.5.1 The Joint Nature Conservation Committee (JNCC) was consulted in January 2010 regarding proposed survey and assessment methodologies and the boat-based survey methodology approach to analysis was then approved by JNCC. These methodologies are presented in Section 2 below. Comments with respect to the monitoring process were considered and are listed in Table 6.3 of the Preliminary Environmental Information Report (PEIR), Volume 2: Offshore (SMart Wind, 2012).

1.5.2 The Project One Scoping Report was submitted to the Infrastructure Planning Commission (IPC) in November 2010 (SMart Wind, 2010), with an addendum in 2012. Stakeholder views were captured in the Scoping Opinion response (IPC, 2010) and a second response in 2012 by the Planning Inspectorate (PINS, 2012).

1.5.3 The PEIR was submitted in June 2012 and provided a description and assessment of the ornithological interests recorded within the Hornsea Survey Area. A response was received from JNCC and Natural England, outlining specific ornithological issues to consider in any future submission, including this report where relevant.

1.5.4 Phase 4 responses were also provided by stakeholders to draft versions of the Environmental Statement chapter and this accompanying Technical Annex, published in January 2013. Please refer to the Consultation Report for a complete summary of the consultation undertaken.

1.5.5 A summary of consultation responses are presented in Table 1.1, where directly relevant to this Technical Annex. Other responses relevant to the ornithology impact assessment are presented in Section 5.4 of Environmental Statement Volume 2, Chapter 5: Ornithology.

Table 1.1 Consultation summary, where relevant to this Technical Annex.

Consultee	Consultation type	Date issue raised	Issues raised	Where addressed
JNCC and Natural England	Scoping opinion	12 January 2012	The frequency (monthly) and duration (24 months) of surveys seems satisfactory. The planned survey design (i.e., 2 km transect spacing within Subzone 1 and 6 km transect spacing across the rest of the Zone) also seems adequate.	Section 1, Methods
			If boat-based surveys exceed one day it will be very important to ensure that the possible movement of birds between successive survey days is somehow accounted for in data analyses and derivation of population estimates.	Appendix C, Population Estimates and Collision Rate Report
			Assessment of baseline data: Careful consideration needs to be given to the way in which the size of passage populations passing through the Zone and Subzone are estimated.	Appendix D, APEM migratory model
			We consider the assessment methodologies will provide a reasonably robust platform for the Environmental Impact Assessment (EIA) so long as they are followed and that all receptors are appropriately identified and assessed.	Section 1, Methods; Section 3, Baseline Characterisation, Section 4 Summary.
JNCC and Natural England	PEIR Response	12 September 2012	Assessment of non-seabird species is absent.	Appendix D, APEM migratory model
			The turnover of species from SPAs along migration corridors crossing the Hornsea Zone needs to be considered and potential collision risk assessed.	Appendix D, APEM migratory model
			Flight heights to be assessed within the context of the recent Strategic Ornithological Support Services (SOSS) review (Cook *et al*., 2012)	Appendix C, Population Estimates and Collision Rate Report
JNCC and Natural England	Meeting	3 October 2012	Discussion of proposed approach to migration study	Appendix D, APEM migration model
			Population modelling requirements	HRA Report: Information to Inform the Habitats Regulation Assessment for Project One, Annex K: Kittiwake PVA Report.
JNCC and Natural England	Phase 4 Consultation Response	13 March 2013	Clarify when correction factors were used, and why they were not when raw counts are presented.	Section 2, Methods and Table A.10 of Technical Annex 5.5.1.
			Recommend taking lesser black-backed gull and herring gull forward for impact assessment.	Section 4, Summary (Table 4.1)
			It is likely that Natural England will propose re-classification of the Flamborough Head and Bempton Cliffs SPA in the near future. These potential changes should be reflected in the assessment of impacts on the SPA (population data for key species provided);	Section 3.5 Designated Sites
			Recommend that final ES should contain an Appendix setting out how APEM migration model operates.	Appendix D, APEM migratory model
RSPB	Phase 4 Consultation Response	4 April 2013	Seabird Species Account of Technical Report, recommend adding 95% confidence intervals to graphs depicting temporal variation in distance-adjusted counts, also indicate where data results from incomplete surveys.	Appendix C, Population Estimates and Collision Rate Report

2 METHODS

2.1 Boat Based Surveys

2.1.1 Boat-based surveys of seabirds across the Hornsea Zone and Subzone 1 survey areas took place over a two year period. Surveys commenced in March 2010 and were completed in February 2012.

2.1.2 The methods used for the baseline seabird surveys followed standard COWRIE approved survey methodology (Camphuysen *et al*., 2004). Seabirds were recorded using an adaptation of the standard JNCC Seabirds at Sea survey method, which uses line transect methodology (see Webb and Durinck, 1992 for further details).

2.1.3 The Hornsea Survey Area for seabird surveys comprises two components – Subzone 1 plus a 4 km buffer and the surrounding Hornsea Zone plus a 10 km buffer. For Subzone 1 plus a 4 km buffer, a series of transects at 2 km spacing running north to south were surveyed each month. For the Hornsea Zone plus a 10 km buffer, a series of transects at 6 km spacing running north to south across the zone were surveyed each month (Figure 2.1).

2.1.4 Birds were counted ahead and to one side of the survey vessel in a 90º arc, with a 300 m transect width, using two surveyors, as per Camphuysen *et al*. (2004). Three European Seabirds at Sea ESAS accredited surveyors were on board for all surveys, where possible, except for five days in Year 1 and seven days in Year 2 when only two ESAS accredited surveyors were available for logistical reasons. At any one time, one surveyor was acting as the primary observer, with a second acting as scribe and secondary observer, while the third surveyor was on a break. When only two surveyors were on board, regular breaks were taken to reduce surveyor fatigue.

2.1.5 Binoculars were used to confirm identifications as well as to scan ahead for species which are easily disturbed and take flight at some distance from the approaching vessel. Birds on the water were assigned to distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201–300 m, E = >300 m), according to their perpendicular distance from the survey vessel's track. A snapshot method was used for flying birds, which takes the survey vessel's speed into account and prevents overestimation of seabird densities. In addition, the estimated height of flying birds was also recorded, to the nearest 5 m. The count interval for snapshots was one minute, and synchronised GPS recorders were used to record the vessel position every minute. All terrestrial bird species as well as rare bird species seen on the 'non-survey' side of the vessel were also recorded.

2.1.6 Environmental conditions such as wind direction and force, Sea State, swell height and visibility were recorded every 15 minutes throughout survey days. Surveys were carried out in good weather, where possible, to maximise detection rates of birds on the water. Surveys were halted if Sea State exceeded Sea State 4, as recommended in Camphuysen *et al*. (2004).

2.1.7 Surveys were conducted on the M.V. Southern Star, which has two custom-built surveyor platforms with an eye-height of greater than 5 m, as recommended for ESAS surveys (Webb and Durinck, 1992, Camphuysen *et al*., 2004). In Years 1 and 2, surveys were conducted by Ciarán Cronin, Ailsa Reid, Adam Batty, Stuart Thomas, Micky Maher, Tim Sykes, Mikey Bailey, Sean Minns John Clarkson and Peter Dodds.

Monthly Survey Effort and Survey Conditions

2.1.8 In Year 1, surveys were conducted over 110 days between March 2010 and February 2011, with a total of 15,268 km surveyed. In Year 2, surveys were conducted over 138 days between March 2011 and February 2012, with a total of 18,949 km surveyed (see Table 2.1).

Table 2.1 Survey effort for the Hornsea Survey Areas in Years 1 and 2.

Month	Subzone 1 and 4 km buffer km travelled		Proportion target coverage (%)		Hornsea Zone and 10 km buffer km travelled		Proportion target coverage (%)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
March	540.3	636.0	100%	100%	812.9	1,364.7	100%	100%
April	537.6	576.4	100%	100%	816.3	1,451.1	100%	100%
May	537.8	576.1	100%	100%	819.1	1,446.6	100%	100%
June	542.8	574.9	100%	100%	818.9	1,861.1	100%	85.2%
July	544.0	578.0	100%	100%	823.5	1,945.1	100%	96.6%
August	544.5	576.4	100%	100%	829.9	1,993.3	100%	100%
September[1]	936.1	428.4	100%	100%	881.2	0	100%	0%
October	542.2	429.6	100%	100%	821.4	0	100%	0%
November	531.4	432.3	100%	100%	569.5	292.6	72.1%	22.8%
December	548.3	78.2	100%	20%	646.8	0	80.8%	0%
January	400.6	440.9	100%	100%	619.9	0	63.3%	0%
February	395.0	436.9	100%	100%	208.2	0	16.8%	0%

[1] Subzone 1 was surveyed twice in September of Year 1, hence the higher coverage figure.

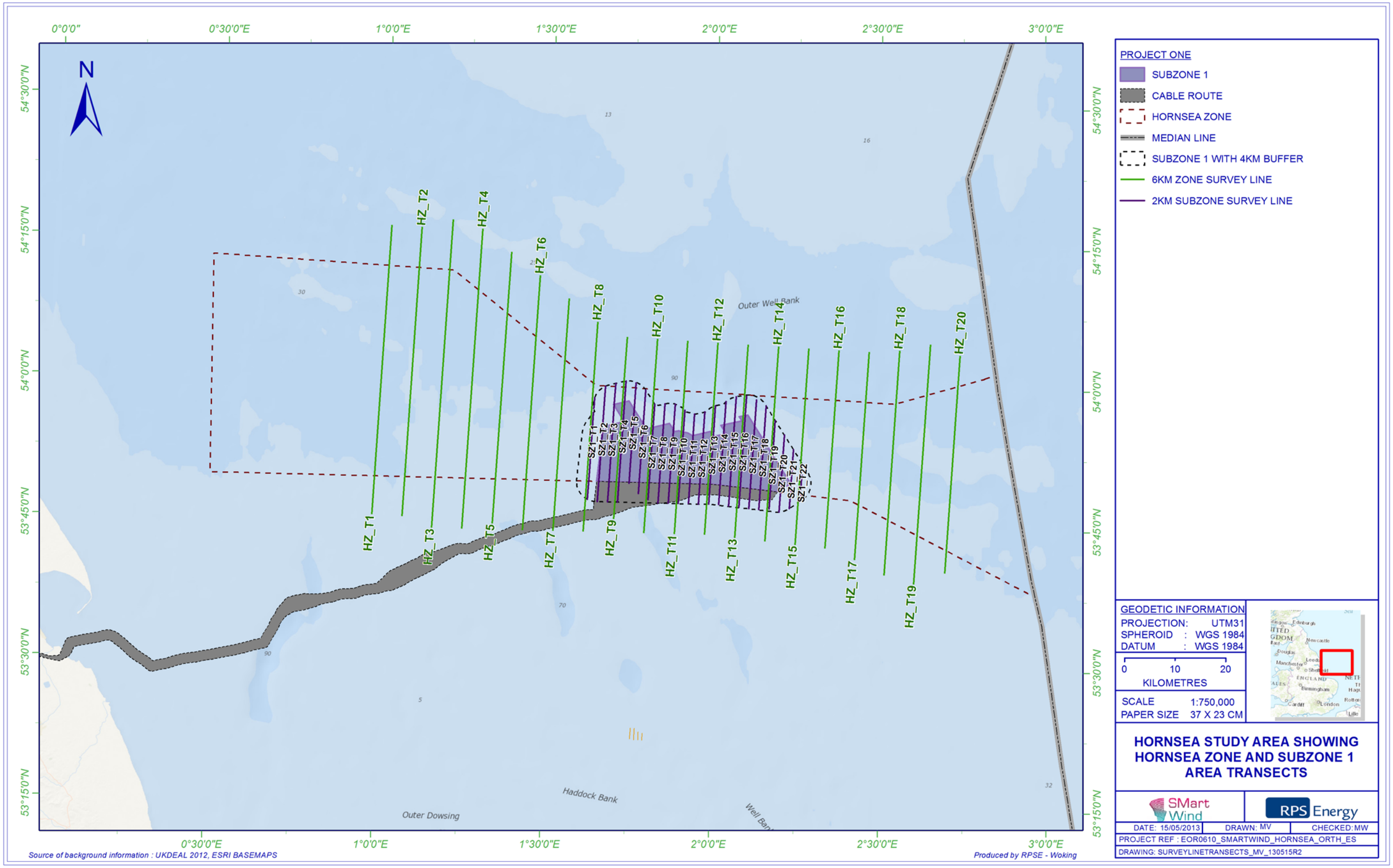


Figure 2.1 Hornsea ornithology study area showing Hornsea Zone and Subzone 1 transects.

2.1.9 Complete survey coverage of Subzone 1 (and 4 km buffer) was achieved in all months, except for December of Year 2, when only 20% of coverage was completed, due to poor weather conditions and short day length.

2.1.10 In the Hornsea Zone (and 10 km buffer), complete survey coverage was achieved between March and October of Year 1, with incomplete coverage between November and February, due to poor weather conditions and short day length.

2.1.11 In Year 2, complete coverage of the Hornsea Zone (and 10 km buffer) was achieved between March and May and in August, with coverage in June and July nearly complete. The Hornsea Survey Area was extended in June of Year 2 to include six previously unsurveyed transects in the west of the Hornsea Zone and two previously unsurveyed transects in the east of the Hornsea Zone.

2.1.12 There was no coverage in the Hornsea Zone in September due to the survey vessel being utilised for marine mammal surveys during installation of the Met Mast. Survey coverage was low or lacking between October and February of Year 2 due to surveys in the Project Two Subzone taking precedence over surveys in the Hornsea Zone, as well as poor weather conditions and short day length. Raw numbers from Project Two Subzone surveys were included as Hornsea Zone data for these months to give some comparability with Year 1 data, and in general it is considered that any incomplete surveys are unlikely to significantly affect the impact assessment in the Environmental Statement (Volume 2, Chapter 5: Ornithology), as they are there to primarily provide contextual information. Survey effort is summarised in Table 2.2.

2.1.13 To improve data quality, Camphuysen *et al.* (2004) recommend that seabird data collected in Sea States greater than 4 are not used in subsequent analyses. Consequently, surveys were normally suspended when Sea State increased above 4. Figure 2.2 and Figure 2.3 summarise the percentage of survey effort conducted in Sea States 0 to 5, during Years 1 and 2.

2.1.14 In Year 1, the majority of all data (99.9%) were collected in Sea States 0 to 4, with only 0.1% conducted in Sea State 5. In Year 2, 99.9% of all data were again collected in Sea States 0 to 4, with only 0.1% conducted in Sea State 5. These data were excluded from further analyses.

2.1.15 A summary table of monthly survey effort in Years 1 and 2 are included in Table A.1.

Table 2.2 Breakdown of survey effort for the Hornsea Zone and 10 km buffer in Year 2.

Month	Regular Hornsea Zone and 10 km buffer transect km travelled	Additional km travelled in Project Two Subzone	Total km travelled
March	1,364.7	0	1,364.7
April	1,451.1	0	1,451.1
May	1,446.6	0	1,446.6
June	1,861.1	0	1,861.1
July	1,945.1	0	1,945.1
August	1,993.3	0	1,993.3
September	0	268.0	268.0
October	0	683.9	683.9
November	292.6	686.9	979.5
December	0	17.7	17.7
January	0	440.8	440.8
February	0	733.2	733.2

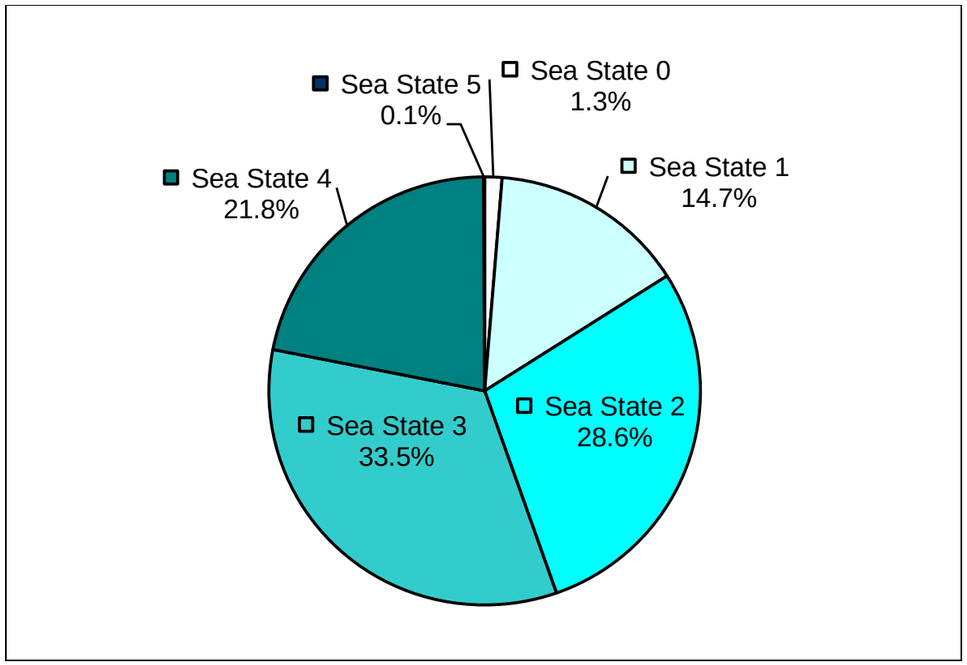


Figure 2.2 Survey effort in the Hornsea Survey Area in relation to Sea State during Year 1.

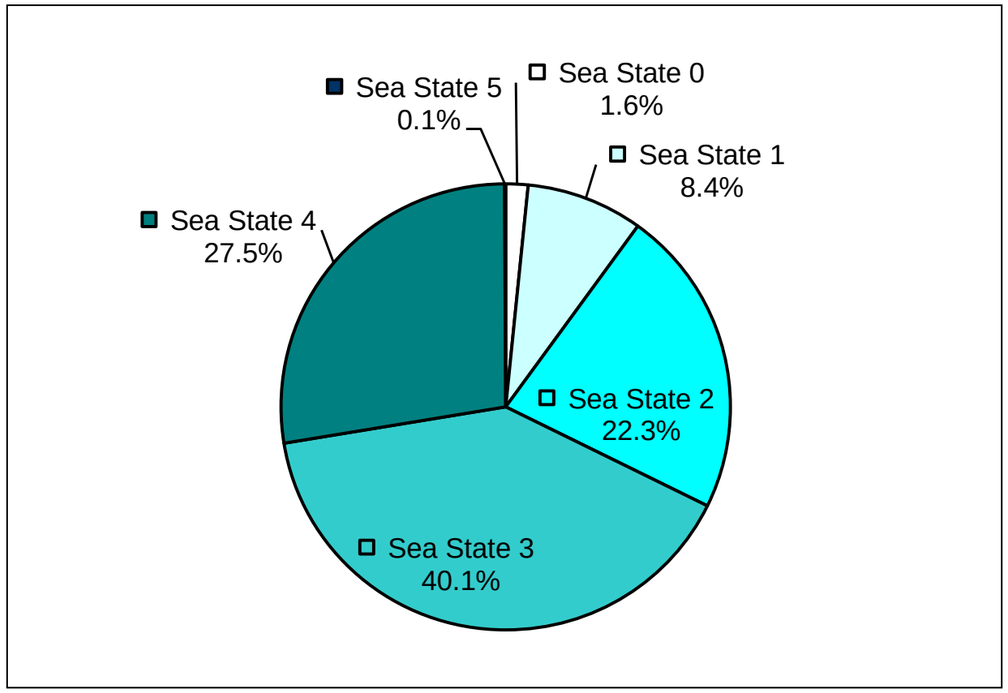


Figure 2.3 Survey effort in the Hornsea Survey Area in relation to Sea State during Year 2.

2.2 Data Processing

2.2.1 The original survey data were processed for the following analyses:

Distance-adjusted Population Estimates

2.2.2 The Distance-adjusted population estimate was derived by extrapolating bird density from the survey transect. Before the numbers were extrapolated, the raw counts were adjusted to account for the decline in detection probability with the increase in distance from the survey vessel, as explained in Appendix C. The Distance-adjusted counts were also used to inform the temporal graphs discussed in Section 3. For birds, only data recorded in Sea States less than 5 were used, as recommended by Camphuysen *et al.* (2004), with data assigned to a 2 km^2 grid for mapping purposes.

Spatial Distribution Mapping

2.2.3 Three types of maps (density, abundance and sightings) were compiled to depict individual species abundance and distribution (Appendix B). Density maps were produced for species which were recorded in sufficient numbers to allow Distance analysis to be undertaken (>60 observations). Abundance maps were produced for species that were less frequently recorded (<60 observations) where data were not sufficient for Distance analysis. For both density and abundance maps, monthly distribution maps were produced.

2.2.4 With regards to species where more than 60 observations were recorded in both Year 1 and Year 2, data are presented as a measure of mean density in each grid square, overlain with records of raw survey data. Due to low species occurrence in the Hornsea Survey Area, grebes, terns, and storm petrels were mapped by species group.

2.2.5 The coloured grid squares underlying the raw data points on these species-specific maps show the peak mean monthly density of species (no. of birds/km^2) in the different subsections of the Hornsea Survey Area. As per the density map analysis, only corrected totals of 'in transect' birds recorded in Sea States less than 5 were used. Monthly densities were calculated by dividing the corrected totals of 'in transect' birds by the total area surveyed in each area.

2.2.6 Unidentified species groups were allocated to the component species, based on the daily ratio for the date on which they were recorded. In this analysis of unidentified species data, unidentified large gull species, 'common/Arctic' terns and 'guillemot/razorbill' were reallocated in this way. Other species groups, such as unidentified black-backed gulls and auk species were disregarded as they comprised less than 2% of the total number of component species 'in transect'.

Temporal Variation and Abundance

2.2.7 Annual graphs were also included for frequently recorded species. These graphs show the temporal variation in both distance-adjusted species counts and species density throughout the two year survey period. This allows the evaluation of temporal trends in species abundance and distribution which may be relevant to determining the nature or magnitude of potential impacts from wind farm construction or operation.

2.2.8 Mean density graphs show the mean monthly density of species (no. of birds/km^2) in Subzone 1, Subzone 1 and 4 km buffer, and the Hornsea Zone and 10 km buffer, as shown in Figure 2.1. As per the density map analysis, only corrected totals of 'in transect' birds recorded in Sea States less than 5 were used. Monthly densities were calculated using the results from the Distance analysis.

2.3 Defining Population Importance and Sensitivity Levels

2.3.1 The significance of an impact on any particular species can be determined as a combination of the size and importance of the species' population affected, and the sensitivity of the species to that particular impact.

2.3.2 The importance of species present in the Subzone 1 (plus 4 km buffer area) was defined in relation to estimated international, national and regional populations through the use of the 1% threshold criterion. The qualification of any SPA species found within the survey areas and conservation status of each species as per the latest Birds of Conservation Concern classification (Eaton *et al*., 2009), and any national or international designated status (e.g., Annex I, Schedule 1) are also considered.

2.3.3 Threshold values for international populations were derived from figures provided by BirdLife International (2004), which represents the most up to date synthesis of international population data. The 1% criterion, whilst not necessarily of biological relevance, has been previously used as a standard for designating areas of conservation interest (Skov *et al*., 2007). National population thresholds were derived from the British Trust for Ornithology (BTO) BirdFacts online species database and national wintering thresholds were derived from the Wetland Bird Survey (WeBS) report (Holt *et al*., 2011). Appropriate numbers for both breeding and wintering populations were determined for each species from the most recent literature, taking into account seasonal patterns of movement (e.g., Kober *et al.* 2010).

2.3.4 Classification of the regional importance of breeding populations observed on site (i.e., if the population exceeded 1% of the regional population) was based on estimates of regular foraging range (e.g., Thaxter *et al*., 2012) and information provided by Natural England and JNCC in their Phase 4 response letter on the latest populations of the Flamborough Head and Bempton Cliffs population, as well as data presented from the Seabird 2000 census in Mitchell *et al.* (2004), the subsequent JNCC Seabird Monitoring Programme (SMP), or site-specific data where available (e.g. tagging studies as part of the Future of the Atlantic Marine Environment (FAME) project [www.fameproject.eu]). For non-breeding species present in winter, or on passage the relevant regional population was considered to be the British east coast population between Hermaness, Shetland, and Kent, as agreed during consultation with JNCC and Natural England.

2.3.5 Species were assigned sensitivity levels based on the evaluation of ornithological effects of offshore wind farms by Langston (2010). A summary of these can be found in Table 3.3. This evaluation used the criteria described above, in addition to analysing the behavioural ecology of the species and synthesising current field research on the vulnerability of these species to specific impact types, and has been used to help inform which species found during baseline surveys are taken forward for impact assessment in the Environmental Statement (Volume 2, Chapter 5: Ornithology) as Valued Ornithological Receptors (VORs).

3 BASELINE CHARACTERISATION

3.1 Seabirds in the Wider Southern North Sea

3.1.1 Extensive ornithological surveys (e.g., Carter *et al*., 1993; Stone *et al*., 1995), reviews (e.g., Stienen *et al*., 2007) as well as results from previous Round 1 and 2 offshore wind farm Environmental Statements and monitoring reports have shown that the southern North Sea, extending roughly between the Humber and the Strait of Dover and incorporating the Hornsea Zone and Project One, is an important area for seabirds. This is particularly the case during passage and in winter months when British breeding birds are joined by birds that have migrated from continental Europe and Fennoscandia. Because of the mix of birds present it is probable that the Hornsea site is used at different times by birds (i) overwintering in the area; (ii) foraging from nearby breeding coastal colonies; and (iii) on post-breeding dispersal, migration and pre-breeding return.

3.1.2 As well as true pelagic seabirds (e.g., gannet, fulmars and auks), other species that spend part of their annual life cycle at sea (e.g., divers, gulls and seaducks) may also be present in particular months, with periodic numbers of non-seabird migrants also present (e.g., waterfowl, waders and passerines).

3.1.3 Stienen *et al*. (2007) demonstrated that the southern North Sea area is an important corridor for migration of some seabird species in particular. For instance, the great majority (40-100%) of the flyway population of great skua use the Strait of Dover to leave the North Sea, as well as 30-70% of the lesser black-backed gull population. Use of the Strait by widely distributed pelagic species, such as kittiwake, are difficult to accurately assess, but are estimated to be less than 3% of the total flyway population.

Seabird Distribution in Relation to the Marine Environment

3.1.4 Seabird distribution is the result of a combination of interacting factors. Prey distribution is thought to be more important than physical factors, although nest site availability and foraging ranges for each species are also limiting factors (see Stone *et al*., 1995 for review).

3.1.5 Physical processes such as wind and weather conditions may have a seasonal effect on seabird distribution, often indirectly through prey distribution. Water movements, temperature and salinity may also have an effect on accumulating prey.

3.1.6 Mixing of waters brings nutrients to the surface which encourages plankton growth, and attracts fish and seabirds. Fronts between water masses with different properties may also be highly productive for birds. Plume fronts exist at the outflow of many large rivers in the southern North Sea (Stone *et al*., 1995).

3.1.7 The 'Flamborough Front' which forms the boundary between the southern North Sea and mid North Sea (Figure 3.1) provides a rich food source for a large number and diversity of seabirds, although relatively little is currently known of the spatial and temporal distribution of seabirds across this area (Jones *et al.,* 2004). In addition to the Flamborough Front, several temporary fronts of seasonal importance occur throughout the southern North Sea.

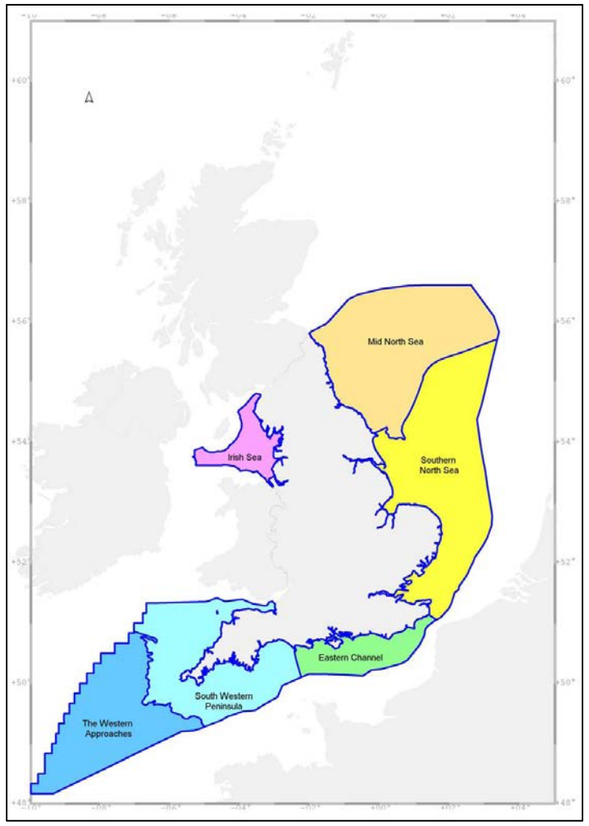


Figure 3.1 Marine natural areas around England, as identified by Jones *et al.* (2004).

3.1.8 Upwellings are common at shelf breaks and are often characterised by higher bird densities. The southern North Sea has two major sandbank systems which provide conditions for fish to spawn; the Dogger Bank in the north and the Brown Ridge located off the Norfolk coastline. Both are probably of great importance to feeding birds (Jones *et al*., 2004). These sandbanks also cause tidal upwellings, which concentrate zooplankton and hence the fish that prey upon them. Auks have been found to remain mostly within coastal shelf waters, while fulmars are commonest at the outer shelf, shelf edge and deep waters (Stone *et al.,* 1995).

Bathymetry and Sea Conditions

3.1.9 The North Sea is mainly shallow (<100 m), particularly in the southern part where depths rarely exceed 50 m. These shallow areas are characterised by sand substrates or sand and gravel mixtures. The sandy conditions provide an ideal habitat (for species such as sandeels, which are an important dietary component for many seabirds.

3.1.10 In winter, surface waters are warmer offshore than inshore and warm water masses enter the English Channel from the southwest, and pass into the southern North Sea. In summer, surface temperature increases in shallow coastal waters. Surface salinity is lower nearer the coasts than further offshore, and the southern North Sea is characterised by low salinity water along continental coasts.

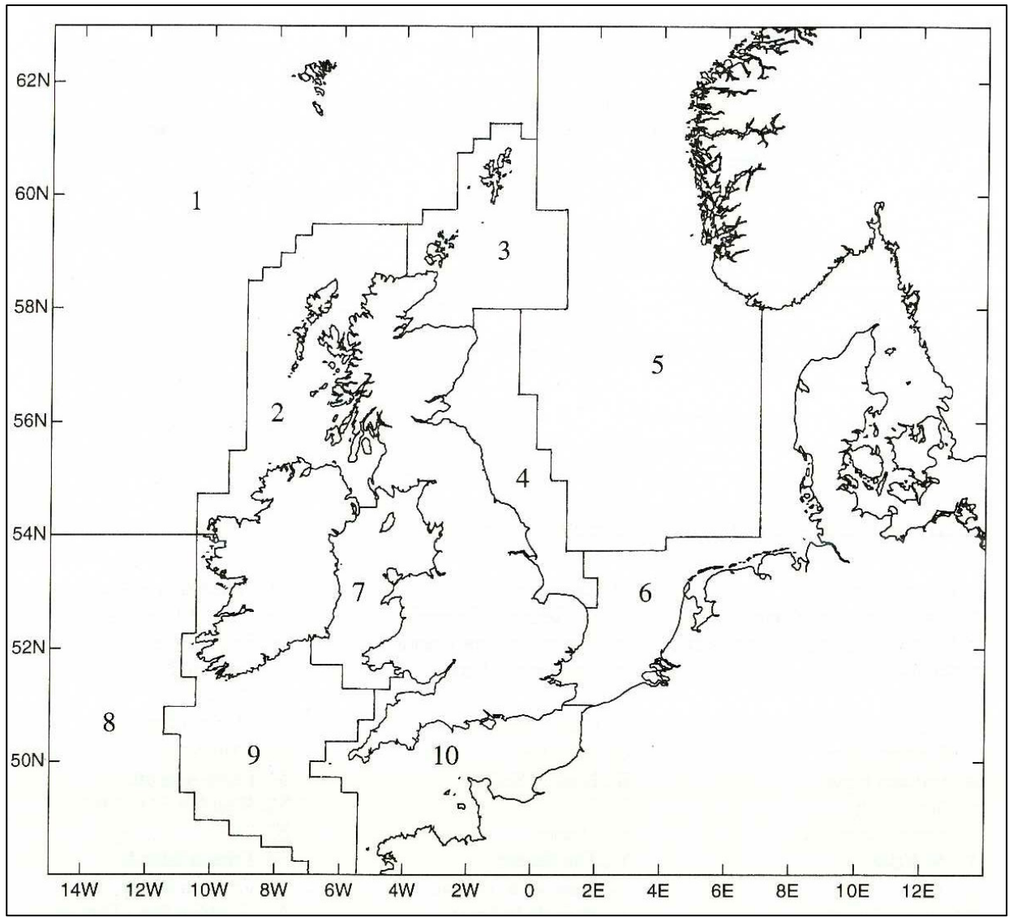
Hornsea Zone

3.1.11 Based on divisions according to geographic, hydrographic and physical differences within the North Sea in Stone *et al*. (1995, Figure 3.2), the Hornsea Zone potentially falls within three sectors; (i) the Western North Sea sector, which stretches along a relatively coastal strip from northeast Scotland to the Greater Wash; (ii) the Central and Northern North Sea sector which is mainly marine in nature, although encompasses the western coastline of Norway; and (iii) the South and East North Sea sector, which reaches from Kent, across the English Channel and northwards to Norfolk, and includes much of coastal Netherlands, Belgium and Denmark, including the Kattegat, Wadden Sea and German Bight.

3.1.12 The division of the North Sea into a number of sectors by Stone *et al*. (1995) allows comparisons of relative importance of the Hornsea site to each species population found within the Hornsea Zone survey areas, in relation to the wider area. The meeting of these three sectors where Hornsea Zone is located means that the differing characteristics of each may play a role in influencing seabird abundance and distribution within the site.

3.1.13 The Western North Sea sector contains breeding colonies such as Flamborough Head and the Farne Islands and was characterised by Stone *et al.* (1995) as being important for auks throughout the year. The area was also used in winter by gulls and eider during winter, with gulls and terns abundant in summer. Skuas, among other species, pass through the area on autumn passage.

3.1.14 The Central and North Sea sector was characterised as being important for guillemots, although less so during the breeding season when birds are constrained to coastal colonies. Fulmars, gannets and kittiwakes were also found throughout the year, with other gulls more widespread during winter. Depth in this sector is mostly shallow, with the exception of the Rinne off the coast of Norway.



1 North-west oceanic	6 Southern & eastern North Sea
2 North-west shelf	7 Irish Sea
3 Shetland, Orkney & Moray Firth	8 South-west oceanic
4 Western North Sea	9 Celtic Sea
5 Central & northern North Sea	10 English & Bristol Channels

Figure 3.2 Areas for analysis of seabird distribution in Stone *et al.* (1995).

3.1.15 The South and East North Sea sector is characterised as being a shallow area of low salinity which forms a distinct zone of distribution for many species. During winter, it was recorded by Stone *et al*. (1995) as being the most important area in north-west European waters for divers, grebes and seaduck. Gulls are common throughout the year, with common gulls and great black-backed gulls most abundant in winter, lesser black-backed gulls in summer, and herring gulls throughout the year. Little gulls are abundant during migration peaks. The area is also important for terns in summer and in winter for auks.

3.1.16 As a reflection of this mixture of habitat types, the area is likely to include a bird assemblage comprising of a mixture of 'true' seabirds, some species which spend part of their annual life cycle at sea (e.g., divers and seaduck), some species associated with the shallow sea area of the Greater Wash, and a wide range of other species on migration both to and from the UK and continental Europe, such as waterfowl, waders and passerines.

Dogger Bank

3.1.17 The Dogger Bank covers an area of approximately 17,600 km^2 in the centre of the North Sea, some 100 km from the coast of England, and close to the eastern boundary of the Hornsea Survey Area. It continues north-eastwards across the Dutch sector and into the German sector of the North Sea. The majority of the area lies in shallow waters, rising to less than 20 m depth (Diesing *et al*., 2009).

3.1.18 The Dogger Bank is important in terms of commercial fisheries for both groundfish species and sandeels (Ammodytes spp.). It has also been identified as a region of high annual phytoplankton production.

3.1.19 Sandeels are a significant prey resource for seabirds such as auks and kittiwake. The distribution of sandeels within the North Sea is highly localised and they are abundant in the Dogger Bank region, concentrated along the edges in water depths of around 20-30 m, where fronts meet.

3.1.20 Predatory fish species present on the Dogger Bank include whiting *Merlangius merlangus,* plaice *Pleuronectes platessa*, mackerel *Scomber scombrus* and cod *Gadus morhua*, with dab *Limanda limanda* and grey gurnard *Eutrigla gurnardus* being particularly abundant.

3.1.21 Hotspots of seabird concentrations within the extent of British Fishery Limits were identified by JNCC in order to identify potential marine SPAs, based on the top 1% qualifying numbers and regularity of occurrence (Kober *et al*., 2010). Four regions were identified as particularly important, as they had a large number of repeatedly occurring qualifying areas. All are located in Scotland, with the closest to Hornsea being the outer Firth of Forth for gannet, kittiwake, guillemot and puffin.

3.1.22 A number of 'near-qualifying' areas (top 5% numbers and regularity) were identified, including Dogger Bank, which is important for guillemot in winter (as reported by Skov *et al*., 1995). Kober *et al*. (2010) reported an estimated 35,869 individuals within the area. Little gull (passage, 98 individuals) and little auk (winter, 3,950 individuals) were also identified as having qualifying numbers only in this area, as was a general seabird assemblage (breeding, summer, winter). Of these, little gull is particularly important since it is one of the species hardly covered by other areas.

3.1.23 As part of the baseline work undertaken for the wider Dogger Bank Zone for the Strategic Environmental Assessment, boat-based surveys undertaken by DECC between March and September 2008 recorded a range of common pelagic seabird species (DECC, 2009). Guillemot and razorbill were recorded within the study areas at significant densities of up to approximately 50 and 20 birds per km^2 respectively during the March surveys. Five further species were considered to occur at moderate densities within the Zone over the course of the surveys, namely fulmar, gannet, herring gull, great black-backed gull and kittiwake.

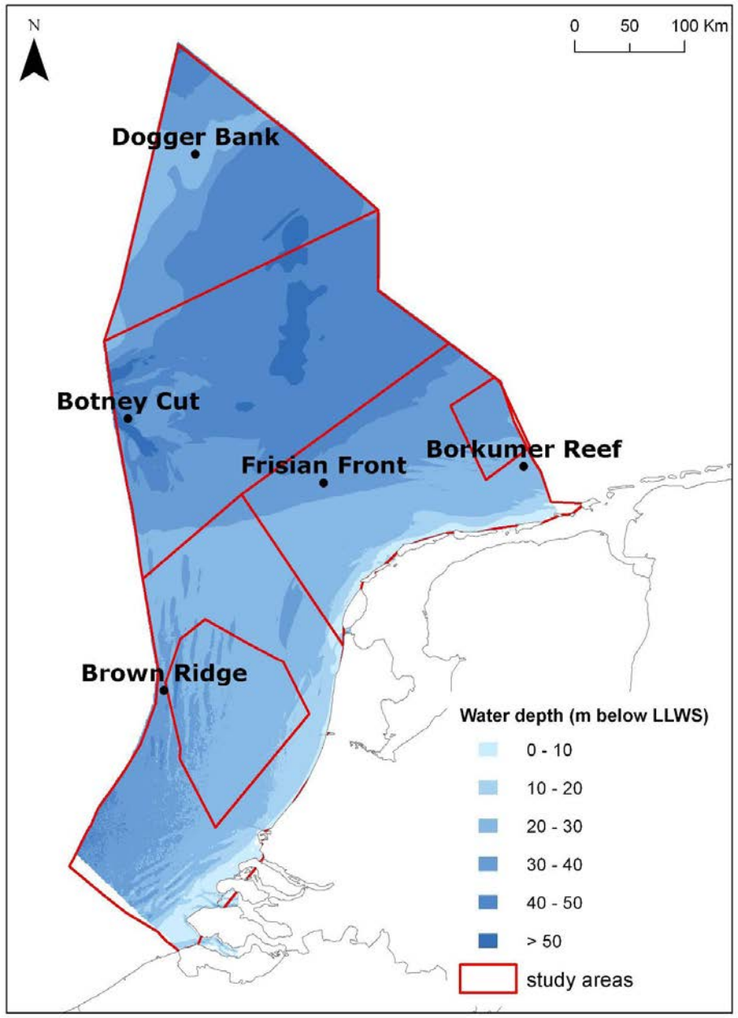


Figure 3.3 Map of the Dutch continental shelf showing location of important bird areas (from Geelhoed *et al.* 2011).

3.1.24 Aerial surveys for The Crown Estate by visual transect and HiDef between May 2009 and April 2010 recorded similar species, although in somewhat lower numbers (The Crown Estate, 2010). The relative abundance of species of auk (guillemot and razorbill) was found to be highest in the winter months (>15 birds per km^2), with auks recorded as being widespread across the study area.

3.1.25 Monthly boat-based surveys have been undertaken within the Dogger Bank offshore wind farm zone (as identified by Strategic Environmental Assessment (DECC, 2009) since January 2010 as part of the Dogger Bank Project One Offshore Wind Farm baseline studies (Forewind, 2010). During the reported six months of data, guillemot were recorded in the greatest densities (up to 2.5 per km^2 during March), with feeding being the most common behaviour (Gardline, 2010). Counts of kittiwake, northern fulmar, gannet and razorbill were also higher (i.e., more than 1.0 per km^2), relative to other species such as great skua, the gulls, little auk and puffin.

Frisian Front

3.1.26 The Important Bird Area (IBA) programme of BirdLife International has aimed to identify, document and conserve sites that are key for the long-term viability of bird populations. BirdLife International has implemented a network of terrestrial IBAs which has formed a scientific reference for the designation of SPAs. It is currently compiling seabird information available in Europe to enlarge the IBA network into the Marine Environment. In the UK, the closest marine IBA identified is The Wash, which is already afforded SPA protection. No other sites are located along the east coast.

3.1.27 The Frisian Front IBA and proposed SPA site lies closest to the Hornsea Survey Area and occupies an area in Dutch waters of approximately 2,880 km^2. According to Noordzee Natura 2000, it has been recommended by the Netherlands as an SPA for great skua, great black-backed gull, guillemot and lesser black-backed gull. In the late summer and autumn the great skua satisfies the standard that 1% of the total European population resides at the site. The guillemot population satisfies the criterion that regularly more than 20,000 individuals reside at the site.

Brown Ridge

3.1.28 Apart from Natura 2000 areas, the Brown Ridge has been identified as an area of sensitivity by Noordzee Natura 2000. The sand bank lies almost entirely on the Dutch part of the North Sea and is located roughly halfway between the Dutch and English coast. It is an important wintering area for several bird species and high concentrations of guillemots and razorbills in winter, which have migrated from Scotland with their young. These concentrations can exceed the 1% limit of the greater population or 20,000 individuals. Also in winter high concentrations of great black-backed gull, great skua and European herring gull, albeit below the 1% threshold of the population or a number of >20,000 individuals (which are the criteria commonly used for the European Bird Directive assessments).

3.2 Raw Counts of Seabirds in the Hornsea Survey Area in Years 1 and 2

3.2.1 A total of 37 seabird species were identified on Subzone and Zone surveys in the Hornsea Survey Area in Year 1 (March 2010 to February 2011). This compares to 38 species recorded during the Year 2 surveys (March 2011 to February 2012). The full data are presented in Table 3.1.

3.2.2 Within Subzone 1 and 4 km buffer, 31 species were recorded in Year 1, with guillemot, kittiwake and razorbill the three most frequently encountered species. These three species plus unidentified guillemot/razorbills together accounted for 78.3% of all birds recorded in Subzone 1 and 4 km buffer in Year 1. In Year 2, a total of 32 species were recorded, with guillemot, kittiwake and razorbill the three most frequently encountered species. These three species plus unidentified guillemot/razorbills accounted for 74.5% of all birds recorded in Subzone 1 and 4 km buffer in Year 2.

3.2.3 In Year 1, 33 species were recorded in the Hornsea Zone and 10 km buffer, and guillemot, kittiwake and razorbill were again the three most frequently encountered species. These three species plus unidentified guillemot/razorbills accounted for 73.1% of all birds recorded. In Year 2, 36 species were recorded in the Hornsea Zone and 10 km buffer, and guillemot, kittiwake and razorbill were again the three most frequently encountered species. These three species plus unidentified guillemot/razorbills accounted for 75.6% of all birds recorded.

3.2.4 Summary tables showing species totals for individual months in Years 1 and 2 are included in Table A.2, Table A.3, Table A.4 and Table A.5.

Table 3.1 Comparison of seabird numbers recorded on surveys in Subzone 1 and the Hornsea Zone in Years 1 and 2 (raw numbers, all Sea States).

Species	Year 1			Year 2		
	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total
Red-throated diver	6	15	21	13	29	42
Black-throated diver	3	1	4	6	3	9
Unidentified divers	4	5	9	4	2	6
Great crested grebe	1	0	1	0	1	1
Slavonian grebe	0	0	0	0	1	1
Red-necked grebe	0	1	1	0	0	0
Black-necked grebe	1	0	1	0	0	0
Fulmar	1,910	4,698	6,608	2,806	5,494	8,300
Sooty shearwater	129	65	194	4	7	11
Manx shearwater	27	68	95	17	72	89
Balearic shearwater	0	1	1	2	2	4
Cory's/great shearwater	0	0	0	0	1	1
Storm petrel	5	7	12	5	12	17
Leach's petrel	0	2	2	0	3	3
Unidentified storm-petrels	0	1	1	0	0	0
Gannet	2,609	4,404	7,013	2,175	9,302	11,477
Cormorant	1	1	2	2	7	9
Shag	0	2	2	1	2	3
Eider	0	2	2	5	2	7
Common scoter	80	49	129	186	104	290
Unidentified scoter species	0	0	0	0	4	4
Goldeneye	0	0	0	0	1	1
Red-breasted merganser	0	0	0	2	0	2
Grey phalarope	2	6	8	16	13	29
Unidentified phalarope species	0	0	0	0	1	1
Pomarine skua	11	22	33	3	14	17
Arctic skua	49	28	77	31	56	87
Long-tailed skua	2	0	2	0	1	1
Great skua	29	27	56	44	91	135

Species	Year 1			Year 2		
	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total
Unidentified skuas	1	3	4	1	6	7
Little gull	3,396	1,407	4,803	146	88	234
Sabine's gull	1	1	2	0	0	0
Black-headed gull	13	83	96	148	184	332
Common gull	95	207	302	142	422	564
Unidentified small gulls	106	1	107	26	70	96
Lesser black-backed gull	509	790	1,299	435	907	1,342
Herring gull	215	375	590	122	440	562
Yellow-legged gull	0	0	0	0	1	1
Great black-backed gull	824	2,323	3,147	1,115	2,567	3,682
Unidentified large gulls	1,372	2,818	4,190	471	2,036	2,507
Unidentified gulls	0	67	67	0	350	350
Kittiwake	12,153	16,665	28,818	10,271	31,625	41,896
Sandwich tern	1	0	1	5	1	6
Common tern	750	654	1,404	292	2,148	2,440
Arctic tern	96	141	237	122	416	538
Common/Arctic tern	1,067	560	1,627	2,236	3,695	5,931
Little tern	0	3	3	0	0	0
Black tern	0	0	0	1	0	1
Guillemot	22,277	24,126	46,403	11,611	36,021	47,632
Razorbill	7,479	7,958	15,437	5,326	13,554	18,880
Little auk	125	341	466	19	126	145
Puffin	1,188	1,307	2,495	1,120	3,613	4,733
Guillemot/razorbill	11,969	8,332	20,301	7,366	20,308	27,674
Unidentified auks	280	549	829	111	432	543
Total numbers	**68,786**	**78,116**	**146,902**	**46,408**	**134,244**	**180,652**

3.3 Flight Height of Birds

3.3.1 Information on the flight height of birds within the whole Hornsea Survey Area between March 2010 and February 2012 (Years 1 and 2) is summarised in Table 3.2. Although the information used to determine collision risk has been compiled with that within Subzone 1 (see Appendix C, Population Estimates and Collision Rate Report), the larger Hornsea Survey Area results are presented here in order to be able to more accurately determine flight height distribution for rarer species, by increasing sample size available, as well as providing comparisons with Subzone 1 results. Note that for the impact assessment, Subzone 1 datasets were deemed of sufficient size for most key species to be able to use in collision modelling.

3.3.2 Species where 20 or fewer individuals have been recorded in flight are excluded from this table, but are presented in the individual species accounts. Monthly flight height breakdowns for key species are included in Appendix A (Table A.8).

3.3.3 Flying birds were recorded in a number of height bands, starting at 0 – 2.5 m above sea level, and in increments of 5 m above this (SMart Wind 2011). Overall, 95.4% of all birds were recorded flying below 22.5 m in height, the nearest height band to the lower blade swept height of 22 m above sea level. For seabirds such as fulmar, auks and shearwaters, all (or almost all) birds were recorded flying below 22.5 m in height, and most frequently within the lowest height bands, and therefore it can be confidently predicted that the risk of collision mortality is likely to be negligible since very few records were within the height bands close to minimum rotor height. For other species such as gulls, more flights may be within the flight bands that straddle minimum rotor height, and although this may lead to incorrect inclusion or exclusion of some flights from being considered at risk, it is considered that any inaccuracies in judgement either way would effectively be evened out during the whole survey period.

3.3.4 For other seabirds a greater proportion of birds were recorded flying above 22.5 m, for example 8.1% of gannets, 9.5% of Pomarine skuas, 12.6% of great skua, 18.6% of lesser black-backed gulls, 26.2% of herring gulls and 28% of great black backed gulls.

3.3.5 The majority of wildfowl, waders and land birds recorded in flight on baseline surveys were flying below 22.5 m in height. However, for some other species a higher proportion were recorded flying above 22.5 m, such as 100% of pink-footed geese, 95.3% of lapwings, 48.3% of bar-tailed godwits, 55.1% of whimbrel, and 74.4% of redwings, although the sample size for these species was generally small and so may be unrepresentative of normal behaviour of this species, which is likely to be at high altitude at night, and therefore missed by diurnal boat-based surveys.

Table 3.2 Flight heights of birds in the Hornsea Survey Area in Years 1 and 2.

Species	Total in flight	No. at 0 – 22.5 m	No at. > 22.5 m	% above 22.5 m
Red-throated diver	41	41	0	0
Fulmar	9,048	9,045	3	<0.1
Sooty shearwater	100	100	0	0
Manx shearwater	115	114	1	0.9
Gannet	13,034	11,977	1,057	8.1
Pink-footed goose	24	0	24	100
Teal	38	38	0	0
Common scoter	413	409	4	1.0
Unidentified ducks	30	28	2	6.7
Oystercatcher	23	23	0	0
Golden plover	148	148	0	0
Lapwing	148	7	141	95.3
Knot	21	21	0	0
Dunlin	41	41	0	0
Bar-tailed godwit	29	15	14	48.3
Whimbrel	49	22	27	55.1
Pomarine skua	42	38	4	9.5
Arctic skua	127	126	1	0.8
Great skua	151	132	19	12.6
Little gull	3,522	3,484	38	1.1
Black-headed gull	388	387	1	0.3
Common gull	741	691	50	6.7
Small gull species	111	110	1	0.9
Lesser black-backed gull	1,960	1,596	364	18.6
Herring gull	940	667	273	26.2
Great black-backed gull	4,906	3,532	1,374	28
Unidentified large gulls	2,564	2,262	302	11.8
Unidentified gulls	56	56	0	0
Kittiwake	37,325	36,283	1042	2.8
Common tern	3,410	3,361	49	1.4
Arctic tern	634	634	0	0
Common/Arctic tern	6,116	5,950	166	2.7
Guillemot	9,701	9,699	2	<0.1

Species	Total in flight	No. at 0 – 22.5 m	No at. > 22.5 m	% above 22.5 m
Razorbill	4,913	4,913	0	0
Guillemot/razorbill	3,185	3,185	0	0
Little auk	256	256	0	0
Puffin	419	419	0	0
Unidentified auks	148	148	0	0
Swift	25	24	1	4
Skylark	23	23	0	0
Swallow	49	49	0	0
Meadow pipit	71	68	3	4.2
Blackbird	35	29	6	17.1
Fieldfare	41	35	6	14.6
Song thrush	31	31	0	0
Redwing	285	73	212	74.4
Starling	807	778	29	3.6
TOTAL	**106,284**	**101,423**	**4,861**	**4.6**

3.4 Overview of Species Sensitivity

3.4.1 A theoretical assessment of species sensitivity to the potential impacts of wind farm construction and operation was carried out as described in Section 2 using values from literature to assign species to sensitivity bands. A summarised desk study of general sensitivity of these species by Langston (2010) appears in Table 3.3. The overall risk value is taken as the highest score across the table for each species. Species for which the UK has a high percentage of the population (e.g. Manx shearwater, gannet) score high risk of impact because of the potential consequences for the population.

3.4.2 Although these qualitative categories are not site-specific, these are used to provide context and inform later evaluations of species sensitivity.

3.4.3 A summary of the results and their implications for the final Environmental Statement is included in Section 4.

Table 3.3 Summary of seabird sensitivities to offshore wind farms (Langston, 2010).

Species [1]	Collision	Displacement	Barrier effects	Habitat/ prey interactions	Overall risk
Red-throated diver	Minor	High	Moderate	Moderate	High
Fulmar	Minor	Minor	Minor	Moderate	Minor
Sooty shearwater	Minor	Minor	Negligible	Negligible	?
Manx shearwater	Minor	Minor	Negligible	Moderate	High
Balearic shearwater	Minor	Minor	Negligible	Moderate	Moderate
Storm petrel	Minor	Minor	Negligible	Moderate	Moderate
Leach's petrel	Minor	Minor	Negligible	Moderate	Moderate
Gannet	Moderate	Minor	Minor	Minor	High
Cormorant	Moderate	Minor	Moderate	Moderate	Moderate
Shag	Minor	Moderate	Moderate	Moderate	Moderate
Eider	Minor	Minor	Moderate	Moderate	Moderate
Common scoter	Minor	Moderate	Moderate	Moderate	Moderate
Pomarine skua	Moderate	Minor	Minor	Minor	Moderate?
Long-tailed skua	Moderate	Minor	Minor	Minor	Moderate
Arctic skua	Moderate	Minor	Minor	Minor	Moderate
Great skua	Moderate	Minor	Minor	Minor	High
Little gull	Minor	Minor	Minor	Minor	?
Black-headed gull	Minor	Minor	Minor	Minor	Minor
Common gull	Minor	Minor	Minor	Minor	Moderate
Lesser black-backed gull	Moderate	Minor	Minor	Minor	High
Herring gull	Moderate	Minor	Minor	Minor	Moderate
Great black-backed gull	Moderate	Minor	Minor	Minor	Moderate
Kittiwake	Moderate	Minor	Minor	Minor	Minor

Species [1]	Collision	Displacement	Barrier effects	Habitat/ prey interactions	Overall risk
Common tern	Moderate	Minor	Minor	Moderate	Moderate
Arctic tern	Moderate	Minor	Minor	Moderate	Moderate
Guillemot	Minor	Moderate	Moderate	Moderate	Moderate
Razorbill	Minor	Moderate	Moderate	Moderate	Moderate
Little auk	Minor	Moderate	Moderate	Moderate	Moderate?
Puffin	Minor	Moderate	Moderate	Moderate	Moderate

[1] All sensitivity values are taken from Langston (2010). For some species, there is insufficient information to be able to confidently determine overall risk (indicated by question mark).

3.5 Designated Sites

3.5.1 Breeding seabirds are central-place foragers, with the nest or colony forming the central location. Foraging range varies widely between species, and is determined by environmental conditions, dietary needs, flight physiology and ability to transport food.

3.5.2 Mean maximum and maximum foraging ranges were used to check for potential connectivity between the Hornsea Survey Area and important colonies or designated sites. The mean maximum foraging range of a species is the average maximum length of the trip taken by individuals to obtain food, based on data obtained from relevant studies of that species (see Thaxter *et al.,* 2012 for example). A maximum foraging range encompasses the longest distance from home colony recorded for a given species. This is a useful tool for identifying colonies which may be using the Subzone 1 area as a feeding ground.

3.5.3 The distance between the Hornsea Zone and Subzone 1, and the relevant breeding colonies indicated that for the majority of species the development is beyond their mean maximum foraging ranges even from the nearest colony. However, the Hornsea Zone lies within the maximum foraging range of several species.

3.5.4 Table 3.4 shows SPAs with possible connectivity to the Hornsea Zone, and the listed species within foraging range (Thaxter *et al.,* 2012). This potential for connectivity is also used to inform the evaluation of species' importance.

Table 3.4 Qualifying SPA species within mean maximum foraging range of the Hornsea Zone (JNCC Seabird Monitoring Programme 2012).

SPA site	Distance to Hornsea Zone (km)	Distance to Subzone 1 (km)	Listed species	Cited SPA population (pairs)	Current estimated SPA population (pairs)
Flamborough Head and Bempton Cliffs*	36.4	117	Fulmar	-	1,447
			Gannet	1,631 [1]	9,947
			Kittiwake	83,370	44,520
			Guillemot	16,150	41,607
			Puffin	3,473	490
			Herring gull	1,110	711
			Razorbill	5,113	10,570
Firth of Forth Islands	295	363	Gannet	34,400	55,842
			Fulmar (assemblage only)	-	-
Fowlsheugh	368.7	407	Fulmar	1,170	193
Buchan Ness to Collieston Coast	410.1	437	Fulmar	1,765	1,765
Troup, Pennan and Lion Heads	462.6	494	Fulmar	4,400	1,795

** Counts at time of designation in 1993 were based on population levels from 1987. Current estimated SPA population from information provided by Natural England, based on a recent site boundary review. Figures include seabirds from the proposed extension at Filey Brigg, and are considered to be the most up-to-date population estimates available (2008-11, except for gannet where a survey was undertaken in 2012. The 2008-11 value for gannet was 8,469 pairs, but for the purposes of this EIA the estimated 2011 population was recommended for use by Natural England).*

[1] - Note gannet was not listed as a qualifying species at time of designation.

3.5.5 With the exception of fulmar and gannet there is, in effect, only one SPA colony potentially at risk of being affected by development in Subzone 1 during the breeding period, the Flamborough Head and Bempton Cliffs SPA. This SPA is designated for breeding kittiwake (and in the reviewed citation, also guillemot and razorbill) but also regularly supports over 300,000 individual seabirds including fulmar, herring gull, puffin and gannet. Subzone 1 is just over 120 km from the named SPA, and is therefore within the mean maximum foraging range of gannet, fulmar and kittiwake

and maximum foraging range of guillemot and puffin. The western edge of the Hornsea Zone sits much closer to the SPA, just over 35 km away, within the mean maximum foraging range of qualifying species. The data is presented in full in Table 3.5.

Table 3.5 SPA species within theoretical mean maximum or maximum foraging range of the Hornsea Zone and Subzone 1.

SPA site	Listed species	Mean max. foraging range (km)	Max. foraging range (km)	Subzone 1		Hornsea Zone	
				Within mean max. foraging range	Within max. foraging range	Within mean max. foraging range	Within max. foraging range
Flamborough Head and Bempton Cliffs	Gannet	229.4	590	Y	Y	Y	Y
	Fulmar	400	580	Y	Y	Y	Y
	Kittiwake	60	120	N	Y	Y	Y
	Guillemot	84.2	135	N	Y	Y	Y
	Puffin	105.4	200	N	Y	Y	Y
	Herring gull	61.1	92	N	N	Y	Y
	Razorbill	48.5	95	N	N	Y	Y
Troup, Pennan and Lion Heads	Fulmar	400	580	N	Y	N	Y
Buchan Ness to Collieston Coast	Fulmar	400	580	N	Y	N	Y
Fowlsheugh	Fulmar	400	580	N	Y	Y	Y
Firth of Forth Islands	Gannet	229.4	590	N	Y	N	Y
	Fulmar	400	580	Y	Y	Y	Y

3.5.6 During the non-breeding period, birds from colonies further afield may be present but it is not known how many individuals from each of the colonies will be affected by Project One. Details of how potential impacts are apportioned across colonies within the region are given in the supporting document report to inform the Habitat Regulations Assessment (see Supporting Documents: Information to inform HRA).

3.5.7 Of the species recorded on the Subzone 1 and Hornsea Zone survey areas, five were therefore identified as having potential connectivity, as SPAs for which they are qualifying features fall within the species' maximum foraging range from Subzone 1:

- Fulmar;
- Gannet;
- Kittiwake; and
- Guillemot and puffin.

3.6 Non-Seabird Species

3.6.1 The non-seabird species listed in Table 3.6 were recorded during the boat surveys undertaken within the Hornsea Survey Area in Years 1 and 2 and include off-effort sightings and birds found on board the vessel. A total of 1,017 birds of 55 species of non-seabird were recorded in the Hornsea Survey Area in Year 1. Starling was recorded in the highest numbers, with 487 birds seen in Year 1, accounting for 47.9% of all non-seabirds recorded. Golden plover was the second most frequently recorded species, with a total of 142 birds (14.0%) seen. Whimbrel and meadow pipit were both the next most frequently recorded species, with 41 birds of each species seen (4.0%), and teal was the fifth most frequently recorded species, with 37 birds recorded (3.6%). Overall, these five species accounted for 73.5% of all non-seabird species recorded in Year 1 (Table 3.6).

3.6.2 In Year 2, a total of 1,342 birds of 69 species of non-seabird were recorded in the Hornsea Survey Area. Starling was recorded in the highest numbers, with 330 birds seen in Year 2, accounting for 24.6% of all non-seabirds recorded. Redwing was the second most frequently recorded species, with 274 birds (20.4%) seen. Lapwing was the third most frequently recorded species, with 148 birds (11.0%) seen. Swallow and meadow pipit were both the next most frequently recorded species, with 48 birds of each species seen (3.6%). Overall, these five species accounted for 63.2% of all non-seabird species recorded in Year 2.

Table 3.6 Comparison of non-seabird numbers recorded on surveys in Subzone 1 and the Hornsea Zone in Years 1 and 2 (Raw numbers, all Sea States).

Species	Year 1			Year 2		
	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total
Grey heron	1	0	1	0	1	1
'Tundra' Bean goose	0	0	0	1	2	3
Pink-footed goose	0	22	22	0	2	2
Greylag goose	10	0	10	0	6	6
'Dark-bellied' Brent goose	0	0	0	1	6	7
Unidentified goose	0	0	0	11	0	11
Shelduck	0	0	0	1	1	2
Wigeon	0	0	0	13	6	19
Gadwall	0	0	0	1	0	1
Teal	37	0	37	0	1	1
Mallard	4	0	4	6	0	6
Shoveler	0	0	0	4	0	4
Pochard	0	3	3	1	1	2
Tufted duck	0	2	2	2	3	5
Goosander	0	0	0	0	3	3
Unidentified duck	2	4	6	19	5	24
Hobby	1	0	1	0	1	1
Oystercatcher	0	11	11	1	11	12
Ringed plover	0	4	4		6	6
Avocet	0	0	0	2	0	2
Golden plover	12	129	141	3	4	7
Grey plover	0	1	1	1	2	3
Lapwing	0	0	0	70	78	148
Knot	0	0	0	6	16	22
Purple sandpiper	0	0	0		1	1
Little stint	0	0	0	2	0	2
Dunlin	1	8	9	22	10	32
Snipe	0	1	1	0	1	1
Woodcock	0	1	1	0	0	0
Bar-tailed godwit	0	25	25	1	3	4
Whimbrel	11	30	41	0	8	8
Curlew	3	1	4	4	10	14
Redshank	0	0	0	0	7	7
Greenshank	0	0	0	0	1	1
Green sandpiper	0	2	2	0	0	0
Common sandpiper	0	0	0	0	2	2
Turnstone	0	1	1	0	3	3
Unidentified waders	2	29	31	8	7	15
Feral pigeon	3	3	6	1	13	14
Woodpigeon	0	2	2	0	3	3
Collared dove	0	0	0	0	2	2
Short-eared owl	2	0	2	6	2	8
Swift	2	3	5	4	16	20
Skylark	3	5	8	5	10	15
Sand martin	0	0	0	0	1	1
Swallow	2	0	2	9	39	48
House martin	0	1	1	0	1	1
Tree pipit	0	0	0	0	1	1
Meadow pipit	14	12	26	19	29	48
Rock pipit	0	0	0	0	1	1
Unidentified pipit	0	0	0	1	4	5
Yellow wagtail	0	3	3	0	0	0

Species	Year 1			Year 2		
	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total	Subzone 1 and 4 km buffer	Hornsea Zone and 10 km buffer	Total
Pied/white wagtail	1	8	9	3	4	7
Wren	0	2	2	3	1	4
Robin	1	0	1	4	3	7
Redstart	1	1	2	0	1	1
Black redstart	0	0	0	1	0	1
Whinchat	1	0	1	0	0	0
Wheatear	1	3	4	2	3	5
Blackbird	1	12	13	12	10	22
Fieldfare	0	4	4	9	28	37
Song thrush	2	2	4	7	21	28
Redwing	4	7	11	244	30	274
Unidentified thrush	0	4	4	14	4	18
Sedge warbler	0	0	0	1	0	1
Garden warbler	1	1	2	0	0	0
Blackcap	3	0	3	0	1	1
Whitethroat	0	0	0	1	0	1
Yellow-browed warbler	1	0	1	0	0	0
Chiffchaff	2	1	3	2	5	7
Willow warbler	1	2	3	1	1	2
Goldcrest	1	0	1	1	0	1
Unidentified warbler	0	2	2	5	4	9
Spotted flycatcher	0	0	0	1	0	1
Pied flycatcher	1	1	2	0	0	0
Jackdaw	0	0	0	0	1	1
Carrion crow	1	0	1	0	1	1
Starling	452	28	480	110	220	330
Chaffinch	0	1	1	0	0	0
Brambling	5	0	5	4	1	5
Goldfinch	0	1	1	0	1	1
Greenfinch	0	0	0	4	0	4
Linnet	0	0	0	0	3	3
Mealy redpoll	1	0	1	0	0	0
Snow bunting	5	1	6	0	0	0
Unidentified finch	0	1	1	0	0	0
Unidentified land bird	1	4	5	9	6	15
Total numbers	**597**	**389**	**986**	**520**	**679**	**1,342**

3.7 Seabird Species Accounts

3.7.1 The following species accounts present information on the seabird species recorded regularly within the Hornsea Survey Area during the monthly baseline boat-based surveys in Years 1 and 2. Results from the baseline surveys are presented for Subzone 1, the surrounding 4 km buffer, and for the Hornsea Zone and 10 km buffer. Full information on methodology and detailed population estimates are presented in Appendix C.

3.7.2 Results include estimated numbers and densities for the more abundant species, and information on flight height, direction, and behaviour, where recorded. Summary information on species conservation status and sensitivity is also included.

3.7.3 For all species where data were sufficient, abundance maps have been produced for the Hornsea Zone plus Subzone 1 and the 4 km buffer. Species density maps have also been produced for both the wider Hornsea Zone and Subzone 1 on its own. These maps are given in Appendix B.

3.7.4 Due to the lack of aerial surveys carried out on the Hornsea Zone, data have been considered from aerial surveys carried out between 2004 and 2008 collated in reports by produced by the Department of Energy and Climate Change (DECC, formerly the Department for Business, Enterprise and Regulatory Reform (BERR) and the Department for Trade and Industry (DTI)).

3.7.5 Three of the Greater Wash aerial survey blocks in particular have been considered because they overlap with, or sit very close to, the westernmost limit of the Hornsea Zone. These are GW2, GW9 and GW10. Because survey coverage was not consistent across all zones and the reports contain only raw counts, this survey data should only be used to inform the temporal pattern of use of the wider area by these species. Because these survey blocks are also closer to the coast that the Hornsea Zone and in particular Subzone 1, they may indicate a pattern of use of more coastal waters in this region.

3.7.6 A summary of this aerial survey data for key species is presented in Table A.9.

3.7.7 Where data from ESAS and ICES are referred to please see Stone *et al.* (1995).

Red-throated Diver (*Gavia Stellata*)

Status overview

3.7.8 Red-throated diver is listed on Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act. The species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.9 An estimated 1,255 pairs of red-throated diver breed in Britain, with the majority of pairs found in the north and west of Scotland (RSPB, 2012). The wintering population around Britain has been estimated at 17,000 individuals (O'Brien *et al.*, 2008) and the 1% threshold for national importance is consequently 170 birds (Holt *et al.*, 2012). Wintering red-throated divers show a preference for sheltered shallow waters and sandy bays along North Sea coasts, and several important areas off the east coast of England have recently been identified; in particular the outer Thames Estuary and the Greater Wash (O'Brien *et al.,* 2008). Numbers may however fluctuate widely in response to weather and other factors affecting the prey supply of sandeels, crustaceans and small fish (Lack, 1986). Red-throated diver is listed as a qualifying interest species in the non-breeding season for two SPAs on the UK east coast between Hermaness and Foreness Point; the Outer Thames SPA and Firth of Forth SPA.

3.7.10 The Outer Thames SPA regularly supports wintering red-throated diver in numbers of European importance (6,466 individuals – wintering 1989 –2006/07) (Natural England / JNCC, 2010), which is around 38% of the British wintering population.

3.7.11 The Firth of Forth SPA held 88 birds or 1.8% of the UK non-breeding population, and 0.1% of the biogeographic population at the time of designation (JNCC, 2011). A similar figure (80 birds) was recorded as the most recent available five-year mean for wintering red-throated divers in the Forth Estuary, between 2004 and 2009 (Calbrade *et al.*, 2010).

3.7.12 Available evidence from ringing studies suggests that red-throated divers may move considerable distances from their breeding grounds in the non-breeding season, with recoveries from Shetland-ringed birds in Kent, Ireland, France and the Netherlands. Birds ringed in Greenland and Scandinavia have also been recovered in the UK, indicating that not all birds recorded in the Hornsea Zone may breed in the UK (Wernham *et al.*, 2002).

3.7.13 Langston (2010) assessed red-throated divers as being at high risk of displacement from offshore wind farms, and there is published evidence from individual offshore wind farm studies to support this (e.g., Peterson, 2005; Barton *et al.*, 2008). Red-throated diver was also assessed as being at moderate risk of barrier effects and habitat loss, and at low risk of collision with turbines. Overall, the species was assessed as being at high risk from offshore wind developments (Langston, 2010) (Table 3.3).

Hornsea Survey Area

3.7.14 A total of 21 red-throated divers were recorded in Year 1 with the majority between March and May in the Hornsea Zone and 10 km buffer (Table 3.1). One bird was aged as an adult, with the remaining birds unaged. In Year 2, 42 red-throated divers were recorded, primarily between March and June, with a survey peak of 19 individuals in April in the Hornsea Zone and 10 km buffer (Figure 3.5).

3.7.15 In Subzone 1, a peak of seven birds was recorded in May 2011, with a peak of only two birds in April and May in Year 1. Due to low overall numbers, temporal distribution data were not gathered for specific subsections of the survey areas.

3.7.16 Flight height was recorded for 41 red-throated divers during the baseline surveys, with all birds flying below 22.5 m (Table 3.2).

3.7.17 Sightings indicate an even spatial distribution throughout the Hornsea Survey Area, with no identifiable areas of primary activity (Figure 3.5). Individuals were observed throughout the survey area, without any identifiable areas of primary activity. The peak of sightings in spring may indicate some passage movement to breeding grounds further north, but the low numbers observed overall do not suggest this is an important location for this species as it is likely further from the coast than preferred diver habitat.

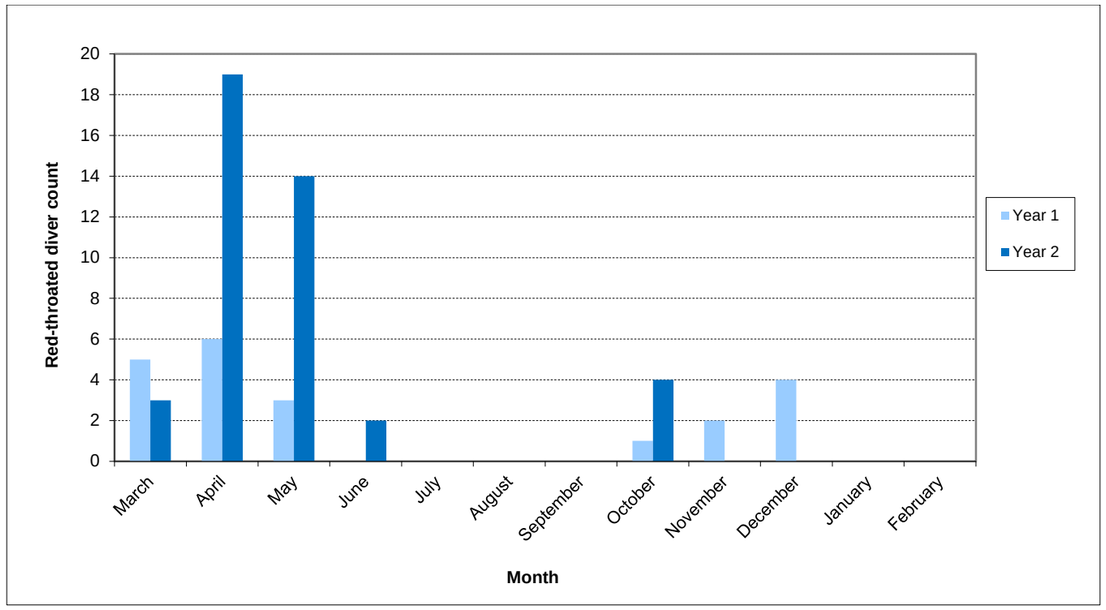


Figure 3.4 **Temporal variation in raw counts of red-throated diver in the Hornsea Zone survey area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.)**

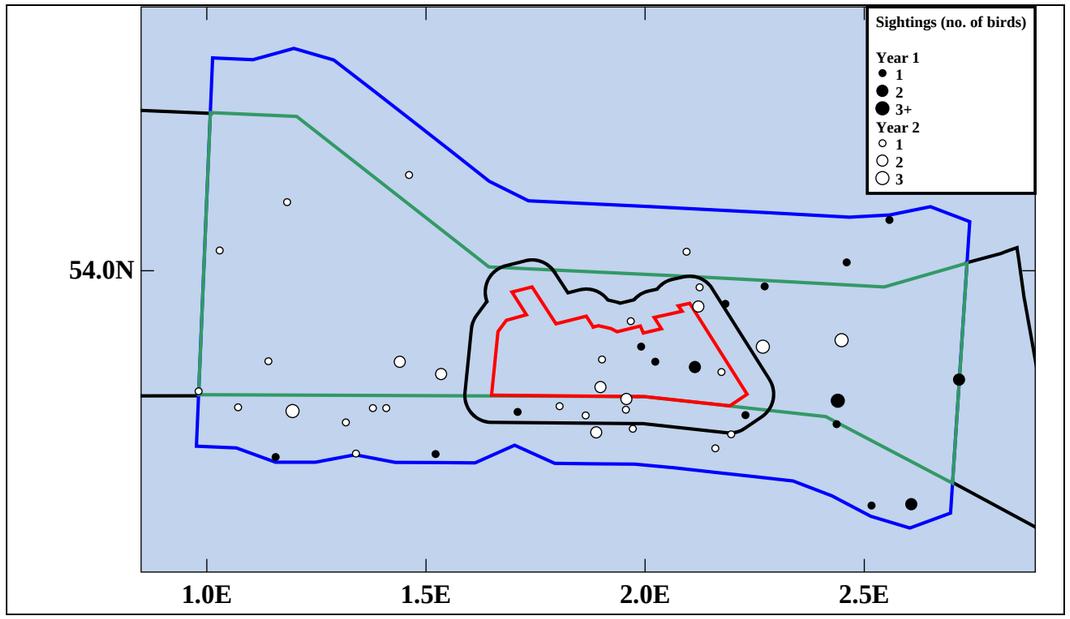


Figure 3.5 **Spatial distribution of red-throated diver sightings in the Hornsea Survey Area.**

Black-throated Diver (*Gavia arctica*)

Status overview

3.7.18 Black-throated diver is listed on Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act. The species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009). The theoretical1% population threshold for national importance for wintering black-throated diver is currently six birds, although 50 individuals are usually considered to be the minimum practical threshold value (Holt *et al.*, 2012). There are no designated SPAs for black-throated divers on the UK east coast (JNCC, 2012)

3.7.19 Black-throated divers are predominantly a wintering species in the UK. They prefer to forage in shallow waters with sandy substrate, feeding on sandeels, crustaceans and flatfish, although herring and sprats are also taken (Lack, 1986). An estimated 700 birds spend the winter months around the UK coast, while an estimated 217 pairs breed in Britain; in the north and west of Scotland (RSPB, 2012).

3.7.20 Langston (2010) assessed black-throated divers as being at high risk of displacement from wind farms, moderate risk of barrier effects and habitat loss, and at low risk of collision with turbines. Overall, the species was assessed as being at high risk from offshore wind developments (Table 3.3).

Hornsea Survey Area

3.7.21 A total of 12 black-throated divers were recorded in the Hornsea Survey Area. Of these, nine were recorded in flight, with all bar one flying below 22.5 m in height.

3.7.22 Four black-throated divers were recorded in the Hornsea Survey Area in Year 1 (Table 3.1). Single birds were recorded in Subzone 1 in April and December only, and a single bird in the 4 km buffer in April and one in the Hornsea Zone in March. In Year 2, nine black-throated divers were recorded, with the majority recorded in March and April, with a peak of five individuals in Subzone 1 in April (Figure 3.6).

3.7.23 Individuals were recorded throughout the Hornsea Survey Area, but sightings were clustered within the Subzone 1 and 4 km buffer (Figure 3.7). Although the concentration in sightings recorded in spring may be indicative of passage birds preferentially foraging in the area, this is not conclusive because of the small numbers recorded.

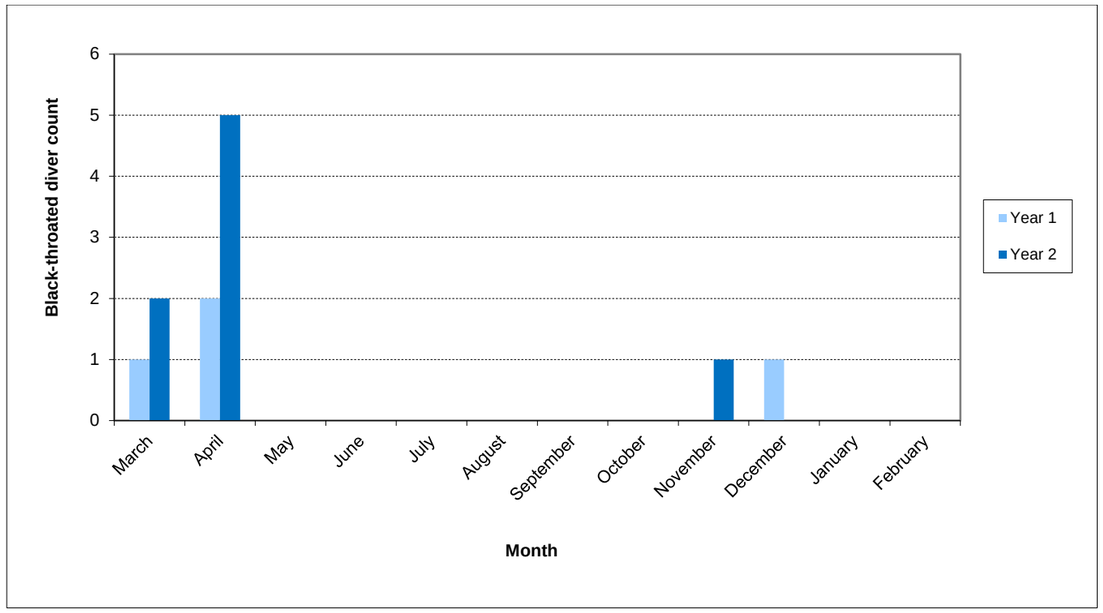


Figure 3.6 **Temporal variation in raw counts on black-throated diver in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

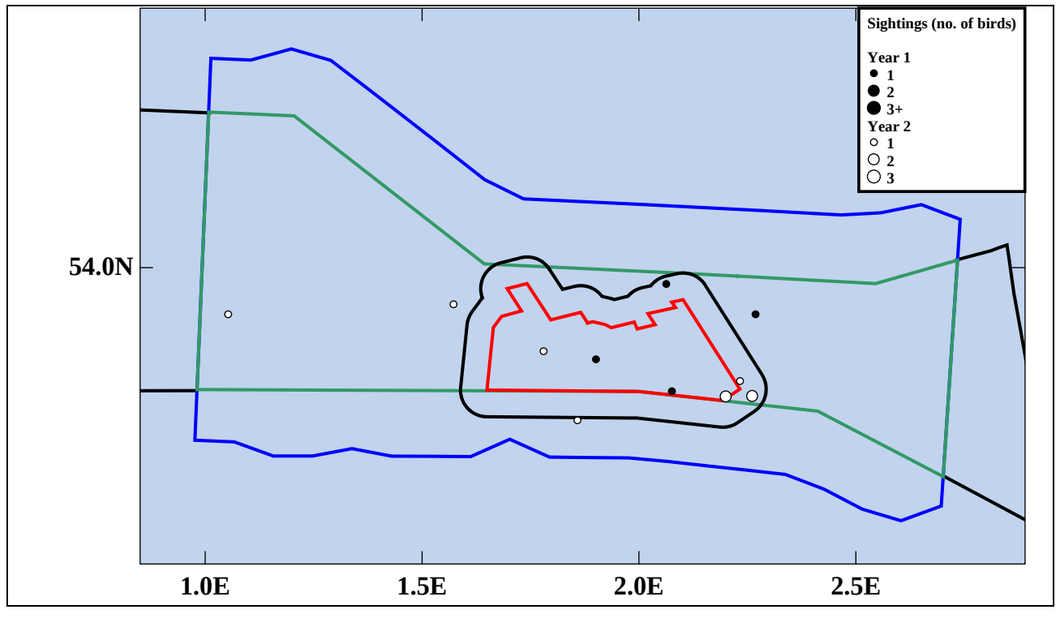


Figure 3.7 **Spatial distribution of black-throated diver sightings in the Hornsea Survey Area.**

Unidentified Divers

3.7.24 In Year 1, nine unidentified divers were recorded in the Hornsea Survey Area and again most birds were observed in early spring. One bird was recorded in Subzone 1, three birds in the 4 km buffer and five birds in the Hornsea Zone (Table 3.1). The remaining three birds recorded in November and December (Table A.2 and Table A.4).

3.7.25 In Year 2, six unidentified divers were recorded, all in April and May, with four birds in Subzone 1 and two birds in the Hornsea Zone.

3.7.26 Twelve unidentified divers were recorded in flight on baseline surveys, with two birds recorded flying above 22.5 m, at an estimated 30 m in height.

Grebes

Status overview

3.7.27 Grebes are typically found in highest concentrations in estuaries and coastal areas in winter months. They breed on freshwater lakes, forage in coastal waters outside of the breeding season. Red-necked, black-necked and Slavonian grebes are currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009). The 1% national population importance threshold in winter for great crested grebe is 190 birds (Holt *et al.*, 2012). The 1% national population importance thresholds in winter for Slavonian grebe (11 birds) and red-necked grebe and black-necked grebe (one bird) reflect the low number of birds that occurs in the UK in winter (Holt *et al.*, 2011).

3.7.28 Great crested grebe is listed as a qualifying interest species in the non-breeding season for eight SPAs on the UK east coast between Hermaness and Foreness Point. These SPAs held 19.4% of the UK non-breeding population, and 1.3% of the biogeographic population at the time of designation (JNCC, 2012). During the non-breeding season, foraging connectivity of birds from these SPAs with the Hornsea Survey Area is considered very unlikely.

3.7.29 Slavonian grebe is listed as a qualifying interest species in the non-breeding season for one SPA on the UK east coast between Hermaness and Foreness Point (Firth of Forth). This SPA held 71 birds or 17.8% of the UK non-breeding population, and 14% of the biogeographic population at the time of designation (JNCC, 2012). A lower figure (30 birds) was recorded as the most recent available five-year mean for wintering Slavonian grebes in the Forth Estuary, between 2005 and 2010 (Holt *et al.*, 2011). Again, connectivity with any SPA is therefore very unlikely.

3.7.30 There are no designated coastal SPAs for red-necked grebe and black-necked grebe on the UK east coast (JNCC, 2012).

3.7.31 Langston (2010) assessed Slavonian grebe as being at moderate risk of displacement from wind farms, barrier effects and habitat loss, and at low risk of collision with turbines. Overall, the species was assessed as being at moderate risk from offshore wind developments (Table 3.3). The three other grebe species recorded in the Hornsea Survey Area on baseline surveys were not assessed by Langston (2010).

Hornsea Survey Area

3.7.32 Due to low numbers of grebe species present on the site, grebes are presented as a species group in this report.

3.7.33 Three species of grebes were seen in the Hornsea Survey Area in Year 1. One black-necked grebe recorded flying in Subzone 1 in December, one great crested grebe was recorded flying in the 4 km buffer in December, while one red-necked grebe was recorded on the sea in the Hornsea Zone 10 km buffer in November. In Year 2 one great crested grebe was recorded flying in the Hornsea Zone in October, with one Slavonian grebe recorded flying in the Hornsea Zone in February. Sightings of grebes are summarised in Figure 3.8.

3.7.34 All flying birds were recorded below 22.5 m in height. There was no evident spatial pattern to the records, and these birds are most likely incidental sightings.

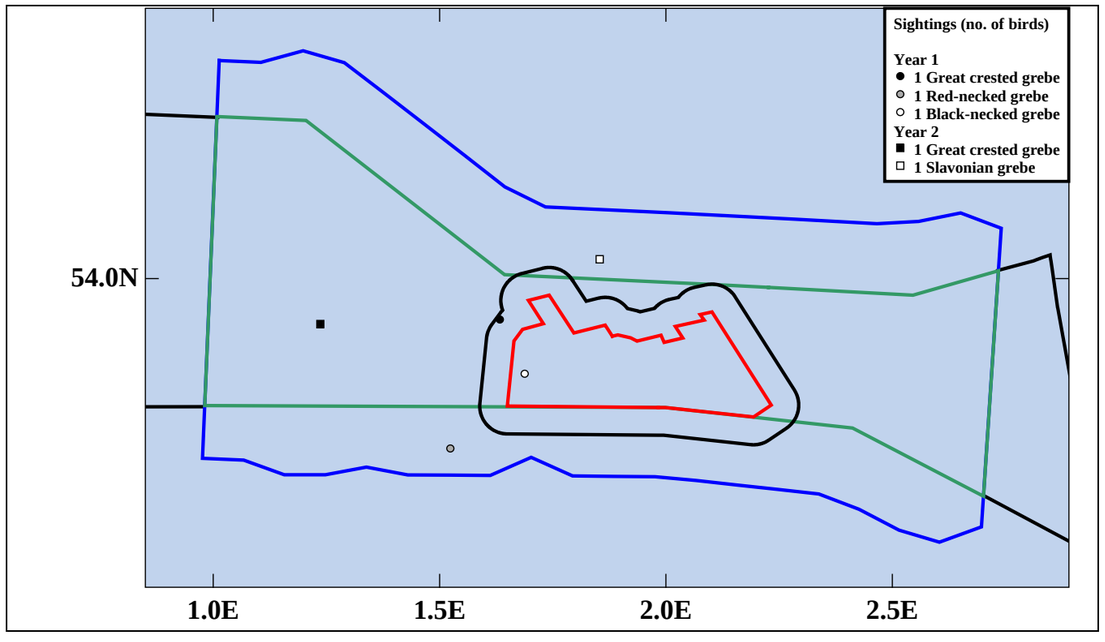


Figure 3.8 Spatial distribution of grebe sightings in the Hornsea Survey Area.

Fulmar (*Fulmarus glacialis*)

Status overview

3.7.35 Fulmar is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.36 Fulmar numbers and distribution around the UK have increased considerably since the mid-19th century (Pennington *et al.*, 2004). The species is now one of the commonest seabirds in Britain, with an estimated breeding population of 499,081 pairs (Mitchell *et al.*, 2004). The largest breeding colonies are located off the north and west coasts of Scotland. Birds are often present at breeding cliffs outside the breeding season.

3.7.37 Fulmars forage at sea over a wide area in search of small fish (sandeels), crustaceans and squid. They also scavenge extensively around fishing vessels, with offal and fish discards from trawlers now a major part of their diet (Phillips *et al.*, 2009).

3.7.38 Langston (2010) assessed fulmar as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision, displacement and barrier effects were rated as low. Overall, fulmar was assessed as being at low risk from offshore wind developments (Table 3.3).

3.7.39 Fulmar is currently listed as a qualifying interest species in the breeding season for 17 SPAs on the UK east coast between Hermaness and Foreness Point. These SPAs held 38% of the UK breeding population, and >2.4% of the biogeographic population at the time of designation (JNCC, 2011).

3.7.40 The Hornsea Survey Area lies within the fulmar mean maximum foraging range (400 km) of one of these current SPAs (Firth of Forth Islands SPA), and within the maximum foraging range (580 km) of a further four (Thaxter *et al.*, 2012) (Table 3.4, Figure 3.9). A review of the Flamborough Head and Bempton Cliffs SPA by Natural England would likely include fulmar as a qualifying species, and this SPA would be the closest colony to Subzone 1, being within mean maximum foraging range.

Hornsea Survey Area

3.7.41 In Year 1, a total of 6,608 fulmars were recorded on surveys in the Hornsea Survey Area, with over two thirds of all birds (71.1%) recorded in the Hornsea Zone and 10 km buffer. In Year 2, 8,300 fulmars were recorded on surveys, with a similar proportion of birds (66.2%) recorded in the Hornsea Zone and 10 km buffer (Table 3.1).

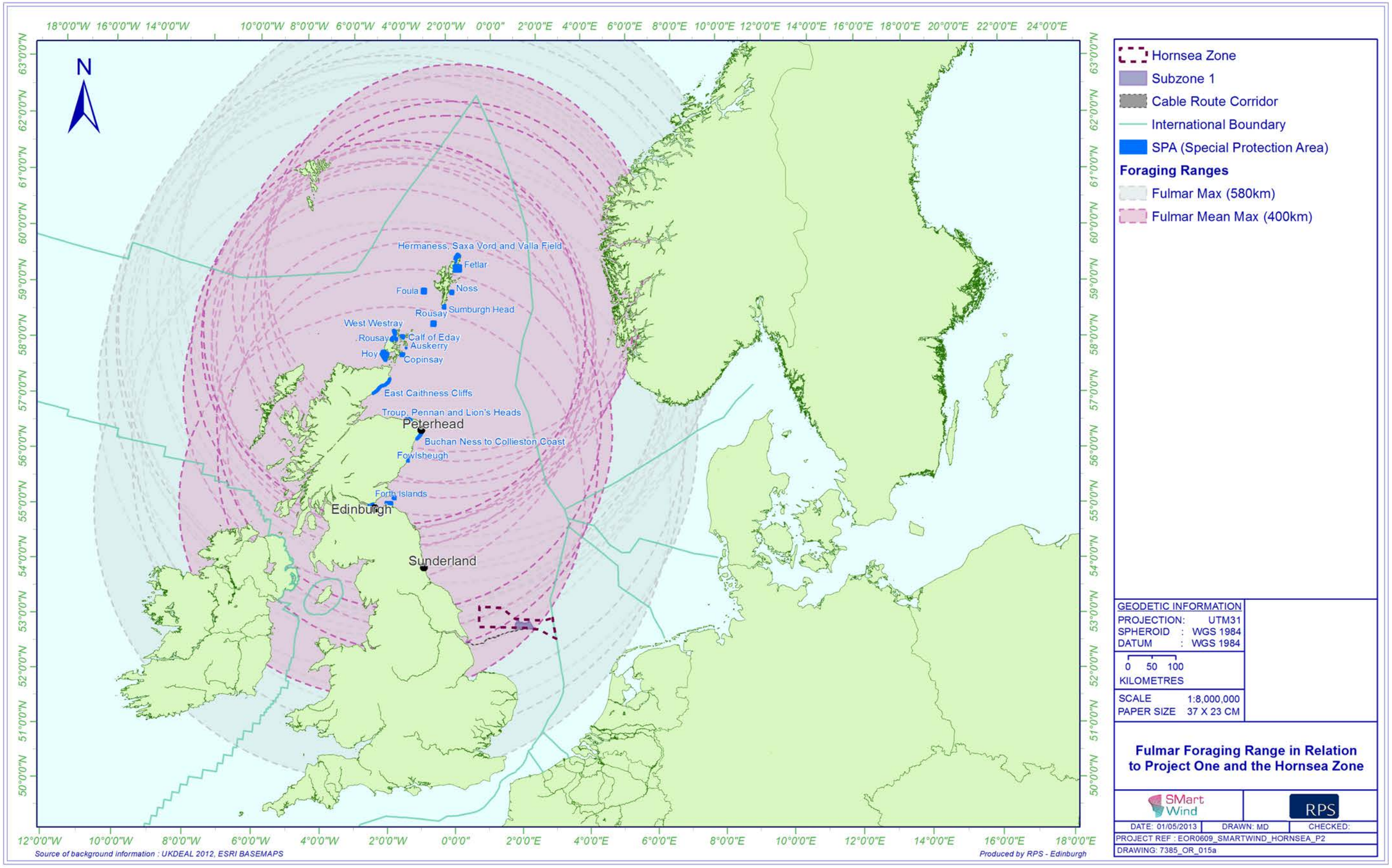


Figure 3.9 Fulmar foraging range in relation to Project One and the Hornsea Zone.

Seasonal distribution and abundance

3.7.42 It is not known how many fulmars are present each year within the southern North Sea, but it is considered that only a small proportion of the biogeographic population (<0.01%) are likely to be resident throughout the year in this region (Stienen *et al.*, 2007).

3.7.43 Between March and July, fulmars are distributed widely across the southern North Sea, although numbers are relatively low compared to further north along Scottish coasts, where the majority of British colonies occur (Stone *et al.*, 1995). From August to November, distribution extends southwards from the main breeding colonies. Through the rest of the winter this species is very widely distributed across the whole North Sea, although it is evident that the continental shelf edge is important for fulmar at most times of the year, with the closest area of high concentrations to the Hornsea Survey Area being at Dogger Bank (Stone *et al.*, 1995).

3.7.44 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show that small numbers of fulmars were recorded throughout the year during aerial surveys of the Greater Wash survey blocks GW2, GW9 and GW10, with a peak mean of 38 birds during December.

3.7.45 Fulmar was present within the Hornsea Survey Area throughout the year, with similar seasonal distribution recorded in the Hornsea Zone and Subzone 1. There was a peak in estimated numbers in May-June in both survey years.

3.7.46 During the breeding season (March to July), the peak estimated number of fulmars in Subzone 1 in Year 1 was 418 birds in May, with a peak of 897 birds when the 4 km buffer is included. In comparison, an estimated peak of 10,050 birds were found in the Hornsea Zone and 10 km buffer in May (Table 3.7).

3.7.47 In the Year 2 breeding season, the peak estimated number of fulmars in Subzone 1 was greater, with 1,477 birds in June, with 3,171 birds estimated when including the 4 km buffer. In comparison, an estimated 8,422 birds were recorded in the Hornsea Zone and 10 km buffer in May of Year 2.

3.7.48 Seasonal variation of fulmar based on Distance adjusted counts are presented in Figure 3.10, Figure 3.11 and Figure 3.12.

3.7.49 In the Year 1 non-breeding season (August to February), the peak estimated number of fulmars in Subzone 1 was 217 birds in August, with 465 birds when including the 4 km buffer. In comparison, peak estimated numbers of wintering fulmars occurred in the Hornsea Zone and 10 km buffer in January (3,488 birds).

3.7.50 In the Year 2 non-breeding season, the peak estimated number of fulmars in Subzone 1 was 152 birds in January, with 327 birds estimated including the 4 km buffer. In comparison, peak estimated numbers of fulmars occurred in the Hornsea Zone and 10 km buffer in March of Year 2 (2,428 birds), although survey coverage in the Hornsea Zone was incomplete over much of the period.

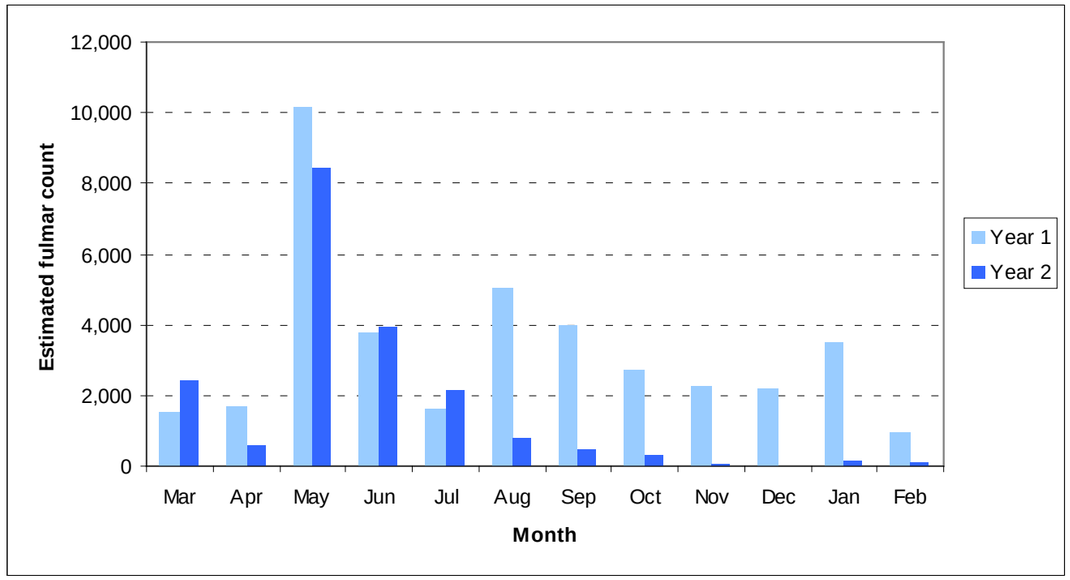


Figure 3.10 Temporal variation in distance-adjusted counts of fulmar in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.)

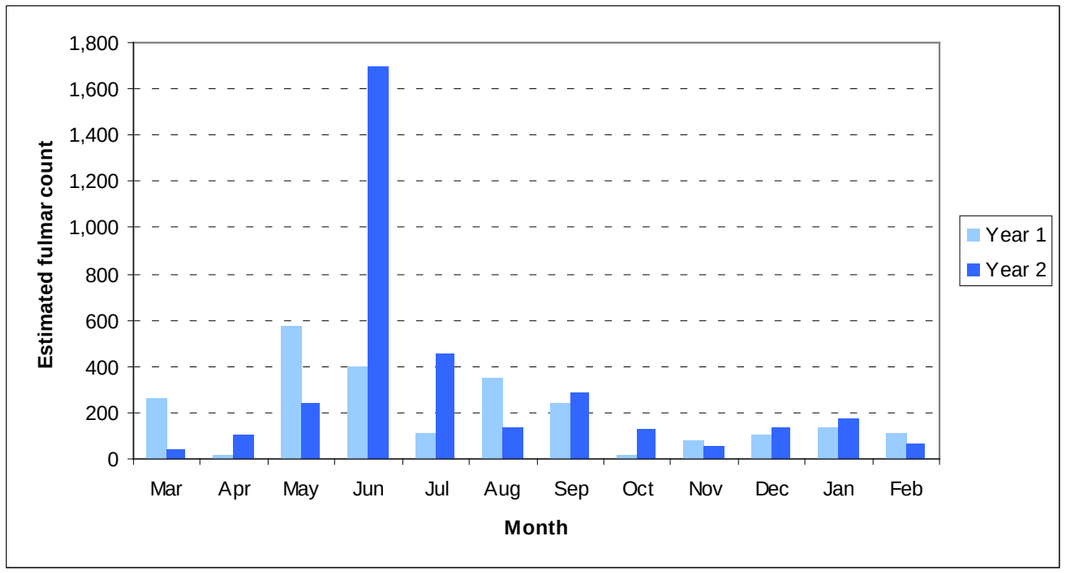


Figure 3.11 Temporal variation in distance-adjusted counts of fulmar in Subzone 1 plus 4 km buffer.

Table 3.7 Estimated numbers of fulmars in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total Subzone 1 [1]	Est. total in HZ and 10 km buffer [2]
1	March	102	47	223	435	537	250	1,491
1	April	0	0	0	29	29	13	1,661
1	May	622	387	1001	275	897	418	10,050
1	June	465	302	716	203	668	311	3,718
1	July	90	52	157	29	119	55	1,600
1	August	320	156	656	145	465	216	4,955
1	September	270	189	387	123	393	183	3,924
1	October	17	3	96	15	32	15	2,676
1	November	35	8	146	72	107	50	2,261
1	December	95	48	188	0	95	44	2,210
1	January	35	11	106	145	180	84	3,488
1	February	107	50	227	87	194	90	955
2	March	15	4	55	64	79	37	2,428
2	April	154	76	313	44	198	92	579
2	May	297	156	565	147	444	207	8,422
2	June	2660	2077	3407	511	3,171	1,477	3,949
2	July	476	326	696	380	856	399	2,170
2	August	204	113	370	44	248	115	804
2	September	541	313	937	0	541	252	477 [3]
2	October	181	87	378	59	240	112	304 [3]
2	November	45	11	184	59	104	48	27 [3]
2	December	261	52	1311	0	261	122	-
2	January	143	79	259	184	327	152	178 [3]
2	February	77	38	158	43	120	56	126 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

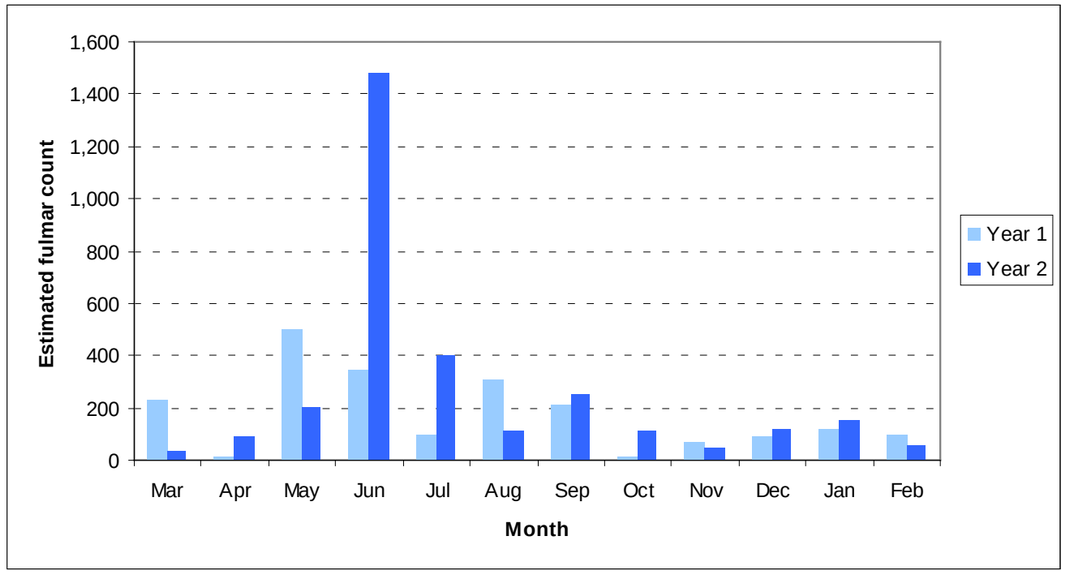


Figure 3.12 Temporal variation in distance-adjusted counts of fulmar in Subzone 1.

Density

3.7.51 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area, and densities in these three areas during the main breeding season were generally between 0.5 and 2.0 birds/km^2. Numbers increased in August and September as birds left their breeding colonies, reaching a peak of 8.1 birds/km^2 in September in the central and north North Sea, and 4.0 to 5.0 birds/km^2 in the western North Sea and south and east North Sea. During the winter months, densities again reverted to a lower level, at around 1.0 to 2.0 birds/km^2.

3.7.52 Fulmar densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.8. The mean density data for Subzone 1 and 4 km buffer are also shown for comparison.

3.7.53 Mean monthly fulmar density in Subzone 1 and 4 km buffer showed a similar pattern to the Hornsea Zone and 10 km buffer in Year 1, although mean monthly values were generally slightly higher in the Hornsea Zone and 10 km buffer, with a peak of 2.0 birds/km^2 in May (Figure 3.13).

3.7.54 In Year 2, mean monthly fulmar density in Subzone 1 and 4 km buffer peaked in June (3.6 birds/km^2), however mean monthly density for the other months of Year 2 were similar to Year 1. Mean monthly density in the Hornsea Zone and 10 km buffer showed a similar pattern to Year 1, although coverage was limited to between March and August.

Table 3.8 North Sea fulmar densities from Stone *et al.* (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0.24	1.40	0.37	0.67	0.34
February	0.86	1.69	0.46	1.00	0.19
March	1.03	4.91	0.46	2.13	0.33
April	0.34	2.10	0.31	0.92	0.13
May	0.54	1.56	0.50	0.87	0.86
June	0.88	1.23	0.82	0.98	2.24
July	1.70	1.63	2.17	1.83	0.61
August	4.33	5.44	2.20	3.99	0.52
September	4.54	8.13	1.15	4.61	0.57
October	3.02	2.67	0.81	2.17	0.16
November	0.46	2.46	0.75	1.22	0.15
December	0.59	1.95	0.36	0.97	0.26

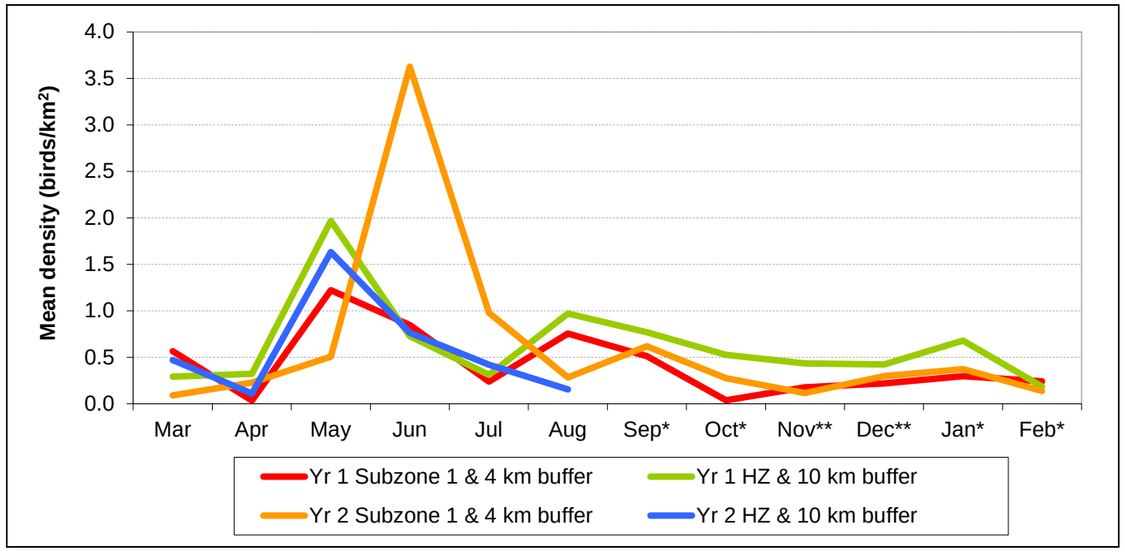


Figure 3.13 Temporal variation in mean density of fulmar in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

3.7.55 ESAS mean density data for fulmar in the surrounding ICES rectangles and Regional Seas 1 and 2 was generally higher than recorded in the Hornsea Survey Area, apart from in June of Year 2, when mean density in Subzone 1 (and 4 km buffer) exceeded the ESAS data values.

3.7.56 Similar temporal distribution patterns were recorded within Subzone 1 and 4 km buffer, indicating that site use patterns are consistent throughout the Hornsea Survey Area (Appendix B).

3.7.57 A comparison of the temporal distribution of fulmar density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.14. The temporal pattern seen across the wider North Sea area is slightly different from that of the Hornsea Survey Area, with peaks in March and then August-September. Overall though, the pattern suggests that the Hornsea Survey Area is not a particularly important area when compared to the wider North Sea area.

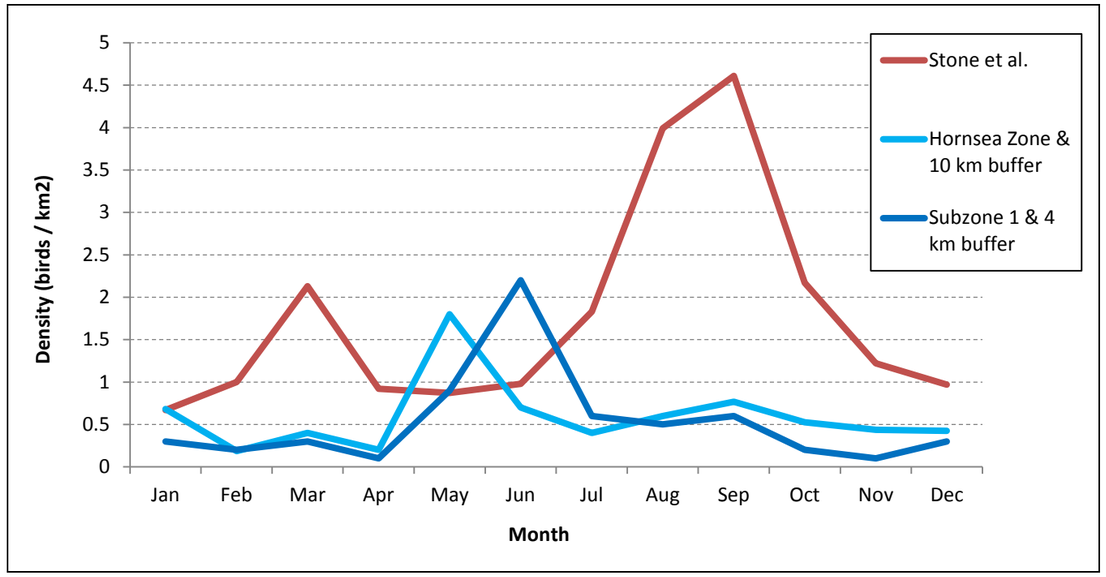


Figure 3.14 A comparison of temporal variation in density of fulmar in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).

Behaviour and distribution

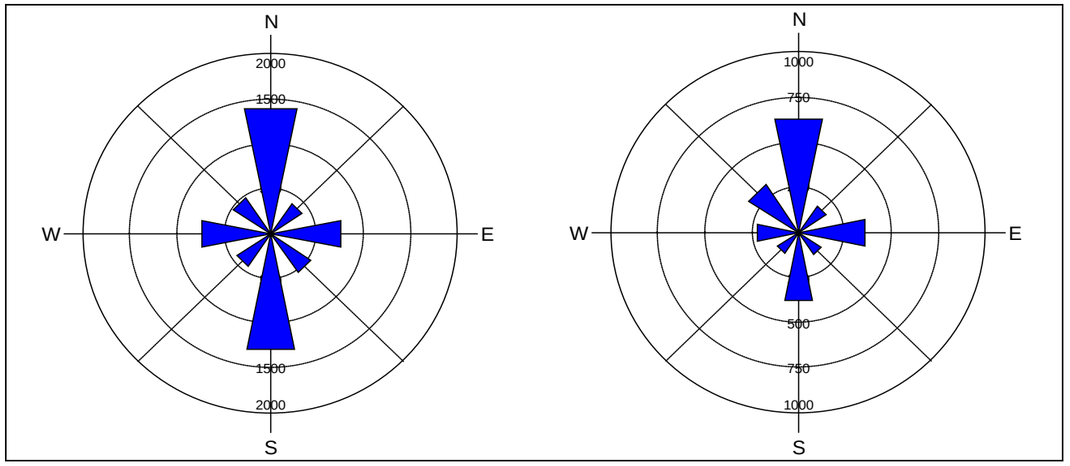
3.7.58 A total of 9,048 fulmars were recorded in flight on baseline surveys, with the vast majority of all birds recorded flying below 22.5 m in height (Table 3.2). Just three birds (<0.1%) were recorded flying above this height.

3.7.59 Flight direction was recorded for 6,063 fulmars in the breeding season and 2,386 in the non-breeding season (with remaining birds recorded as circling).

3.7.60 No clear foraging patterns were recorded, although a north-south axis appeared slightly more common. In the breeding season, just under one quarter of all birds recorded were flying north (23.3%) with just over one fifth of all birds recorded flying south (21.5%). In the non-breeding season, just over a quarter of fulmars (26.9%) were recorded flying north, with 15.9% flying south and 15.2% flying east (Figure 3.15).

3.7.61 Eight types of foraging behaviour were recorded for fulmars in the Hornsea Survey Area on baseline surveys, with actively searching (35.5%) and scavenging at fishing vessels (33.3%) the most frequently observed behaviours (Table 3.9).

3.7.62 The density distribution maps for Fulmar cover the periods April to September and October to March for Years 1 and 2 in Subzone 1 and 4 km buffer and for the Hornsea Zone (Appendix B). Fulmar distribution is even across the site during both survey years, with fewer individuals recorded in the winter. This is consistent with the wide-ranging foraging patterns exhibited by this species.



April to September (n=6,063 birds) October to March (n=2,386 birds)

Numbers shown on figures are numbers of birds recorded.

Figure 3.15 Flight direction of fulmar in the Hornsea Survey Area in Years 1 and 2.

Table 3.9 Fulmar foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	221	35.5
Dipping	2	0.3
Holding fish	2	0.3
Scavenging	20	3.0
Scavenging at fishing vessel	207	33.3
Shallow plunging	3	0.5
Surface pecking	104	16.7
Surface seizing	21	3.4
Feeding, method unspecified	42	6.8
Total	**622**	

Sooty Shearwater (*Puffinus griseus*)

Status overview

3.7.63 Sooty shearwaters breed in the southern hemisphere on islands off New Zealand, Australia, Chile and the Falkland Islands. The species is regularly recorded in low numbers in the western North Sea between July and November on migration (Stone *et al.*, 1995). Sooty shearwaters are currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.64 Langston (2010) assessed sooty shearwater as being at low risk of collision and displacement resulting from offshore wind farms (Table 3.3). There are no SPAs designated for sooty shearwater in the breeding or non-breeding season in the UK (JNCC, 2012).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.65 In Year 1, 194 sooty shearwaters were recorded on surveys in the Hornsea Survey Area, with the majority of birds recorded in Subzone 1 and 4 km buffer, mainly in September and October (Table A.2 and Table A.4. Numbers of sooty shearwaters in Year 2 were much lower, with just 11 birds recorded over summer/autumn (Table A.3 and Table A.5).

3.7.66 In Year 1, peak numbers of sooty shearwaters were recorded in October, when the peak estimated number of sooty shearwaters in Subzone 1 was 102 birds, with a total of 218 birds estimated when including the 4 km buffer.

3.7.67 In comparison, 599 birds were estimated for the Hornsea Zone and 10 km buffer. Lower numbers were estimated for August, September and November, with no birds recorded in other months.

3.7.68 Estimated numbers of sooty shearwaters in Year 2 were lower, with no sooty shearwaters estimated for Subzone 1 or the 4 km buffer throughout the year, and only an estimated 25 birds in the Hornsea Zone and 10 km buffer in August. Coverage in the Hornsea Zone and 10 km buffer was, however, incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

3.7.69 The data are presented in Figure 3.16, Figure 3.17 and Figure 3.18.

Densities

3.7.70 Mean monthly sooty shearwater density in Subzone 1 and 4 km buffer was similar compared to the Hornsea Zone and 10 km buffer in Year 1, with a peak of 0.3 birds/km^2 in Subzone 1 and 4 km buffer in October. Mean monthly densities for sooty shearwater in Year 2 were at or close to zero in all months.

3.7.71 ESAS mean density data for sooty shearwater was generally very low, with a peak in September (0.1 birds/km^2) in Regional Seas 1 and 2. Mean monthly density for the ¼ ICES rectangles surrounding the Hornsea Zone was lower, with 0.01 birds/km^2 recorded in September and October.

Behaviour and distribution

3.7.72 A total of 10 sooty shearwaters were recorded in flight on baseline surveys, with all birds flying below 22.5 m in height (Table 3.2).

3.7.73 The density distribution maps for sooty shearwater cover the period September to October for Years 1 and 2 in Subzone 1 and the 4 km buffer and for the Hornsea Zone (Appendix B). Sooty shearwater was primarily recorded within Subzone 1 and the 4 km buffer, although this may be influenced by survey effort. Within this area, individuals were widely distributed, with no apparent spatial patterns in site use. Overall there is no indication that the Subzone 1 area is foraged preferentially by the species.

Table 3.10 Estimated numbers of sooty shearwaters in Subzone 1, Subzone 1 and 4 km buffer, and the Hornsea Zone and 10 km buffer in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1[1]	Est. total Subzone 1 and 4 km buffer[1]	Est. total in HZ and 10 km buffer[2]
1	March	0	0	0	0	0	0	0
1	April	0	0	0	0	0	0	0
1	May	0	0	0	0	0	0	0
1	June	0	0	0	0	0	0	0
1	July	0	0	0	0	0	0	0
1	August	0	0	0	0	0	0	24
1	September	147	77	281	14	75	161	230
1	October	160	71	362	58	102	218	599
1	November	0	0	0	0	0	0	61
1	December	0	0	0	0	0	0	0
1	January	0	0	0	0	0	0	0
1	February	0	0	0	0	0	0	0
2	March	0	0	0	0	0	0	0
2	April	0	0	0	0	0	0	0
2	May	0	0	0	0	0	0	0
2	June	0	0	0	0	0	0	0
2	July	0	0	0	0	0	0	0
2	August	0	0	0	0	0	0	25
2	September	0	0	0	0	0	0	-
2	October	0	0	0	0	0	0	-
2	November	0	0	0	0	0	0	-
2	December	0	0	0	0	0	0	-
2	January	0	0	0	0	0	0	-
2	February	0	0	0	0	0	0	-

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

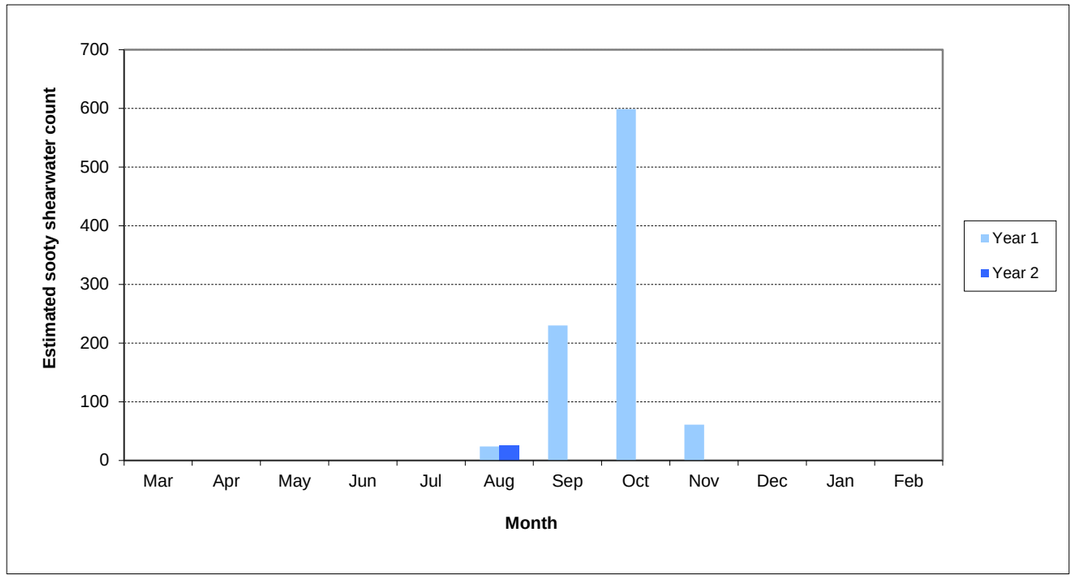


Figure 3.16 **Temporal variation in distance-adjusted counts of sooty shearwater in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

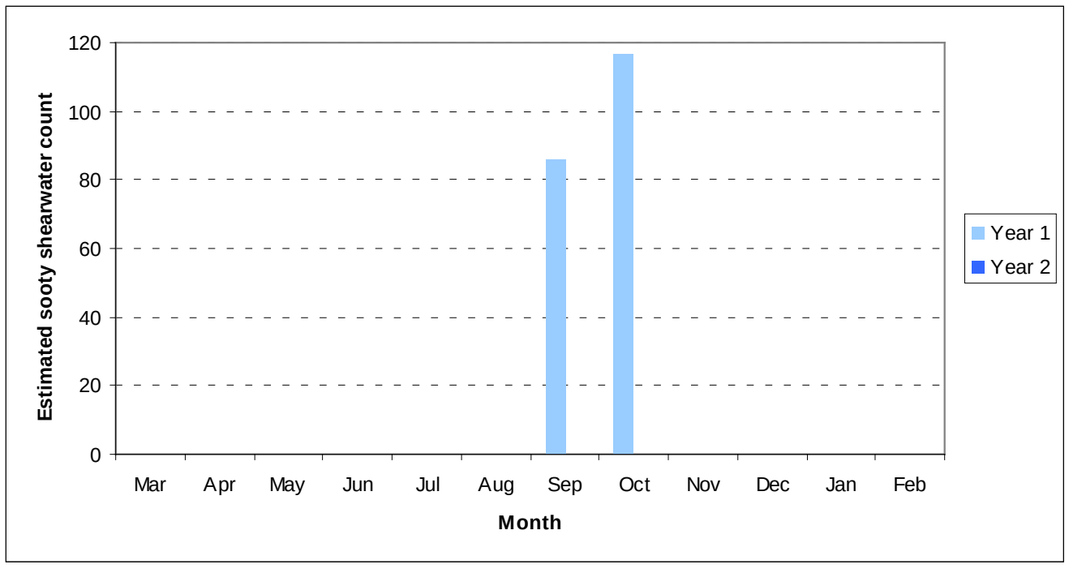


Figure 3.17 **Temporal variation in distance-adjusted counts of sooty shearwater in Subzone 1 and 4 km buffer.**

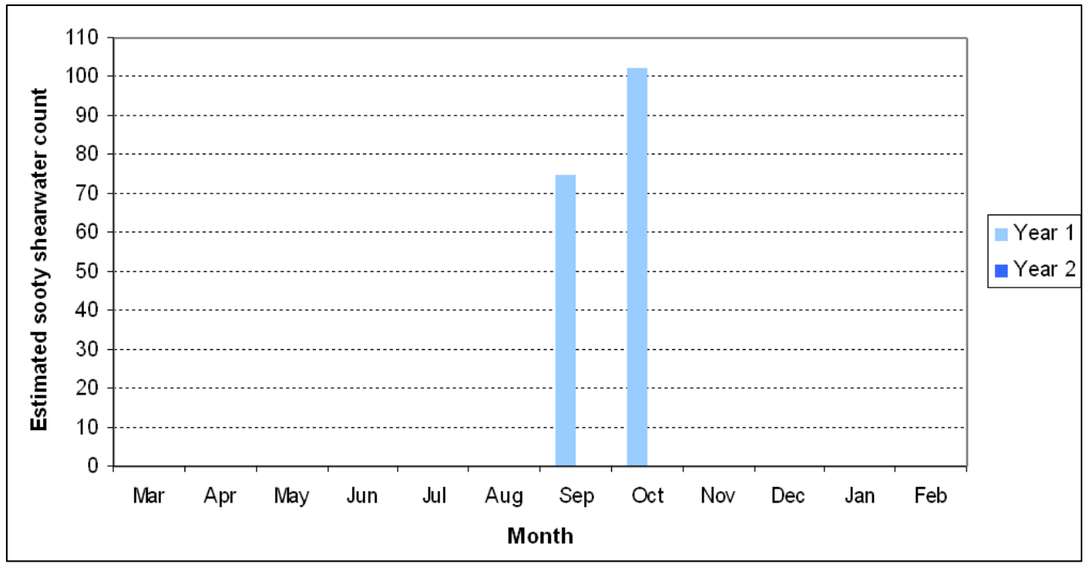


Figure 3.18 **Temporal variation in distance-adjusted counts of sooty shearwater in Subzone 1.**

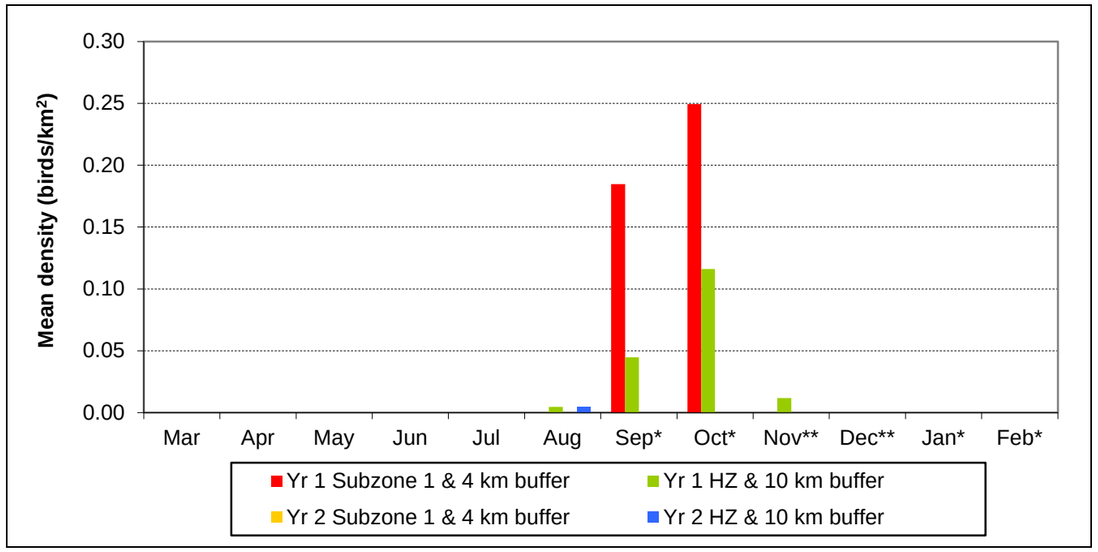


Figure 3.19 **Temporal variation in mean density of sooty shearwater in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Manx Shearwater (*Puffinus puffinus*)

Status overview

3.7.74 Manx shearwater is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.75 This species is a summer visitor to UK waters, occurring at breeding colonies between March and September. Seabird 2000 estimated the British breeding population at 295,089 breeding pairs, with large colonies on the west coast of Scotland and off south-west Wales (e.g., Rum, Skomer and Skokholm). There are no breeding colonies on the east coast of Britain (Mitchell *et al.*, 2004) and the species is not listed as a qualifying interest for any SPAs on the UK east coast (JNCC, 2012).

3.7.76 Counts of more than 100 off the east coast of Britain are uncommon, and the species is rare in the North Sea in winter months, as birds migrate to the South Atlantic for the winter, primarily off the east coast of South America (Forrester *et al.*, 2007). Manx shearwaters spend most of their lives at sea, only coming ashore to breed. They typically eat small squid, fish, including sandeels and free-swimming crustaceans, which they catch by shallow plunge-diving or surface feeding (Forrester *et al.*, 2007).

3.7.77 Langston (2010) assessed Manx shearwater as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision and displacement were rated as low. Overall, Manx shearwater was assessed as being at high risk from offshore wind developments, due to the importance of the UK breeding population (Langton, 2010) (Table 3.3).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.78 In Year 1, a total of 95 Manx shearwaters were recorded on surveys in the Hornsea Survey Area between April and October. Peak numbers in Subzone 1 and the 4 km buffer were recorded in September (15 birds), while in the Hornsea Zone and 10 km buffer, peak numbers occurred in August (25 birds). Overall, the majority of birds were recorded between June and October (Figure 3.20).

3.7.79 Numbers recorded on surveys were similar in Year 2, with 89 birds counted between April and September. Peak numbers in Subzone 1 and the 4 km buffer were recorded in August (six birds), while in the Hornsea Zone and 10 km buffer, peak numbers occurred in June (27 birds). Overall, the majority of birds (80.9%) were recorded in the Hornsea Zone and 10 km buffer area, between April and August.

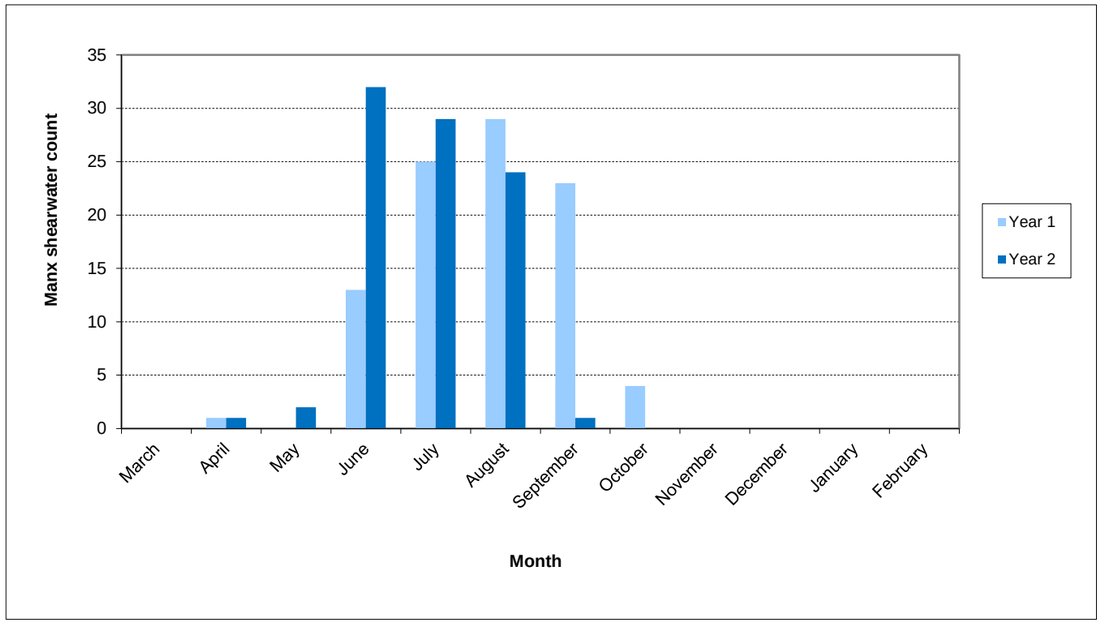


Figure 3.20 Temporal variation in raw counts of Manx shearwater in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

3.7.80 Due to the low sample size of Manx shearwaters recorded in Years 1 and 2, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. The highest mean monthly abundance of 0.03 birds/km was recorded in the Hornsea Zone and 10 km buffer in July and August of Year 1 (Figure 3.21).

Behaviour and distribution

3.7.81 A total of 115 Manx shearwaters were recorded in flight on baseline surveys, with only one bird (0.9%) flying above 22.5 m in height, at an estimated height of 40 m (Table 3.2).

3.7.82 The abundance map for Manx shearwater covers the period April to October for Years 1 and 2 in the Hornsea Zone (Appendix B). Few individuals were recorded on the site, both within Subzone 1 and the 4 km buffer and in the Hornsea Zone. There was no spatial pattern in distribution.

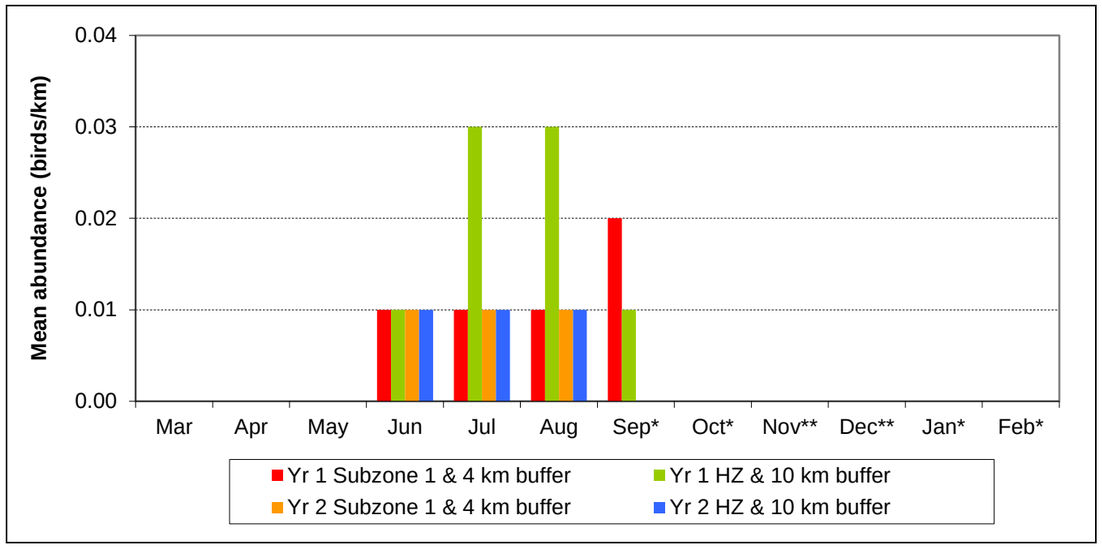


Figure 3.21 Temporal variation in mean abundance of Manx shearwater in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Balearic Shearwater (*Puffinus mauritanica*)

Status overview

3.7.83 Balearic shearwater is listed as Critically Endangered on the IUCN (World Conservation Union) Red List, and is also listed on Annex I of the EU Birds Directive, due to its small, rapidly declining breeding population. The species is also currently red-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.84 This species breeds on the Balearic Islands and the small, rapidly declining breeding population is estimated at 3,193 pairs (Birdlife International, 2012). The total world population may be within the range of 20,000 to 30,000 individuals (Birdlife International, 2012).

3.7.85 Balearic shearwater is classed as a scarce migrant off the Yorkshire coast, occurring mainly in late summer and autumn (Thomas, 2011).

3.7.86 Langston (2010) assessed Balearic shearwater as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision, and displacement were rated as low (Table 3.3). The species is not listed as a qualifying interest for any UK SPA (JNCC, 2012).

Hornsea Survey Area

3.7.87 In Year 1, one Balearic shearwater was recorded in the south-west of the Hornsea Zone in August (Figure 3.22). In Year 2, four Balearic shearwaters were recorded in July, with two in Subzone 1 and two in the Hornsea Zone.

3.7.88 Due to the low number of sightings, no further evaluations were made of temporal or spatial distribution of this species on the study site, as the birds appear to be distributed randomly throughout Subzone 1 and the 4 km buffer.

3.7.89 Three Balearic shearwaters were seen in flight during baseline surveys, with all three birds flying below 7.5 m.

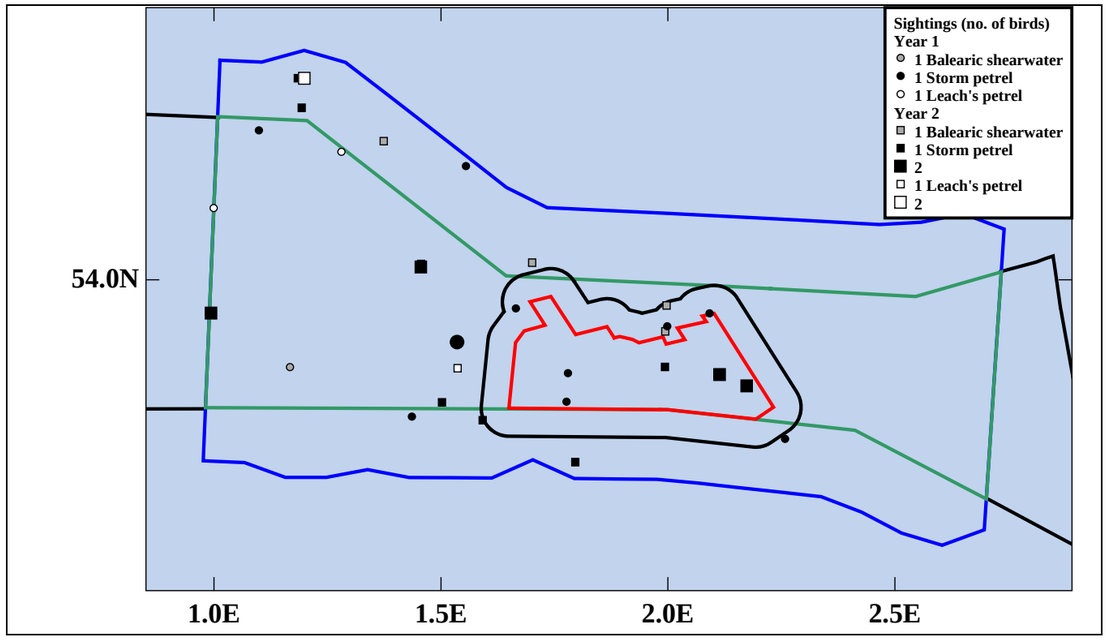


Figure 3.22 Spatial distribution of Balearic shearwater, storm petrel and Leach's petrel in the Hornsea Survey Area.

European Storm Petrel (*Hydrobates pelagicus)*

Status overview

3.7.90 Storm petrel is listed on Annex I of the EU Birds Directive, and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.91 Storm petrels breed at a few colonies around the UK, primarily on Shetland, Orkney, Western Isles and the west coast of Scotland, as well as on islands off the Welsh coast, Isles of Scilly and the Channel Islands. Seabird 2000 estimated the UK breeding population to be 25,710 pairs, however outside of Orkney and Shetland, there are no breeding colonies on the east coast of Britain (Mitchell *et al.*, 2004). After the breeding season, birds migrate south and spend the winter off the coast of southern Africa. The species is classed as an uncommon to scarce migrant off the Yorkshire coast, in late summer and autumn (Thomas, 2011).

3.7.92 Langston (2010) assessed storm petrel as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision, and displacement were rated as low. Overall, storm petrel was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.93 Storm petrel is listed as a qualifying interest species in the breeding season for two SPAs on the UK east coast between Hermaness and Foreness Point; Auskerry and Mousa. These two SPAs held 12.2% of the UK breeding population, and 4.0% of the biogeographic population at the time of designation (JNCC, 2011). Although the most recent estimate for Auskerry has declined, the population on Mousa has almost doubled (Seabird Monitoring Programme (SMP) 2012). The maximum foraging distance is not currently known, however storm petrels are known to forage at least 65 km from their colonies (Thaxter *et al.*, 2012). Non-trivial connectivity to the Hornsea Survey Areas is however considered very unlikely.

Hornsea Survey Area

3.7.94 In Year 1, 12 storm petrels were recorded in the Hornsea Survey Area between September and December. Two were recorded in Subzone 1 in November, with three in the 4 km buffer between September and December. The remaining birds were mostly recorded in the western half of the Hornsea Zone and 10 km buffer, in October and November (Figure 3.22).

3.7.95 In Year 2, a total of 17 storm petrels were seen between July and November, with a peak of eight in November. Twelve birds were recorded in the Hornsea Zone, with four seen in Subzone 1.

3.7.96 A total of 19 storm petrels were seen in flight on baseline surveys, with all birds recorded flying below 2.5 m in height. In addition, one unidentified storm petrel species was recorded flying below 2.5 m in height on the western edge of the Hornsea Zone in October of Year 1.

Leach's Petrel (*Oceanodroma leucorhoa*)

Status overview

3.7.97 Leach's petrel is listed on Annex I of the EU Birds Directive and Schedule 1 of the Wildlife and Countryside Act. The species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.98 The majority of breeding Leach's petrels are found on St Kilda, with smaller colonies on the Western Isles and also on Shetland. Seabird 2000 estimated the UK breeding population to be 48,047 pairs (Mitchell *et al.*, 2004). Birds occur in low numbers in the North Sea between September and November (Stone *et al.*, 1995). After the breeding season, birds migrate south and spend the winter off the Azores, South Atlantic and off South Africa (Forrester *et al.*, 2007). The species is classed as a scarce to rare migrant off the Yorkshire coast, usually in late autumn (Thomas, 2011).

3.7.99 Langston (2010) assessed Leach's petrel as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision, and displacement were rated as low. Overall, Leach's petrel was assessed as being at moderate risk from offshore wind developments (Table 3.3). Although Leach's petrel is listed as a qualifying interest for two SPAs on Shetland (Foula and Ramna Stack and Gruney) (JNCC, 2012), these SPAs were not considered in this report as the species was not recorded within Subzone 1 or the 4 km buffer on baseline surveys.

Hornsea Survey Area

3.7.100 Single Leach's petrels were recorded in the north-west of the Hornsea Zone in October and November of Year 1. In Year 2, one was recorded in March, with two seen in November. The species was not recorded in Subzone 1 or the 4 km buffer on baseline surveys (Figure 3.22).

3.7.101 Five Leach's petrels were seen in flight on baseline surveys, with all birds recorded flying below 2.5 m in height.

Gannet (*Morus bassanus*)

Status overview

3.7.102 Gannet is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009). The species breeds in a few large, colonies around the UK. The nearest gannet breeding colony to the Hornsea Zone is at Bempton Cliffs. This colony was estimated at 7,859 nests in 2009 (SMP, 2012), and increased to an estimated 9,947 pairs in 2011, and 11,061 pairs in 2012 (data provided by Natural England via Phase 4 consultation response). The largest UK gannet colony is at Bass Rock, with an estimated breeding population of 55,482 nests in 2009 (Murray, 2011). Breeding birds have been shown by satellite-tagging to range widely across the North Sea, at times travelling as far as the Norwegian coast (Hamer *et al.*, 2007).

3.7.103 A recent review assessed gannet as being at high risk of collision resulting from offshore wind farms, based on its activity rate at risk heights, including at night, and its conservation importance in the UK (Furness and Wade, 2012). Langston (2010) rated the risk of collision as moderate, and the risk of displacement, barrier effects, habitat loss or changes in prey distribution were rated as low. Overall, gannet was assessed as being at high risk from offshore wind developments, due to the large proportion of the global population found within the UK (Langston, 2010) (Table 3.3).

3.7.104 Gannet is listed as a qualifying interest species in the breeding season for five SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.11). These SPAs held 28.5% of the UK breeding population, and 21.9% of the biogeographic population at the time of designation (JNCC, 2011). Only Flamborough Head and Bempton Cliffs is within the mean maximum foraging range of 229.4 km (Thaxter *et al.,* 2012). The Firth of Forth Islands SPA is within the estimated maximum foraging range of 590 km (Figure 3.23).

Table 3.11 SPAs for gannets on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Fair Isle	698.1	1,166	0.4	0.6	3,582	2009
Firth of Forth Islands	*365.9*	*34,400*	*13.1*	*17.1*	*55,482*	*2009*
Flamborough Head and *Bempton Cliffs*	*123.4*	*2,501*	*0.95*	*1.2*	*9,947*	*2011*
Hermaness, Saxa Vord and Valla Field	771.8	12,000	4.6	6.0	24,353	2008
Noss	702.6	7,310	2.8	3.6	8,652	2003
Total	**-**	**57,377**	**21.9**	**28.5**	**100,537**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database. Flamborough Head and Bempton Cliffs population estimate provided by Natural England.

Sites in italics lie within mean maximum/maximum foraging range (590 km) (Thaxter *et al.*, 2012).

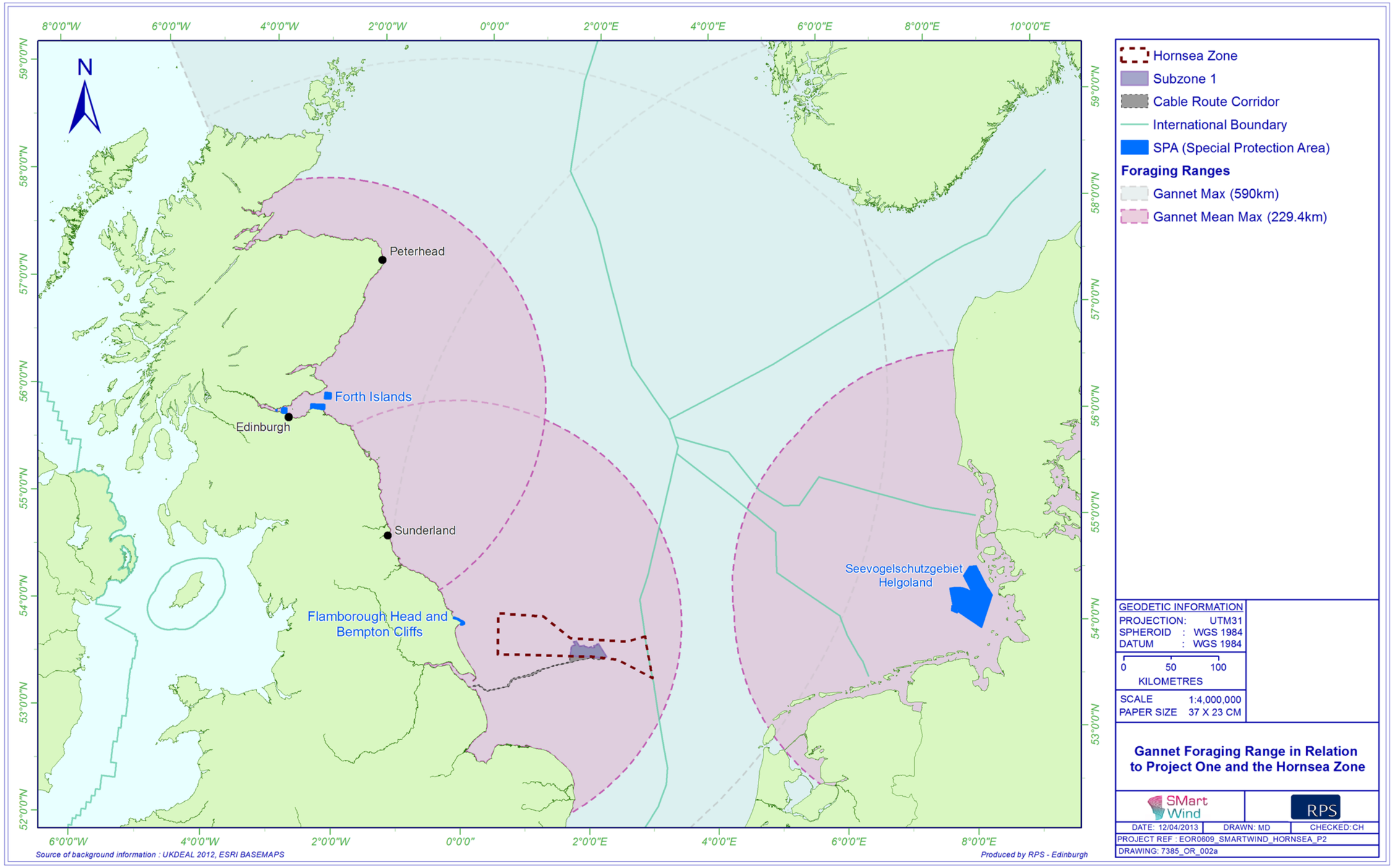


Figure 3.23 Gannet foraging ranges from SPAs in relation to the Hornsea Survey Area. Note Northern Isles SPAs (beyond maximum foraging range) not shown on map.

Hornsea Survey Area

3.7.105 Gannet was the fourth most frequently seen seabird in the Hornsea Survey Area in Year 1, with 7,013 birds recorded on surveys (Table 3.1). Just under two thirds of gannets (62.8%) were recorded in the Hornsea Zone and 10 km buffer in Year 1. In Year 2 numbers were higher, with 11,477 birds recorded. Again, the majority of birds (81%) were recorded in the Hornsea Zone and 10 km buffer (Table 3.12).

Seasonal distribution and abundance

3.7.106 Gannet is a widely dispersed species throughout the southern North Sea with an estimated flyway population of 892,000. Of this population, it is estimated that 40-60,000 birds pass through the southern North Sea on the way to the Strait of Dover, with 10,000 birds remaining in the area through winter (Steinen *et al.,* 2007). Between March and August gannets are present in low densities in the southern North Sea with populations concentrated on the shelf edge or, in the breeding season, focussed around the major colonies (Stone *et al.,* 1995). During post-breeding and the winter months, gannets remain close to their breeding colonies or again travel to the shelf edge where densities of up to five birds/km^2 are recorded (Stone *et al.,* 1995).

3.7.107 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show gannet numbers in the Greater Wash survey blocks GW2, GW9 and GW10, were at their peak during July, with a peak mean of 390 birds recorded. Birds were much less frequently seen during the winter surveys.

3.7.108 During the breeding season in Year 1 (April to September), the peak estimated number of gannets occurred in August, with 307 birds in Subzone 1, or 660 birds including the 4 km buffer. In comparison, an estimated 4,008 birds occurred in the Hornsea Zone and 10 km buffer in August (Table A.2 and Table A.4). In the Year 2 breeding season, the peak estimated numbers occurred in September, with 375 birds in Subzone 1, or 805 birds including the 4 km buffer. An estimated 1,955 birds were recorded in the Hornsea Zone and 10 km buffer in July, although there were no data for September (Table A.3 and Table A.5).

3.7.109 During the non-breeding season in Year 1 (October to March), peak estimated numbers of gannets were 385 birds for Subzone 1, and 827 birds including the 4 km buffer, in November. Estimated numbers of gannets in the Hornsea Zone and 10 km buffer in the non-breeding period were highest in October (6,619 birds). In the Year 2 non-breeding period, peak estimated numbers of gannets were 290 birds for Subzone 1, and 624 birds including the 4 km buffer in October. Estimated numbers of gannets in the Hornsea Zone and 10 km buffer in the non-breeding period were highest in March (2,342 birds).

3.7.110 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1). Gannet estimated count data are presented in Figure 3.19, Figure 3.25, Figure 3.26 above.

Densities

3.7.111 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area, and during the breeding season, the mean monthly density of all three areas combined was low, with only 0.18 birds/km^2 or fewer. During the non-breeding season, numbers in the areas increased, with the monthly mean for all three areas being around 0.30 birds/km^2 or above. When comparing the three areas with each other, overall gannet numbers were highest in Area 4 (western North Sea) with a peak of 0.82 birds/km^2 in September.

3.7.112 Gannet densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.13.

3.7.113 Estimated mean monthly gannet density in Subzone 1 (and 4 km buffer) and the Hornsea Zone (and 10 km buffer) showed a similar pattern between Years 1 and 2. In general, mean density decreased with the onset of the breeding season in March and April, and slowly increased again to peaks between September and November, before decreasing again through winter. In Subzone 1 (and 4 km buffer) mean density peaked in November of Year 1 (0.9 birds/km^2), and September of Year 2 (0.9 birds/km^2), while in the Hornsea Zone (and 10 km buffer), peak mean density was recorded in October of Year 1 (1.3 birds/km^2), and March of Year 2 (0.5 birds/km^2), although data for September to February of Year 2 was lacking (Figure 3.27).

3.7.114 ESAS mean density data for gannet in the surrounding ICES rectangles and Regional Seas 1 and 2 was generally similar to the baseline survey data, apart from in June, when mean density in Regional Seas 1 and 2 exceeded the baseline survey data values.

3.7.115 A comparison of the temporal distribution of gannet density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.28.

3.7.116 The temporal pattern for the Hornsea Survey Area densities was similar to that for the wider North Sea, with slightly higher values outside the breeding season, particularly in the Hornsea Zone and 10 km buffer.

Table 3.12 Estimated numbers of gannets in Subzone 1, Subzone 1 and 4 km buffer, and the Hornsea Zone and 10 km buffer in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 and 4 km buffer[1]	Est. total Subzone 1[1]	Est. total in HZ and 10 km buffer[2]
1	March	107	50	229	223	585	273	3,247
1	April	65	24	182	27	123	57	1,965
1	May	0	0	0	27	58	27	515
1	June	102	31	335	13	131	61	542
1	July	47	18	122	0	47	22	1,029
1	August	443	230	855	101	660	307	4,008
1	September	393	238	651	67	537	250	2,309
1	October	357	262	485	189	764	356	6,619
1	November	363	246	535	216	827	385	3,355
1	December	8	1	44	34	81	38	358
1	January	32	8	133	81	206	96	1,042
1	February	146	44	485	54	262	122	4,287
2	March	92	46	182	125	360	168	2,342
2	April	72	39	135	28	131	61	645
2	May	24	8	69	0	24	11	842
2	June	64	22	182	0	64	30	1,605
2	July	224	136	370	54	341	159	1,955
2	August	154	74	322	14	183	85	1,701
2	September	304	177	523	233	805	375	410[3]
2	October	446	292	681	83	624	290	1,913[3]
2	November	287	173	475	96	492	229	2,002[3]
2	December	0	0	0	0	0	0	-
2	January	39	11	130	118	293	137	64[3]
2	February	0	0	0	7	14	7	67[3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

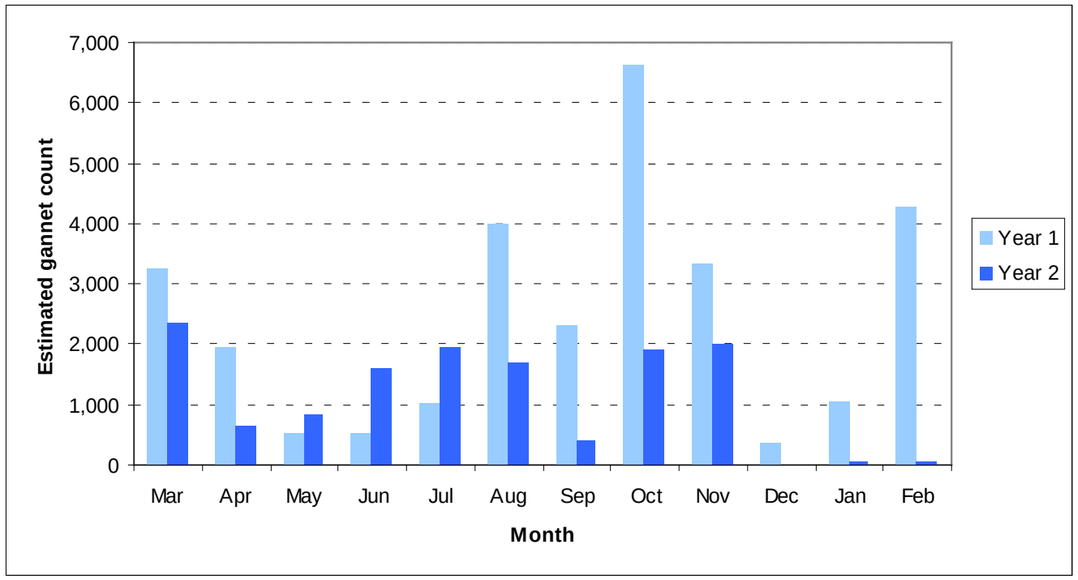


Figure 3.24 **Temporal variation in distance-adjusted counts of gannet in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

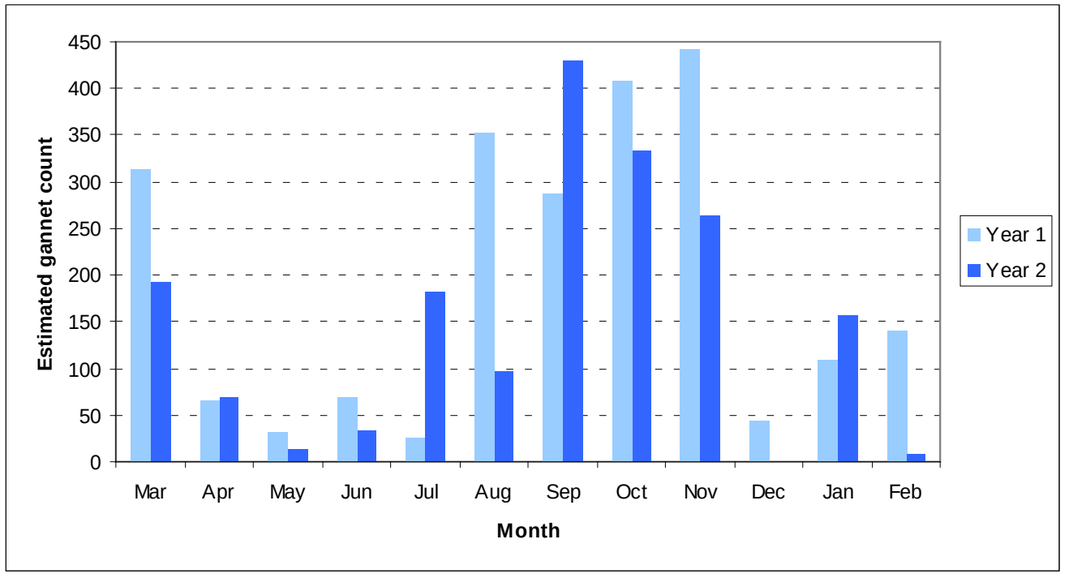


Figure 3.25 **Temporal variation in distance-adjusted counts of gannet in Subzone 1 and 4 km buffer**

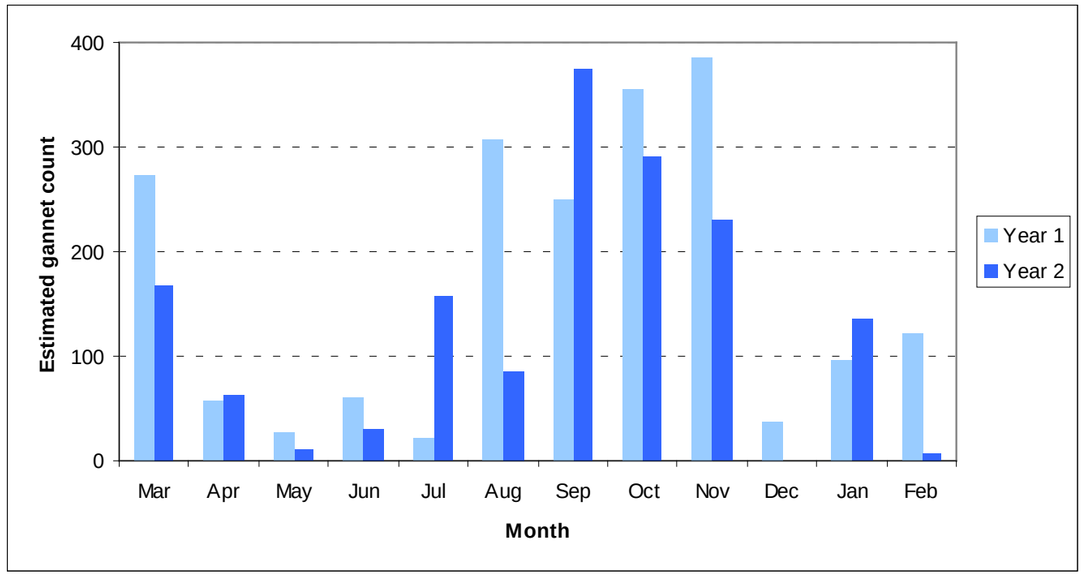


Figure 3.26 **Temporal variation in distance-adjusted counts of gannet in Subzone 1.**

Table 3.13 **North Sea gannet densities from Stone *et al*. (1995).**

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0.16	0.09	0.01	0.09	0.28
February	0.72	0.21	0.04	0.32	0.16
March	0.18	0.19	0.08	0.15	0.54
April	0.39	0.11	0.04	0.18	0.15
May	0.30	0.02	0.02	0.11	0.05
June	0.49	0.04	0.02	0.18	0.11
July	0.40	0.12	0.03	0.18	0.22
August	0.81	0.10	0.07	0.33	0.48
September	0.82	0.23	0.17	0.41	0.77
October	0.50	0.28	0.35	0.38	0.79
November	0.14	0.18	0.16	0.16	0.75
December	0.08	0.68	0.08	0.28	0.05

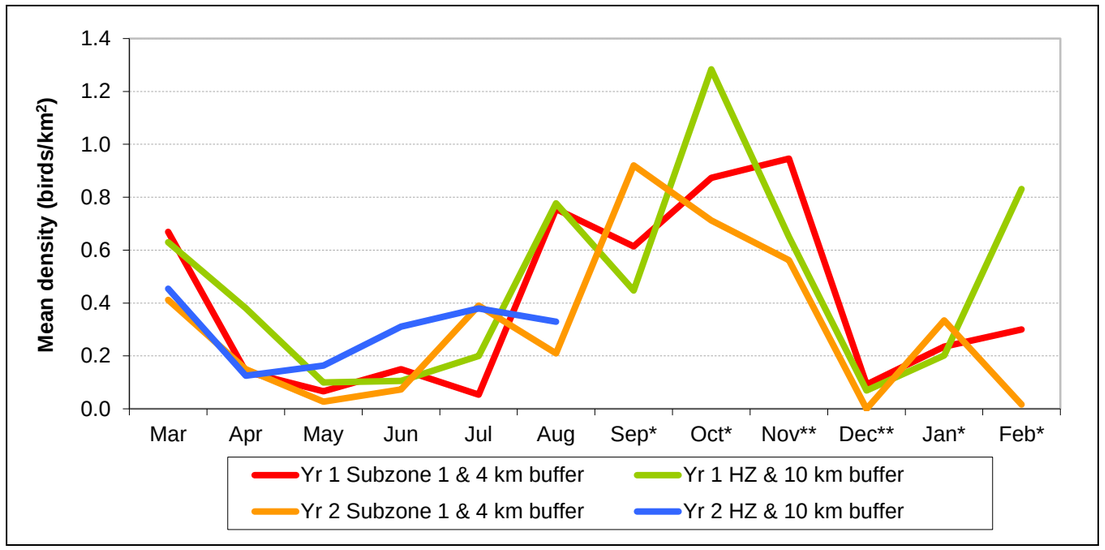


Figure 3.27 Temporal variation in mean gannet density in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

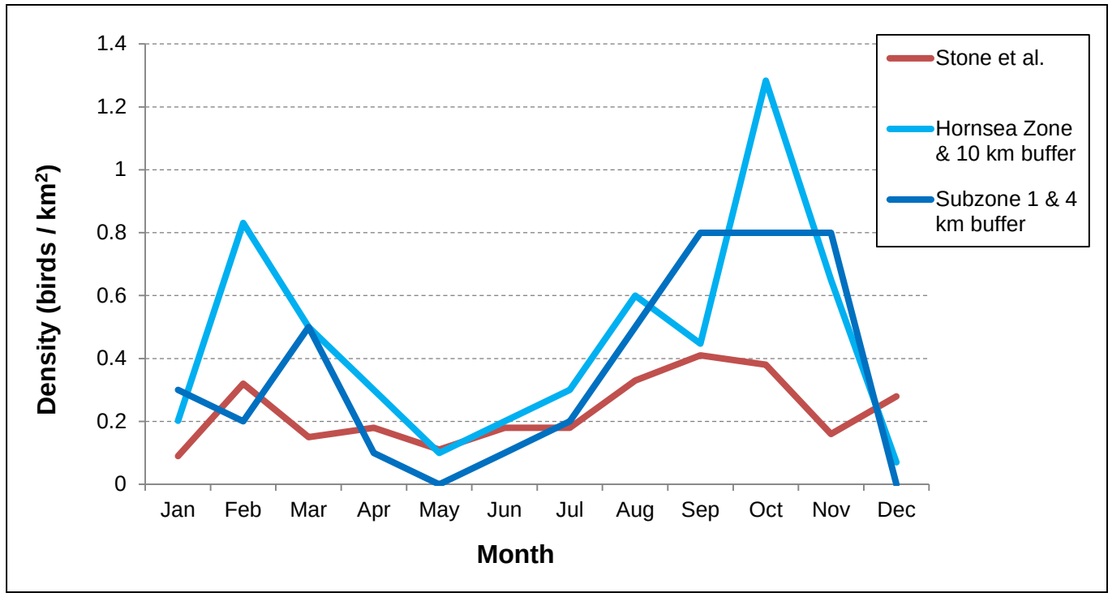


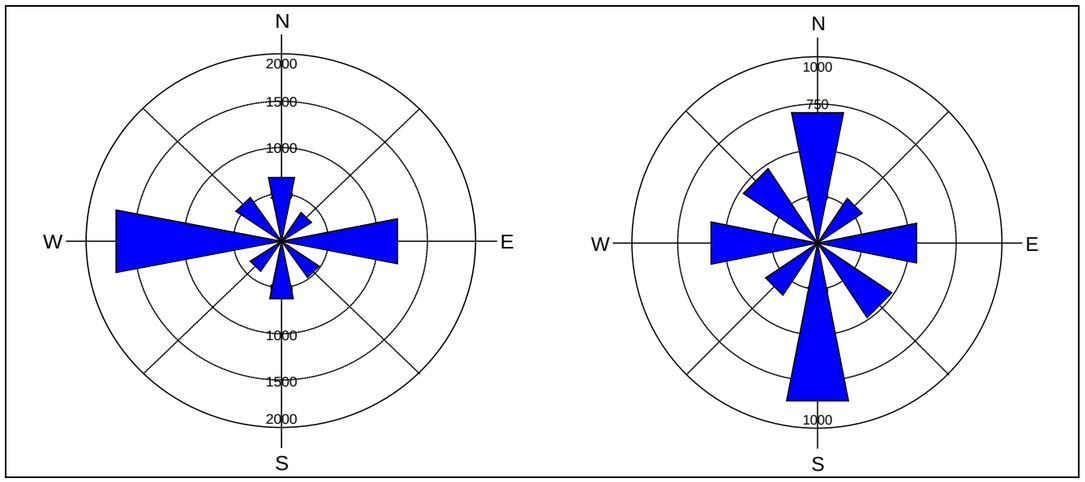
Figure 3.28 A comparison of temporal variation in density of gannet in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).

Behaviour and distribution

3.7.117 A total of 13,034 gannets were recorded in flight on baseline surveys, with 702 birds (8.1%) flying above 22.5 m, at estimated heights of between 25 and 80 m (Table 3.2).

3.7.118 Flight direction was recorded for over 6000 gannets in the breeding season with direction recorded for over 4000 in the non-breeding season. In the breeding season, over a quarter of all birds recorded were flying west, towards the breeding colony at Bempton Cliffs, and just under a fifth flying east. In the non-breeding season, there was a less clear pattern (Figure 3.29).

3.7.119 In the breeding season, over a quarter of all birds recorded were flying west (28.5%), towards the breeding colony at Bempton Cliffs, with 18.4% of birds flying east. In the non-breeding season, there was a less clear pattern, with 20.1% of birds recorded flying south, and 16.6 birds flying north.



March to September (n=6,028 birds) October to February (n=4,301 birds)

Numbers shown on figures are number of birds recorded

Figure 3.29 Flight direction of gannets in the Hornsea Survey Area in Years 1 and 2.

3.7.120 Gannets sometimes feed by plunge diving for fish, often from a considerable height above the surface. Foraging behaviour was recorded for 2,858 gannets in the Hornsea Survey Area on baseline surveys, with 12 types of foraging behaviour recorded, and unspecified feeding behaviour recorded for a further 223 birds (Table 3.14) The majority of all foraging birds on baseline surveys were recorded actively searching (66.5%) and plunge diving (17.0%).

Table 3.14 Gannet foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	1,901	66.5
Deep plunging	487	17.0
Dipping	1	0.03
Holding fish	3	0.1
Pursuit plunging	16	0.6
Scavenging at fishing vessel	135	4.7
Scooping prey from surface	20	0.7
Surface seizing	2	0.06
Shallow plunging	70	2.4
Feeding – method unspecified	223	7.8
Total	**2,858**	

3.7.121 A total of 10,828 gannets were aged on baseline surveys. Over the 12 months, the average percentage of non-adult (immature) birds was 21.8% (Table 3.15). Proportions of non-adult birds peaked in May and September.

Table 3.15 Age breakdown of gannets recorded in Years 1 and 2.

Month	Number of non-adults	Number of adults	Total aged birds	% of adult birds
March	39	1,207	1,246	96.9%
April	108	469	577	81.3%
May	138	58	196	29.6%
June	232	596	828	72.0%
July	301	914	1,215	75.2%
August	586	761	1,347	56.5%
September	494	221	715	30.9%
October	311	2,062	2,373	86.9%
November	108	1,028	1,136	90.5%
December	19	108	127	85.0%
January	11	291	302	96.4%
February	12	754	766	98.4%
Annual	**2,359**	**8,469**	**10,828**	**78.2%**

3.7.122 The density distribution maps for gannet cover the periods April to September and October to March for Years 1 and 2 in Subzone 1 and the 4 km buffer and for the Hornsea Zone (Appendix B). Gannet density and distribution was consistent throughout the year, with individuals observed throughout the Hornsea Survey Area. As this species forages widely, a lack of patterns in spatial distribution on the site is expected.

Cormorant (*Phalacrocorax carbo*)

Status overview

3.7.123 Cormorants breed in colonies, and their distribution is closely linked to sheltered shallow coastal waters, usually less than 20 m deep, where foraging birds can reach the seabed. Seabird 2000 recorded 6,824 pairs of cormorants breeding around the coast of Britain, with a further 1,646 pairs breeding inland (Mitchell *et al.*, 2004). Cormorants typically prey on a wide range of small fish species, from shallow, inshore waters (Forrester *et al.*, 2007). Two sub-species exist in the UK; *P. c. carbo* and the continental *P. c. sinensis* which is more of an inland species.

3.7.124 Langston (2010) assessed cormorant as being at moderate risk of collision, barrier effects and habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of displacement was rated as low. Overall, cormorant was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.125 Cormorant is listed as a qualifying interest species in the breeding season for five SPAs on the UK east coast. However, none of these locations are located within foraging range of the Hornsea Zone (Table 3.16).

3.7.126 Cormorant is also listed as a qualifying interest species in the non-breeding season for 15 SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.17). These SPAs held 36.6% of the UK non-breeding population, and 4.2% of the biogeographic population at the time of designation (JNCC, 2012). Recent five-year means are also shown for comparison, where available.

3.7.127 Evidence from ringing studies suggests that movements of UK cormorants across the North Sea are very rare, although there is limited evidence of birds from France, Denmark and other countries bordering the North Sea crossing to Britain (Wernham *et al.*, 2011). Non-trivial connectivity with any winter SPA is therefore considered very unlikely.

Table 3.16 SPAs for cormorants on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Firth of Forth islands	365.9	240	0.6	3.4	242	2007
Farne Islands	280.7	194	0.5	2.8	141	2009
East Caithness Cliffs	613.7	144	0.4	2.1	111	1999
Calf of Eday	644.4	223	0.5	3.2	195	2003
Abberton Reservoir	265.1	490	1.2	7.0	216	2005
Total	**-**	**1,291**	**3.2**	**18.5**	**905**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

3.7.128 Two cormorants were recorded in the Hornsea Survey Area in Year 1 (Figure 3.30). One was seen in the 4 km buffer in March, with another in the north-west of the Hornsea Zone in June (Table A.2 and Table A.4). Nine cormorants were recorded in Year 2, with two in Subzone 1 and seven in the Hornsea Zone. Peak numbers occurred in March and April (six birds) (Table A.3 and Table A.5).

3.7.129 A total of 11 cormorants were recorded in flight on baseline surveys, with only one bird recorded flying above 22.5 m, at an estimated height of 45 m.

3.7.130 It is considered that the Hornsea Survey Area is too far offshore for regular foraging cormorants, hence the limited number of records of this species on the baseline surveys.

Table 3.17 SPAs for cormorants on the UK east coast in the non-breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]
Abberton Reservoir	265.1	400	0.3	3	582 [2]
Blackwater Estuary	260.1	555	0.5	4.2	351 [3]
Breydon Water	147.8	139	0.1	1.1	x
Broadland	118.4	633	0.5	4.8	x
Colne Estuary	248.5	313	0.3	2.4	233 [2]
Dengie	256.2	200	0.2	1.5	x
Firth of Forth	365.9	697	0.6	5.3	614 [3]
Firth of Tay and Eden Estuary	392.8	230	0.2	1.7	224 [2]
Inner Moray Firth	607.6	418	0.4	3.2	x
Medway Estuary and Marshes	288.9	231	0.2	1.8	97 [2]
North Norfolk Coast	104.3	140	0.1	1.1	275 [2]
Stour and Orwell Estuaries	228.0	225	0.2	1.7	x
Teesmouth and Cleveland Coast	193.3	191	0.2	1.5	362 [3]
The Swale	285.1	187	0.2	1.4	x
The Wash	121.4	256	0.2	1.9	431 [3]
Total	**-**	**4,815**	**4.2**	**36.6**	**4,971+**

[1] JNCC (2011) – SPA online species accounts.

[2] Calbrade *et al.*, 2010.

[3] Holt *et al.*, 2011.

x No data available.

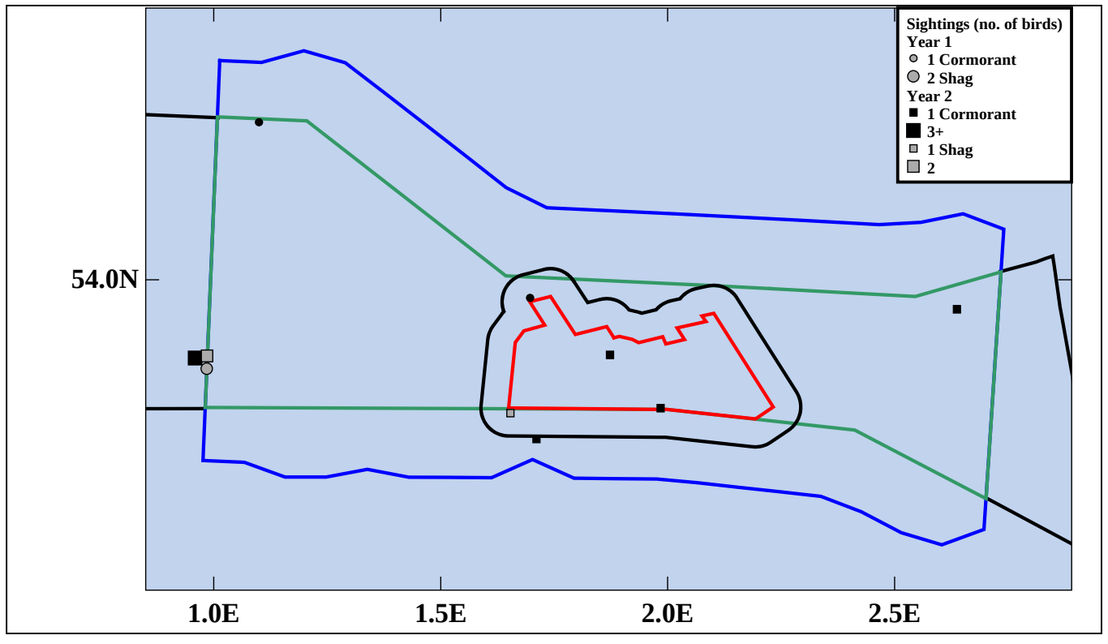


Figure 3.30 Spatial distribution of cormorant and shag in the Hornsea Survey Area.

European Shag (*Phalacrocorax aristotelis*)

Status overview

3.7.131 Shag is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.132 Shags are surface-diving bottom-foraging birds that generally forage in inshore waters, at depths of between 20 m and 40 m. The main prey species is the lesser sandeel, caught on or near the seabed (Forrester *et al.*, 2007). Seabird 2000 recorded 28,579 pairs of shags around the coast of Britain (Mitchell *et al.*, 2004).

3.7.133 Langston (2010) assessed shag as being at moderate risk of displacement, barrier effects and habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision was rated as low. Overall, shag was assessed as being at moderate risk from offshore wind developments (Table 3.3)

3.7.134 Shag is listed as a qualifying interest species in the breeding season for eight SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.18). These SPAs held 31.9% of the UK breeding population and 9.5% of the biogeographic population at the time of designation (JNCC, 2012). None of these SPA colonies lie within the maximum known foraging range of this species (17 km) (Thaxter *et al.*, 2012).

Hornsea Survey Area

3.7.135 Two shags were recorded together in the south-west of the Hornsea Zone in February 2010 of Year 1 (Figure 3.30). There were three shags recorded in the Hornsea Survey Area in Year 2; two in the Hornsea Zone in March and one in Subzone 1 in November.

3.7.136 A total of five flying shags were recorded on baseline surveys, with all birds flying below 7.5 m in height.

3.7.137 Like cormorant, it is considered likely that the Hornsea Survey Area is too far offshore for shags, so the birds recorded during surveys do not reflect recurring use of the site by this species.

Eider (*Somateria mollissima*)

Status overview

3.7.138 Eider is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.139 The eider is the commonest species of seaduck in the UK, with a mainly sedentary breeding population of around 31,650 pairs (RSPB, 2012). Eiders are an inshore species, usually found within 10 km of the coast. Their main prey are blue mussels, as well as sea urchins, starfish and other marine invertebrates (Forrester *et al.*, 2007).

3.7.140 Langston (2010) assessed eider as being at moderate risk of barrier effects and habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision and displacement were ranked as low. Overall, eider was assessed as being at moderate risk from offshore wind developments (Table 3.3)

3.7.141 Eider is listed as a qualifying interest species for five SPAs in the non-breeding season on the UK east coast between Hermaness and Foreness Point (Table 3.19). These SPAs held 19.5% of the UK non-breeding population and 0.9% of the biogeographic population at the time of designation (JNCC, 2012). Recent five-year means are also shown for comparison, where available. The distance from each of the SPAs to the Hornsea Survey Areas suggest that non-trivial connectivity is unlikely.

Table 3.18 SPAs for shags on the UK east coast in the breeding season

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Buchan Ness to Collieston coast	473.1	1,045	0.8	2.8	344	2007
East Caithness cliffs	613.7	2,345	1.9	6.3	1,075	1999
Fair Isle	698.1	1,099	0.9	2.9	732	2003
Foula	717.3	2,400	1.9	6.4	2,300	2000
Hermanes, Saxa Vord and Valla Field	771.8	540	0.4	1.4	-	-
Firth of Forth islands	365.9	2,887	2.3	7.7	235	2009
Farne Islands	280.7	994	0.8	2.7	838	2009
St Abb's Head to Fast Castle	325.5	651	0.5	1.7	131	2008
Total	-	11,961	9.5	31.9	5,695+	-

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

3.7.142 Two eiders were recorded in the south-west of Hornsea Survey Area in April of Year 1 (Figure 3.31). In Year 2, seven eiders were recorded, five in Subzone 1 and two in the Hornsea Zone.

3.7.143 A total of nine eiders were recorded flying on baseline surveys, but none were recorded flying above 22.5 m in height. These few individuals indicate that the proposed wind farm site does not provide important habitat for this species.

Table 3.19 SPAs for eiders on the UK east coast in the non-breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]
Firth of Tay and Eden Estuary	392.8	2,061	0.1	2.7	7,453 [3]
Firth of Forth	365.9	7,887	0.5	10.2	5,297 [3]
Lindisfarne	287.6	1,568	0.1	2.0	930 [3]
Montrose Basin	404.8	1,794	0.1	2.3	2,376 [3]
Ythan Estuary, Sands of Forvie, Meikle Loch	437.4	1,778	0.1	2.3	3,404 [3]
Total	-	15,088	0.9	19.5	19,460

[1] JNCC (2011).

[2] Calbrade *et al.*, 2010.

[3] Holt *et al.*, 2011.

x No data available.

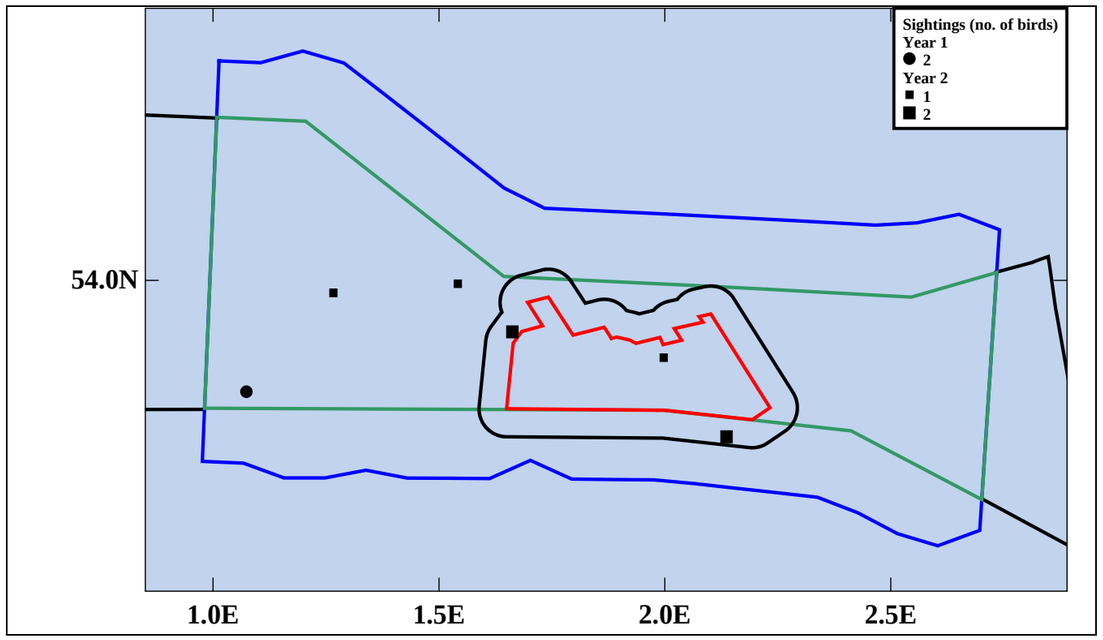


Figure 3.31 Spatial distribution of eider sightings in the Hornsea Survey Area.

Common Scoter (*Melanitta nigra*)

Status overview

3.7.144 Common scoter is currently red-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.145 Most of the UK winter population of tends to be found in a few large flocks off the mouths of major estuaries around the UK coast. A review of numbers for the UK and survey work at key sites suggested that the number of wintering common scoter is likely to be in the region of 100,000 birds (Musgrove *et al.*, 2011).

3.7.146 The UK breeding population of common scoter has declined by more than 50% in recent years, and was estimated at between 9 and 52 pairs in 2007, all in northern Scotland (Holling *et al.*, 2010).

3.7.147 Langston (2010) assessed common scoter as being at moderate risk of displacement, barrier effects and habitat loss or changes in prey distribution resulting from offshore wind farms. Risk of collision was ranked as low. Overall, common scoter was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.148 Common scoter is listed as a qualifying interest species in the non-breeding season for five SPAs on the UK east coast (Table 3.20). These SPAs held 29.8% of the UK non-breeding population and 0.7% of the biogeographic population at time of designation (JNCC, 2012). Recent counts are included for comparison.

Hornsea Survey Area

Seasonal distribution and abundance

3.7.149 A total of 129 common scoter were recorded in the Hornsea Survey Area in Year 1 (Table 3.1). Birds were recorded in April to June and then August to September only, December and January. The peak counts was 34 birds in both August and November (Figure 3.32). The majority of common scoter were seen flying through Subzone 1 and 4 km buffer, with fewer sightings in the Hornsea Zone.

3.7.150 Higher numbers were recorded in Year 2, with a total of 290 birds seen. Birds were recorded in all months except June, December and January, which was a similar pattern to Year 1. The peak counts were 119 birds in July in Subzone 1 and 61 in March in the Hornsea Zone.

3.7.151 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

Table 3.20 SPAs for common scoter on the UK east coast in the non-breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]
Firth of Forth	365.9	2,653	0.2	9.6	1,393 [2]
Firth of Tay and Eden Estuary	392.8	1,444	0.1	5.3	632 [2]
Lindisfarne	287.6	654	<0.1	2.4	257 [2]
Moray and Nairn Coast	550.0	531	<0.1	1.9	2,982 [2]
North Norfolk Coast	104.3	2,909	0.2	10.6	4,808 [2]
Total	**-**	**8,191**	**0.7**	**29.8**	**10,072**

[1] JNCC (2011).

[2] Holt *et al.* (2011).

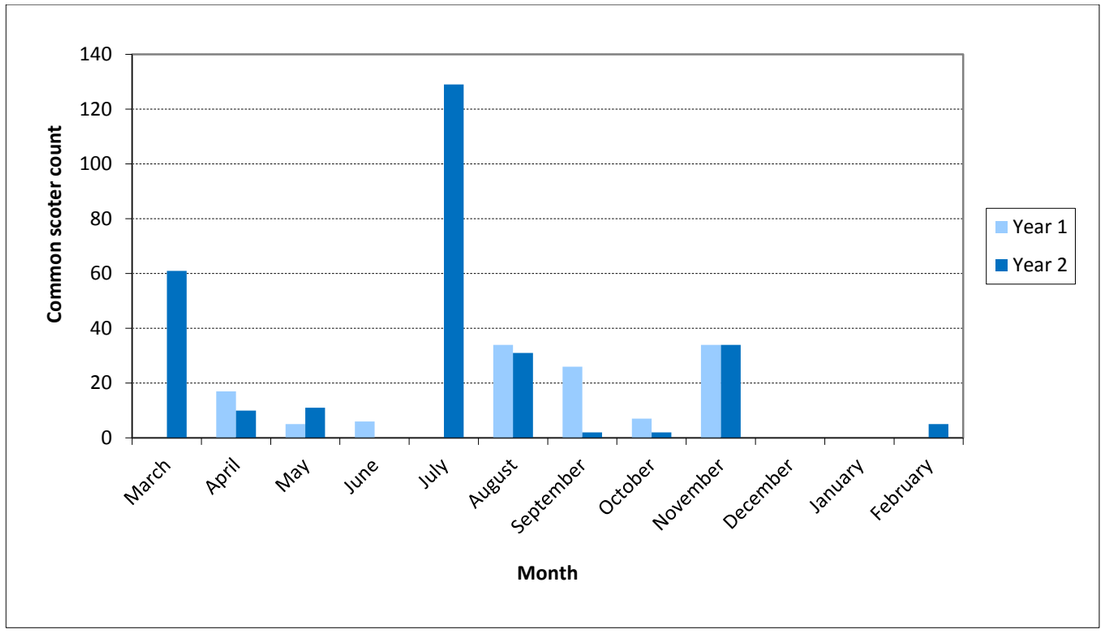


Figure 3.32 Temporal variation in raw counts of common scoter in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.)

3.7.152 Due to the low sample size of common scoters recorded on baseline surveys, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. Mean monthly abundance of common scoters on baseline surveys was low, with a peak of 0.06 birds/km in Subzone 1 and 4 km buffer in November of Year 1, and a peak of 0.21 birds/km in Subzone 1 and the 4 km buffer in July of Year 2 (Figure 3.33).

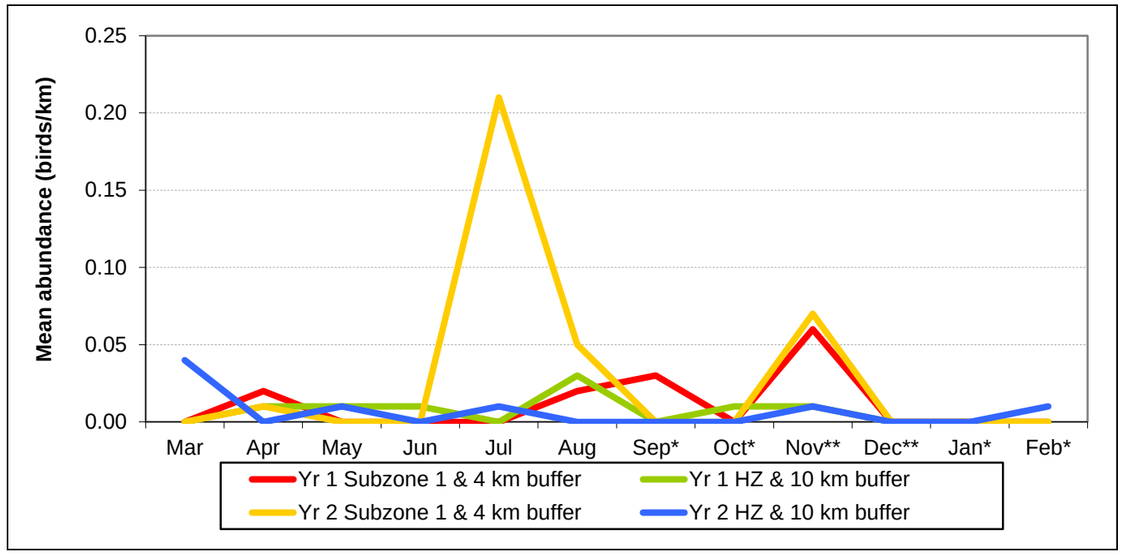


Figure 3.33 Temporal variation in mean abundance of common scoter in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

3.7.153 Coverage in the Hornsea Zone and 10 km buffer between September and February was limited (Table 2.1).

Behaviour and distribution

3.7.154 A total of 413 common scoter were recorded in flight on baseline surveys, with four birds (0.9%) recorded flying above 22.5 m, at an estimated 40 m (Table 3.2).

3.7.155 The abundance map for common scoter covers the period February to November for Years 1 and 2 in the Hornsea Survey Area (Appendix B). Few common scoter were recorded, primarily within Subzone 1 and the 4 km buffer, which may be influenced by the distribution of survey effort. As this species does not show a distinct pattern of spatial or temporal distribution within the survey area, it is unlikely that the site is an important habitat for scoter.

Grey Phalarope (*Phalaropus fulicarius*)

Status overview

3.7.156 Grey phalarope is an uncommon passage migrant in UK waters, with most records occurring in autumn (Stone *et al.*, 1995). Off the Yorkshire coast, it is a scarce to rare passage migrant and winter visitor (Thomas, 2011). Grey phalarope is not a qualifying interest species for any UK SPA (JNCC, 2012).

Hornsea Survey Area

3.7.157 Eight grey phalaropes were recorded in the Hornsea Survey Area between September and January of Year 1, with most sightings in the western half of the Hornsea Zone. There was one sighting in Subzone 1 and one sighting in the 4 km buffer in Year 1 (Figure 3.34). Higher numbers were recorded in Year 2, with 29 birds between September and October. A total of 16 birds were recorded in Subzone 1 and 4 km buffer, with a peak of 13 birds in October (Table A.3 and Table A.5). Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2 (Table 2.1).

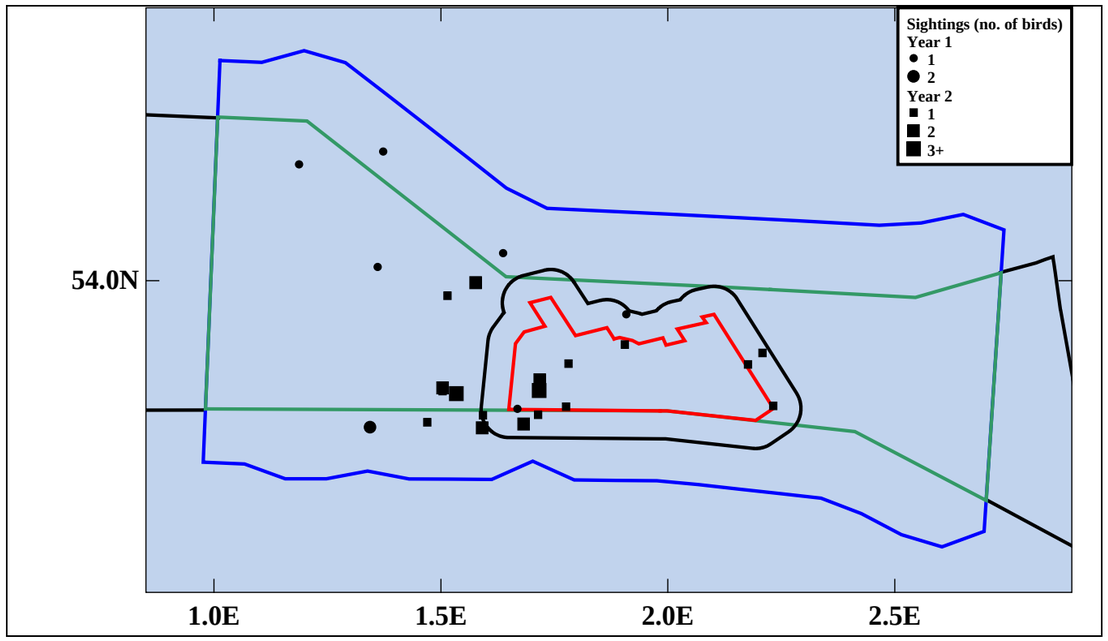


Figure 3.34 Spatial distribution of Grey phalarope sightings in the Hornsea Survey Area between September and January, Years 1 and 2.

3.7.158 A total of 15 grey phalaropes were seen in flight on baseline surveys, all flying below 22.5 m in height. Sightings were clustered to the southwest of Subzone 1 and 4 km buffer, however, given the low total numbers and the high degree of variability between survey years, this does not appear to reflect an ongoing pattern of site.

Pomarine Skua (*Stercorarius pomarinus*)

Status overview

3.7.159 Pomarine skuas are regular but uncommon passage migrants in the North Sea, both in spring and autumn, with numbers varying between years (Stone *et al.*, 1995). Off the Flamborough coast, pomarine skua is classed as an uncommon passage migrant, more numerous in autumn (Thomas, 2011). Pomarine skuas do not breed in Britain.

3.7.160 Langston (2010) assessed Pomarine skua as being at moderate risk of collision with turbines. Risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were ranked as low. Overall, pomarine skua was assessed as being at moderate risk from offshore wind developments, although this ranking was uncertain (Table 3.3). The species is not listed as a qualifying interest for SPAs in the UK (JNCC, 2012).

Hornsea Survey Area

3.7.161 A total of 33 pomarine skuas were recorded in the Hornsea Survey Area in Year 1 (Table 3.1). Birds were recorded in all months except February, March and June. The highest numbers were recorded in May (nine birds in the Hornsea Survey Area with two of those in Subzone 1 and 4 km buffer) (Figure 3.35). The birds were recorded primarily in the southern half of the Hornsea Zone and 10 km buffer (Figure 3.36).

3.7.162 Fewer pomarine skuas were seen on Year 2 surveys, with only 17 birds recorded in the Hornsea Survey Area (14 in the Hornsea Zone and 10 km buffer and three in Subzone 1 and 4 km buffer). Highest numbers were recorded in May (eight birds in the Hornsea Zone and 10 km buffer and two in Subzone 1 and 4 km buffer).

3.7.163 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, (Table 2.1).

3.7.164 A total of 42 pomarine skuas were recorded in flight on baseline surveys, with four birds recorded flying above 22.5 m (9.5%) (Table 3.2).

3.7.165 A total of 32 pomarine skuas were aged on baseline surveys, with 23 adults and nine immature birds recorded. Pomarine skua was recorded throughout the Hornsea Survey Area, with a greater number of birds seen in the western portion of the site. As sightings are distributed throughout the year, these individuals most likely represent a combination of breeding and non-breeding adults on long foraging trips.

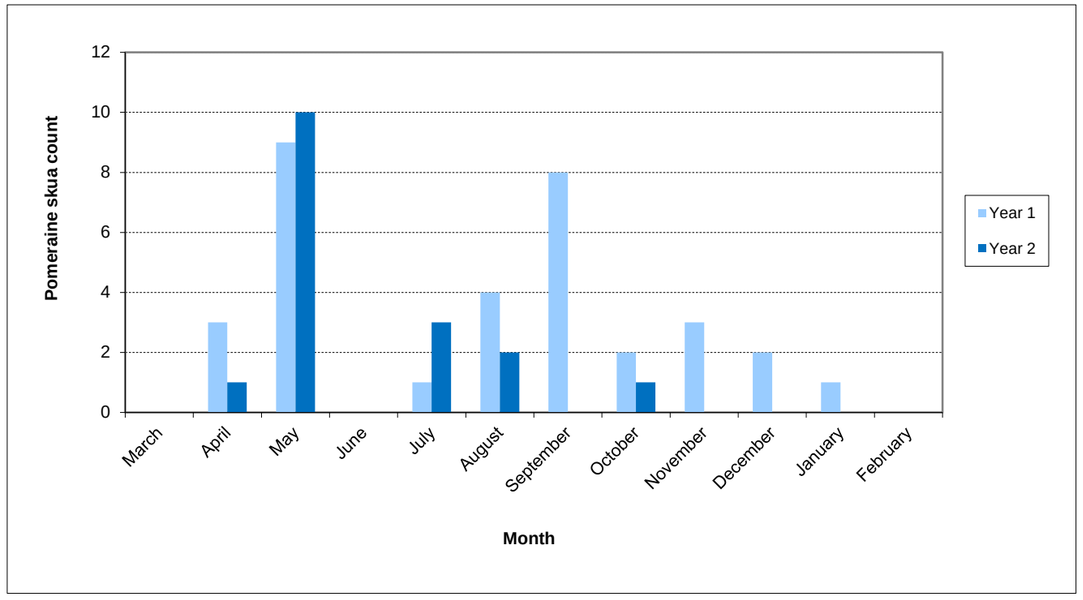


Figure 3.35 Temporal variation in raw counts of pomarine skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

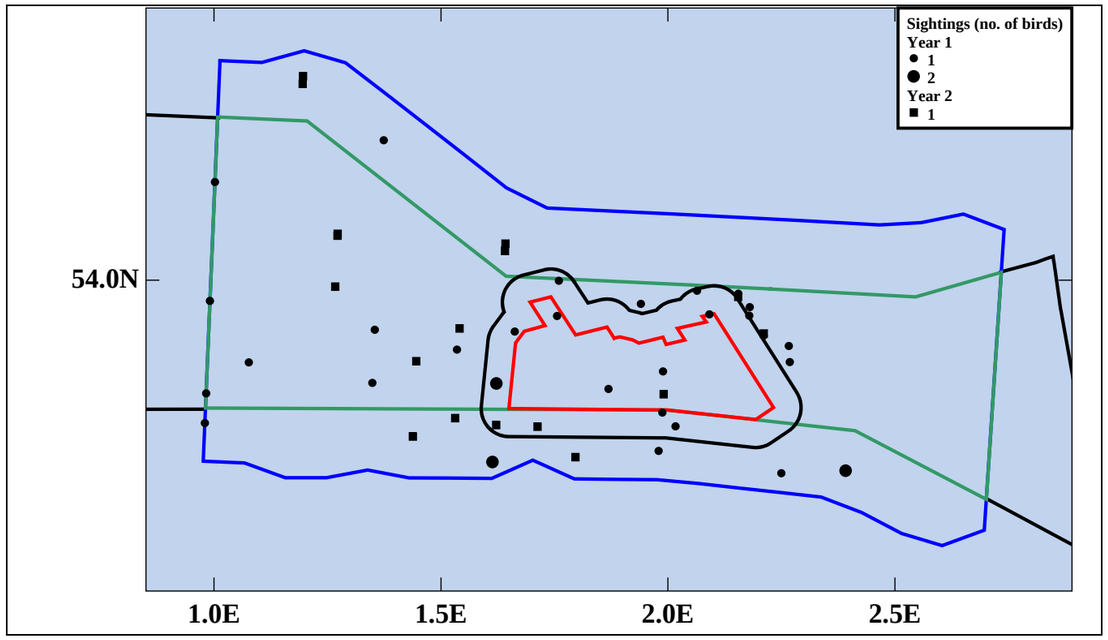


Figure 3.36 Spatial distribution of pomarine skua sightings in the Hornsea Survey Area.

3.7.166 In addition, single unidentified skuas were also recorded in the 4 km buffer in September, the Hornsea Zone in June, and the Hornsea Zone 10 km buffer in September and October of Year 1 (Table A.2 and Table A.4). In Year 2, seven unidentified skuas were recorded between July and November, with a peak of five birds in August (Table A.3 and Table A.5).

Long-tailed Skua (*Stercorarius longicaudus*)

Status overview

3.7.167 Long-tailed skuas are regular but scarce passage migrants in the North Sea in spring and autumn, with numbers varying between years (Stone *et al.*, 1995). Off the Flamborough coast, long-tailed skua is a scarce migrant, occurring mainly in autumn (Thomas, 2011). Long-tailed skuas do not breed in Britain.

3.7.168 Langston (2010) assessed long-tailed skua as being at moderate risk of collision with turbines. Risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were ranked as low. Overall, long-tailed skua was assessed as being at moderate risk from offshore wind developments, although this ranking was uncertain (Table 3.3). The species is not listed as a qualifying interest for SPAs in the UK (JNCC, 2012).

Hornsea Survey Area

3.7.169 Single long-tailed skuas were recorded in October of Year 1 in Subzone 1 and 4 km buffer. One long-tailed skua was recorded in Year 2 in the Hornsea Zone in June (Figure 3.37). Two long-tailed skuas were aged as immature birds.

3.7.170 Two long-tailed skuas were recorded in flight on baseline surveys, both flying below 22.5 m in height (Table 3.2). These records most likely represent incidental sightings, and indicate that this species does not regularly forage in the Hornsea Survey Area.

Arctic Skua (Stercorarius parasiticus)

Status overview

3.7.171 Arctic skua is currently red-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009) due to its significant recent decline. The Scottish breeding population showed a 74% decline between 1986 and 2011 (SNH, 2012). It is a passage migrant in spring and autumn in the North Sea, and a scarce UK breeding species, restricted to Shetland, Orkney, north Scotland and the Western Isles (Forrester *et al.*, 2007). Seabird 2000 estimated the Scottish breeding population at 2,136 pairs (Mitchell *et al.*, 2004).

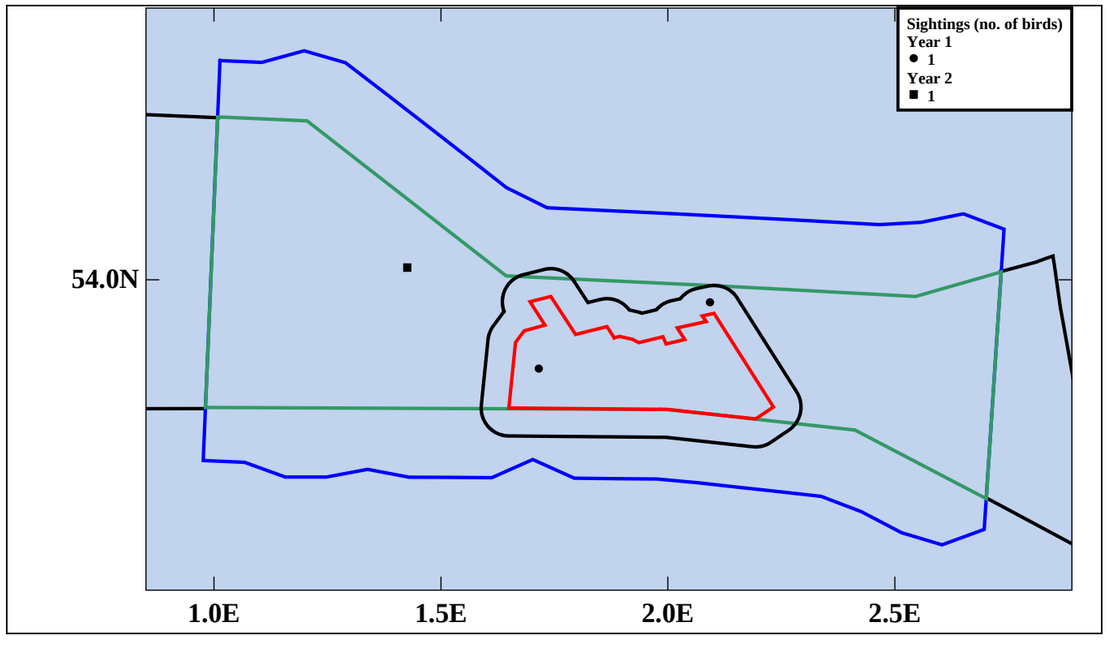


Figure 3.37 Spatial distribution of long-tailed skuas in the Hornsea Survey Area.

3.7.172 Langston (2010) assessed Arctic skua as being at moderate risk of collision with turbines. Risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were ranked as low. Overall, Arctic skua was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.173 Arctic skua is listed as a qualifying interest species in the breeding season for seven SPAs on the UK east coast (Table 3.21). These SPAs held 24.3% of the UK breeding population, and 2.7% of the biogeographic population at the time of designation (JNCC, 2012). Since designation, populations at five of these SPAs have decreased (SMP, 2012). None of these SPA colonies lie within the maximum known foraging range of this species (75 km, Figure 3.40) (Thaxter *et al.*, 2012).

Table 3.21 SPAs for Arctic skua on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Fair Isle	698.1	74	0.3	2.3	65	2009
Fetlar	746.2	130	0.4	4.1	96	2001
Foula	717.3	125	0.4	3.9	63	2009
Hoy	616.9	59	0.2	1.8	70	2000
Papa Westray (North Hill and Holm)	662.6	135	0.5	4.2	66	2009
Rousay	646.3	180	0.6	5.6	133	2000
West Westray	655.7	77	0.3	2.4	88	2000
Total	**-**	**780**	**2.7**	**24.3**	**581**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

3.7.174 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show that no Arctic skuas were recorded during aerial surveys of the Greater Wash survey blocks GW2, GW9 and GW10. Birds recorded as 'Skua spp.' were recorded, however, albeit in low numbers, with only one or two birds recorded in March and May.

3.7.175 A total of 77 Arctic skuas were recorded on surveys in the Hornsea Survey Area in Year 1 between May and November, with a peak of 53 birds recorded in September, when 34 birds were recorded in Subzone 1 and the 4 km buffer and 19 birds were recorded in the Hornsea Zone and 10 km buffer (Table A.2 and Table A.4).

3.7.176 Higher numbers were recorded in Year 2 (87 birds), with a peak of 32 birds in August (24 in the Hornsea Zone and 10 km buffer in August and eight birds in Subzone 1 and the 4 km buffer).

3.7.177 Raw counts for the Hornsea Survey Area are presented in Figure 3.38.

3.7.178 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

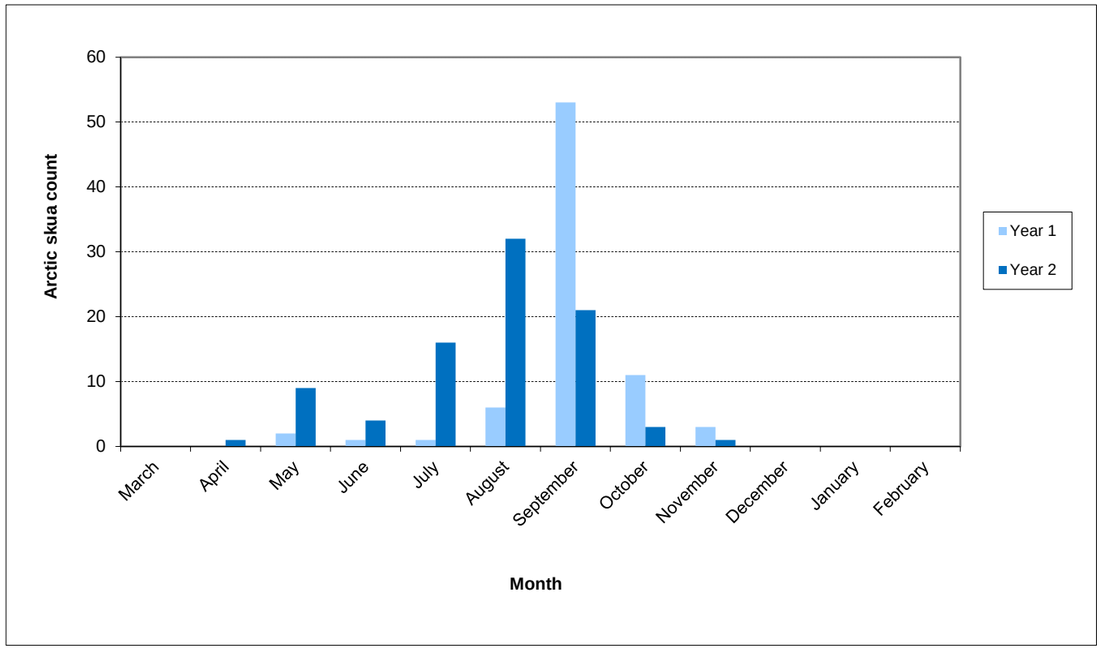


Figure 3.38 Temporal variation in raw counts of Arctic skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

3.7.179 Due to the low sample size of Arctic skuas recorded in Years 1 and 2, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. Highest mean abundance in both Years 1 and 2 was 0.04 birds/km in Subzone 1 and 4 km buffer in September (Figure 3.39).

3.7.180 Arctic skua densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.22 (along with the mean density data from Subzone 1 and 4 km buffer to allow a comparison of temporal variation). Similarly low figures are seen for Arctic skuas, with virtually the only birds occurring being at a very low abundance from July to October. This suggests that the Hornsea Survey Area is not an important area for Arctic skuas.

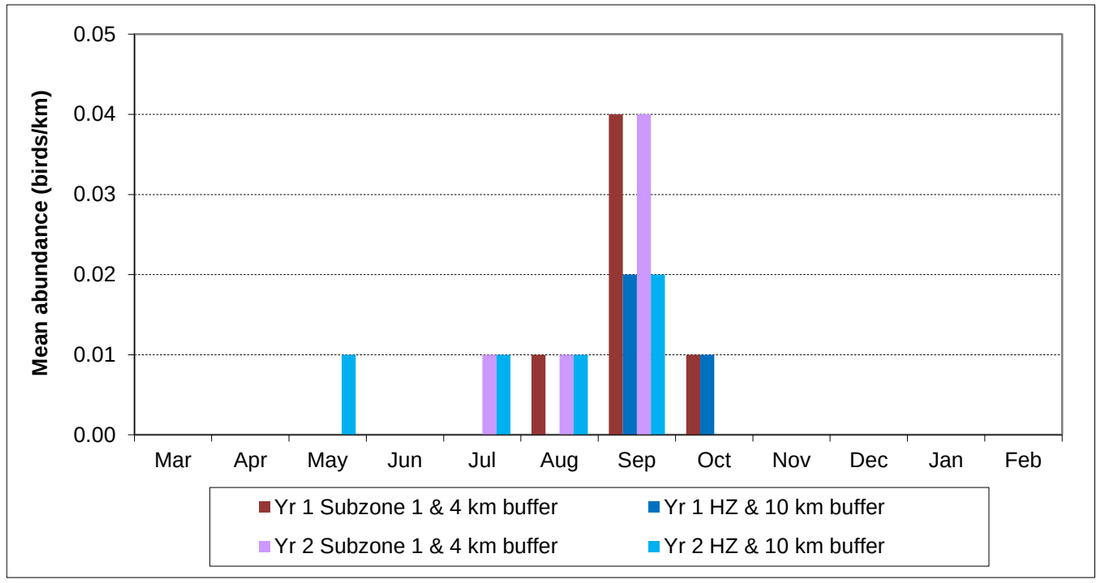


Figure 3.39 Temporal variation in mean abundance of Arctic skuas in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Table 3.22 North Sea Arctic skua densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Mean abundance in Subzone 1 and 4 km buffer
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	0	0	0.05	0.02	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0.01	0	0	0	0.01
August	0.06	0	0.01	0.02	0.01
September	0.04	0.02	0.01	0.02	0.04
October	0	0	0.01	0	0.01
November	0	0	0	0	0
December	0	0	0	0	0

Behaviour and distribution

3.7.181 A total of 127 Arctic skuas were recorded flying on baseline surveys, but only one was recorded flying above 22.5 m (Table 3.2).

3.7.182 The majority of birds on baseline surveys (73.5%) were unaged, however 17 adults, five immature birds and 21 juveniles were aged.

3.7.183 The abundance map for Arctic Skua cover the period August to October for Years 1 and 2 in the Hornsea Zone (Appendix B). The distribution does not indicate a consistent pattern of site use by this species, and the low numbers indicate that the individuals do not regularly visit the site.

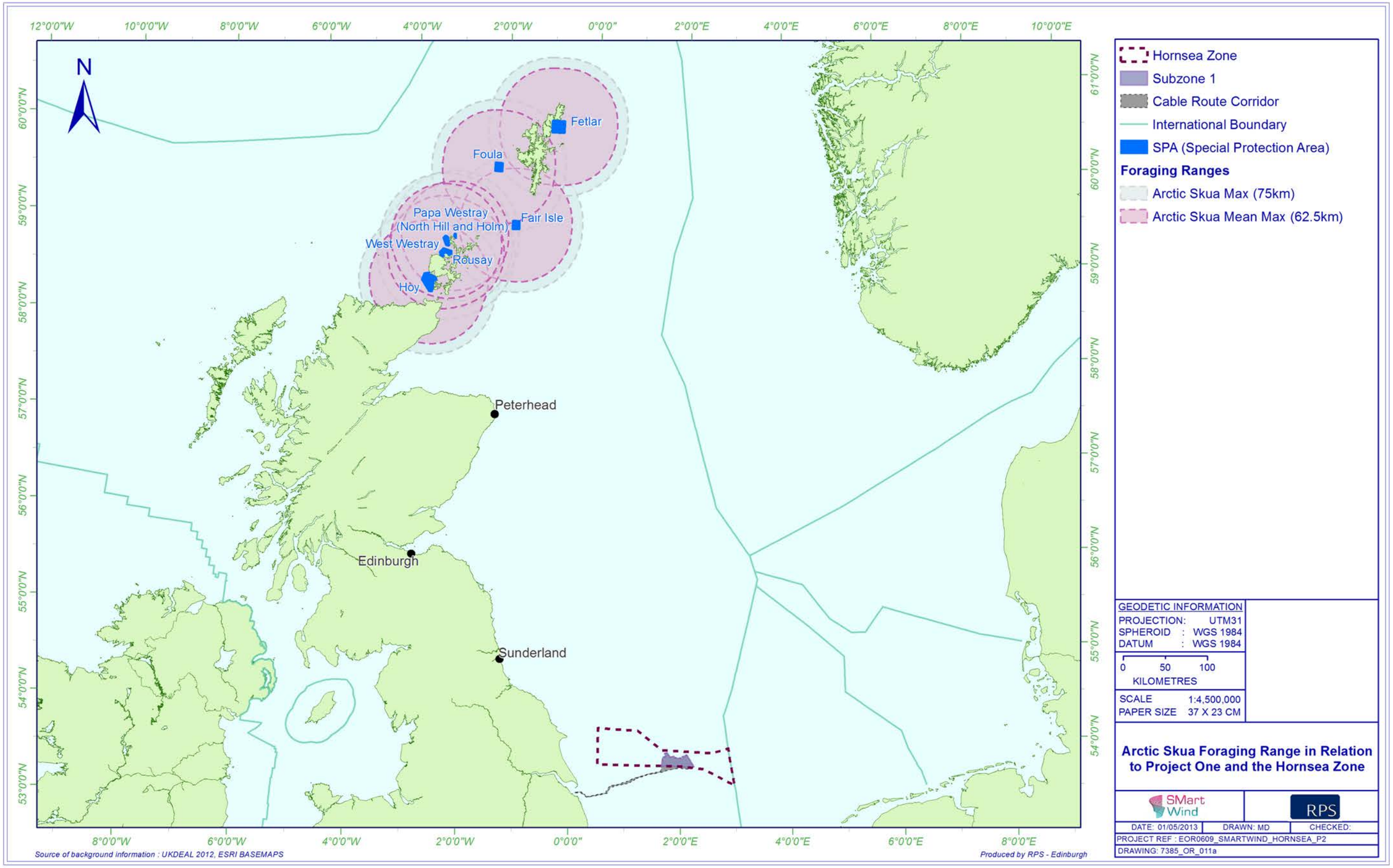


Figure 3.40 Arctic skua foraging range in relation to Project One and the Hornsea Zone.

Great Skua (*Stercorarius skua*)

Status overview

3.7.184 Great skua is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.185 Great skuas occur regularly in the North Sea on spring and autumn passage, with some birds remaining for the winter months (Stone *et al.*, 1995). Great skuas breed on Shetland, Orkney and the Western Isles, with an estimated population of 9,634 pairs during Seabird 2000 (Mitchell *et al.*, 2004). Great Skuas breed close to other seabird colonies, in order to scavenge and parasitise food from other seabirds, as well as predating other birds and nests.

3.7.186 Great skua is listed as a qualifying interest species in the breeding season for seven SPAs on the UK east coast (Table 3.23). These SPAs held 69.1 % of the UK breeding population, and 43.4 % of the biogeographic population at the time of designation (JNCC, 2011). None of these SPA colonies lie within the maximum known foraging range of this species (219 km, Figure 3.43) (Thaxter *et al.*, 2012).

Table 3.23 SPAs for great skuas on the UK east coast in the breeding season

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeographic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Fair Isle	698.1	130	1.0	1.5	277	2009
Fetlar	746.2	512	3.8	6.0	593	2001
Foula	717.3	2,170	16.0	25.5	2,293	2000
Hermaness , Saxa Vord and Valla Field	771.8	630	4.6	7.4	572	2002
Hoy	616.9	1,900	14.0	22.4	42	2007
Noss	702.6	410	3.0	4.8	365	2007
Ronas Hill - North Roe and Tingon	765.4	130	1.0	1.5	x	
Total	-	5,882	43.4	69.1	4,142+	-

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

3.7.187 Langston (2010) assessed great skua as being at moderate risk of collision with turbines. Risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were ranked as low. Overall, great skua was assessed as being at high risk from offshore wind developments, due to the importance of the UK breeding population (Table 3.3).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.188 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show that almost no great skuas were recorded during aerial surveys of the Greater Wash survey blocks GW2, GW9 and GW10, with only one or two birds recorded during July.

3.7.189 In Year 1, 56 great skuas were recorded in the Hornsea Survey Area, between March and January, although none were seen between May and July. Peak numbers were recorded between August and October, with a peak of 21 in September. Higher numbers were recorded in Year 2, with 135 birds recorded in the Hornsea Survey Area. Birds were recorded in all months except February. A peak of 31 great skuas were recorded in October (Figure 3.41).

3.7.190 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2.

3.7.191 Due to the low sample size of great skuas recorded in Years 1 and 2, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. Peak mean abundance in Year 1 was 0.02 birds/km, recorded in Subzone 1 and 4 km buffer area in August, while in Year 2, peak mean abundance was 0.04 birds/km in Subzone 1 and 4 km buffer area in September (Figure 3.42).

3.7.192 Great skua densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.24 (along with the mean density data from Subzone 1 and 4 km buffer to allow a comparison of temporal variation). Similarly low figures are seen for great Skuas, with virtually the only birds occurring being at a very low abundance from July to October. This suggests that the Hornsea Survey Area is not an important area for this species.

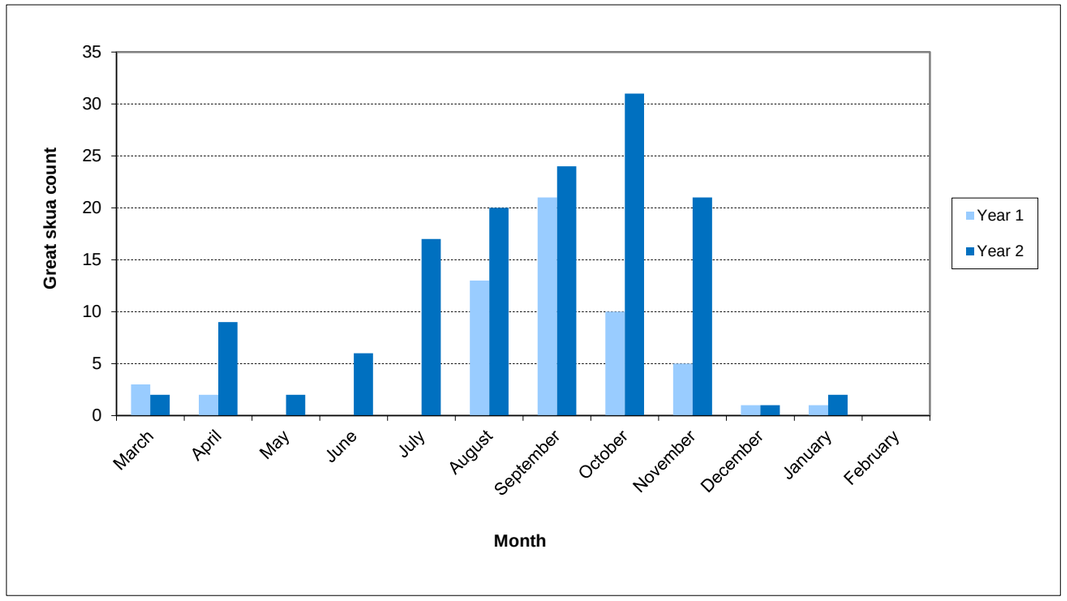


Figure 3.41 **Temporal variation in raw counts of great skua in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

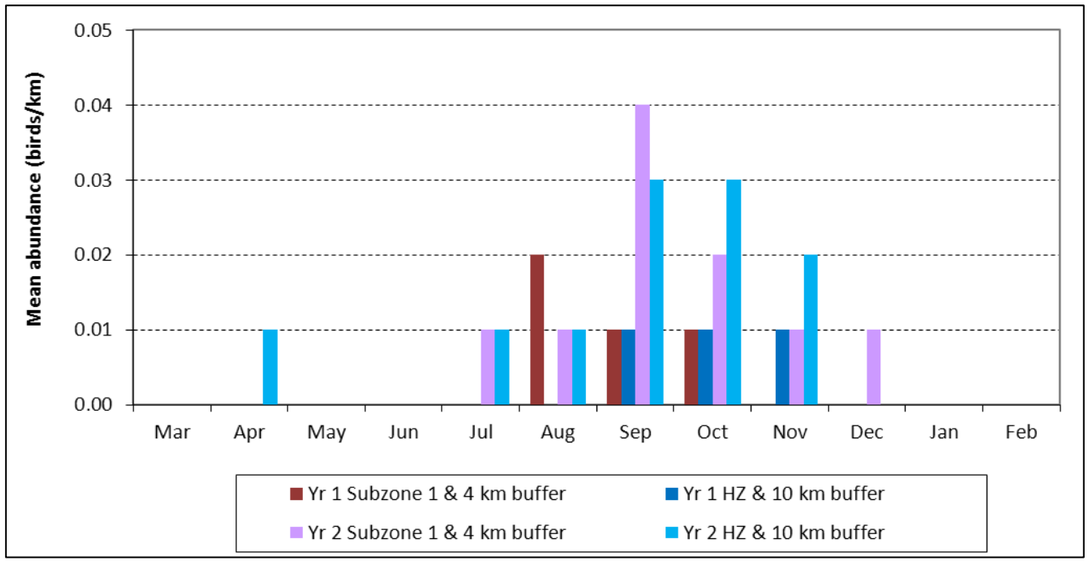


Figure 3.42 **Temporal variation in mean abundance of great skuas in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Table 3.24 **North Sea great skua densities from Stone *et al*. (1995).**

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Mean abundance in Subzone 1 and 4 km buffer
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0.01	0	0	0
April	0	0.01	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0.03	0.02	0.01	0.02	0.01
August	0.09	0.03	0.04	0.05	0.02
September	0.15	0.03	0.04	0.02	0.03
October	0.02	0.01	0.01	0.01	0.02
November	0	0	0	0	0.01
December	0	0	0	0	0.01

Behaviour and distribution

3.7.193 A total of 151 great skuas were recorded in flight on baseline surveys, with the majority (87.4%) flying below 22.5 m in height (Table 3.2).

3.7.194 The majority of great skuas (83.2%) were unaged, with six adults, one immature and three juvenile birds recorded.

3.7.195 The abundance map for great skua covers the period August to November for Years 1 and 2 (Appendix B). Low numbers were recorded primarily in the northern edge of Subzone 1 and the 4 km buffer. Though this may indicate a pattern of site use, the low numbers indicate that Hornsea is not a significant habitat for great skua.

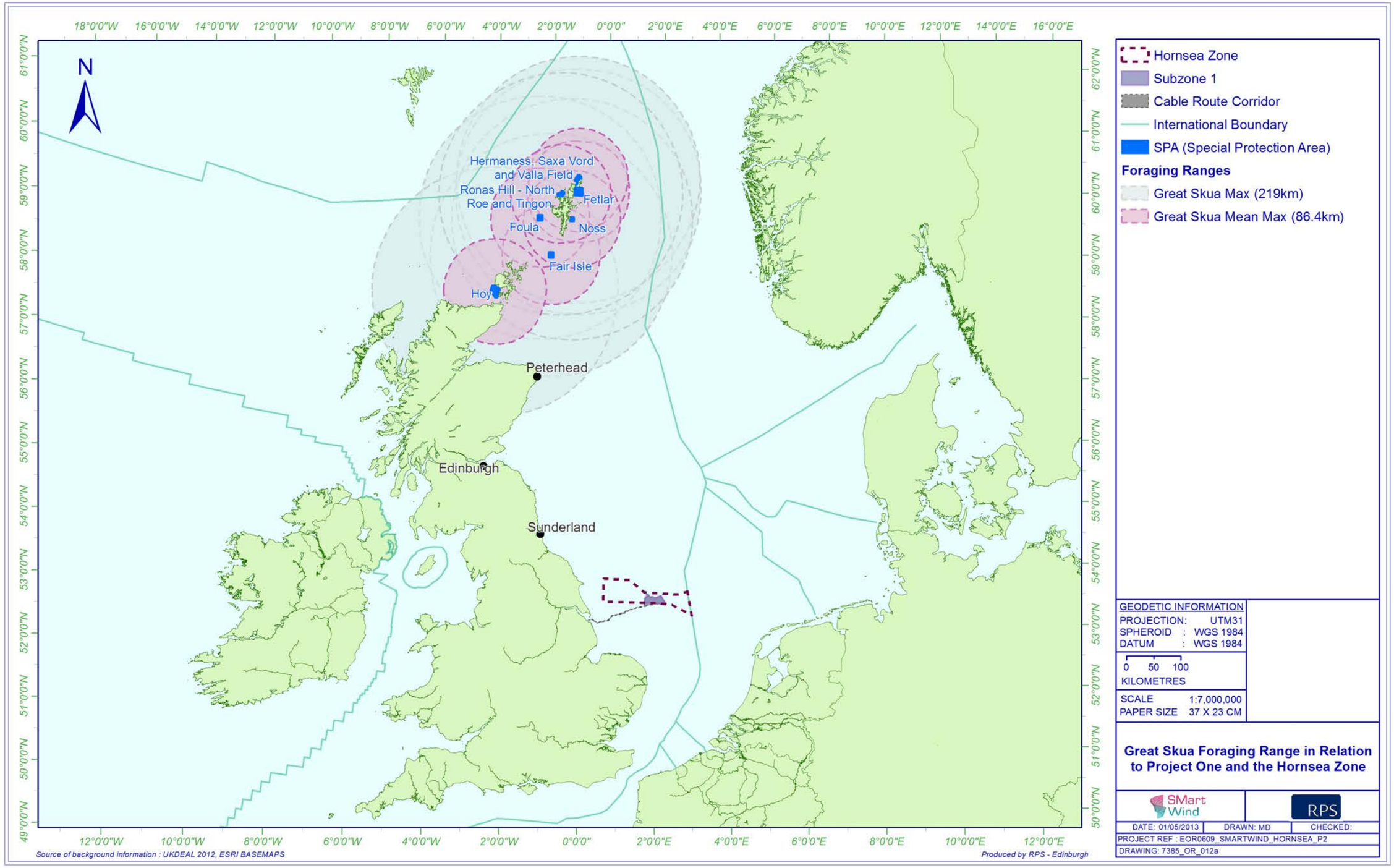


Figure 3.43 Great skua foraging range in relation to Project One and the Hornsea Zone.

Little Gull (*Larus minutus*)

Status overview

3.7.196 Little gull is listed on Annex I of the EU Birds Directive and Schedule 1 of the Wildlife and Countryside Act. It is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.197 Little gull occurs on passage in the North Sea, in spring, and more commonly in autumn (Stone *et al.*, 1995). Off the Flamborough coast, it is a fairly common to uncommon passage migrant, with highest numbers occurring in autumn (Thomas, 2011). Large numbers occur at Hornsea Mere, in late summer, with up to 21,500 birds present in 2007 (Calbrade *et al.*, 2010). There have been five unsuccessful little gull breeding attempts in England up to 2007 (Holling *et al.*, 2010).

3.7.198 Langston (2010) assessed little gull as being at low risk of collision with turbines, displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms (Langston, 2010) (Table 3.3). There are no terrestrial UK SPAs for little gull, (JNCC, 2012), although the species was considered for marine SPAs in a recent JNCC report (Kober *et al.*, 2010).

Hornsea Survey Area

3.7.199 Little gull occurs on passage in the North Sea in spring, and more commonly in autumn (Stone *et al.*, 1995). Off the Flamborough coast, it is considered a fairly common to uncommon passage migrant, with highest numbers occurring mainly in autumn (Thomas, 2011).

Seasonal distribution and abundance

3.7.200 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show that almost no little gulls were recorded during aerial surveys of the Greater Wash survey blocks GW2, GW9 and GW10, with only three birds recorded during November. A slightly higher number of birds recorded as 'Small gull spp.' were seen, however, with a peak mean of 33 in November.

3.7.201 In Year 1, 4,803 little gulls were recorded on surveys in the Hornsea Survey Area (Table 3.1), with the majority of birds (70.7%) recorded in Subzone 1 and 4 km buffer, mainly in October. In Year 2, numbers were considerably lower, with a total of 234 birds recorded in the Hornsea Survey Area. Peak numbers occurred in October, with 146 little gulls recorded in Subzone 1 and 4 km buffer, and 88 in the Hornsea Zone and 10 km buffer, although coverage of was incomplete at this time.

3.7.202 In Year 1, the peak estimated number of little gulls was in October, with 5,694 birds in Subzone 1, and 12,226 birds including the 4 km buffer. In comparison, an estimated 19,376 birds occurred in the Hornsea Zone and 10 km buffer in October (Table 3.25). In Year 2, estimated numbers of little gulls were much lower, with no large peak in the autumn. Highest estimated numbers were 32 birds in October and November in Subzone 1, and 68 birds when including the 4 km buffer in the same months. In comparison, an estimated 174 birds were estimated in the combined Subzone survey area for Projects 1 and 2 in September, with 170 birds estimated for November. Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2.

3.7.203 The estimated numbers for all three areas exceeded the 1% threshold for internationally important numbers of little gulls in October of Year 1 (1,230 birds) (Holt *et al.*, 2011). In comparison, estimated numbers for the same months of Year 2 were low or zero (Figure 3.44 and Figure 3.45).

Densities

3.7.204 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area. The highest density estimates occur in the autumn with the peak mean for all three areas being 0.11 birds/km^2 in October. During the summer months of May to August, these figures drop to zero, or almost zero.

3.7.205 Little gull densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.26.

3.7.206 Mean monthly little gull density in Subzone 1 and 4 km buffer peaked in October of Year 1, with a peak mean density of 14.0 birds/km^2. This was higher than the corresponding peak recorded in the Hornsea Zone and 10 km buffer (3.8 birds/km^2). In Year 2, mean monthly density was much lower, with peaks of 0.1 birds/km^2 in Subzone 1 and 4 km buffer in October, November and February (Figure 3.46).

3.7.207 A comparison of the temporal distribution of little gull density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.47. On first impressions, this suggests that the Hornsea Survey Area, and in particular Subzone 1, may be of particular importance for little gull in the autumn. However, caution should be taken when interpreting such results, since Stone *et al.* (1995) surveys may have missed peak migratory periods, and also, numbers appear to have increased in this part within the North Sea since the mid-1990s.

Table 3.25 Estimated numbers of little gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Year 1 and Year 2.

Month	Est. number on water Subzone 1 + 4 km[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km[1]	Est. total 4 km buffer [1]	Est. total Subzone 1 [1]	Est. total in HZ and 10 km buffer [2]
March	0	0	0	0	0	0	0
April	54	10	303	0	54	25	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	272
August	0	0	0	0	0	0	19
September	267	63	1132	65	332	155	103
October	7649	5282	11076	4,577	12,226	5,694	19,376
November	623	282	1380	406	1,029	479	0
December	0	0	0	0	0	0	42
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	35
July	0	0	0	0	0	0	19
August	13	2	76	0	13	6	69
September	0	0	0	29	29	14	174 [3]
October	68	12	382	0	68	32	96 [3]
November	68	21	221	0	68	32	170 [3]
December	0	0	0	0	0	0	-
January	0	0	0	0	0	0	0 [3]
February	74	26	211	0	74	34	58 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

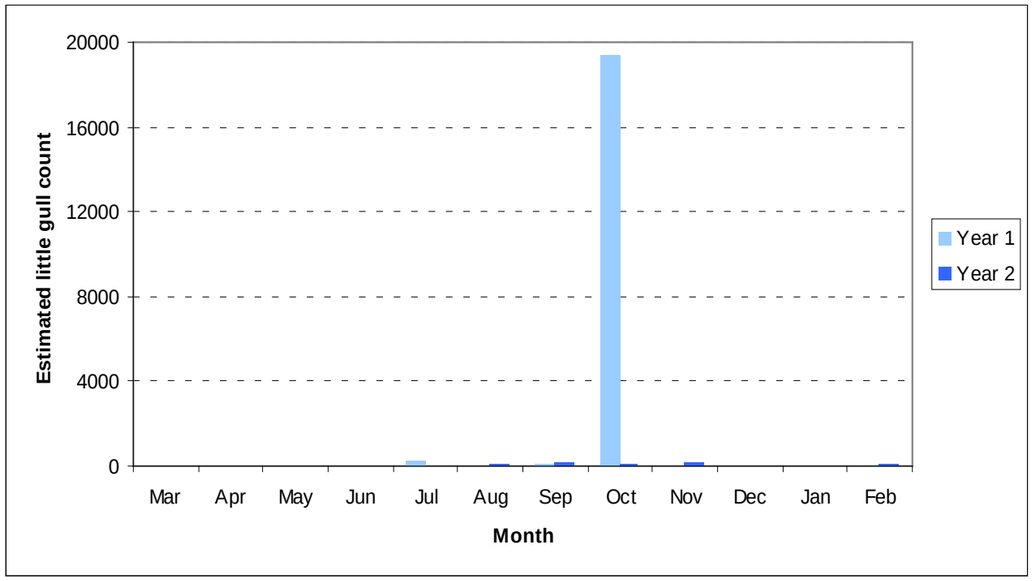


Figure 3.44 **Temporal variation in distance-adjusted counts of little gull in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

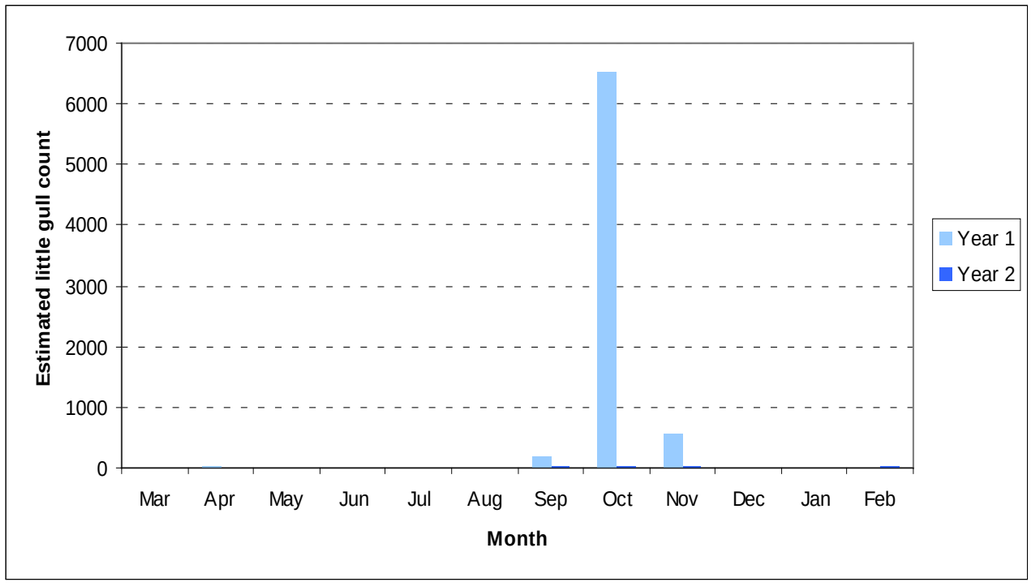


Figure 3.45 **Temporal variation in distance-adjusted counts of little gull in Subzone 1 and 4 km buffer.**

Table 3.26 **North Sea little gull densities from Stone *et al*. (1995).**

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0	0	0.09	0.03	0
February	0	0	0.07	0.02	0.04
March	0	0	0.14	0.05	0
April	0.01	0.01	0.24	0.09	0.03
May	0	0	0.02	0	0.00
June	0	0	0	0	0.00
July	0	0	0	0	0.00
August	0	0	0	0	0.01
September	0.18	0.02	0.01	0.07	0.21
October	0.09	0.01	0.24	0.11	7.03
November	0	0	0.24	0.08	0.63
December	0.05	0	0.06	0.04	0

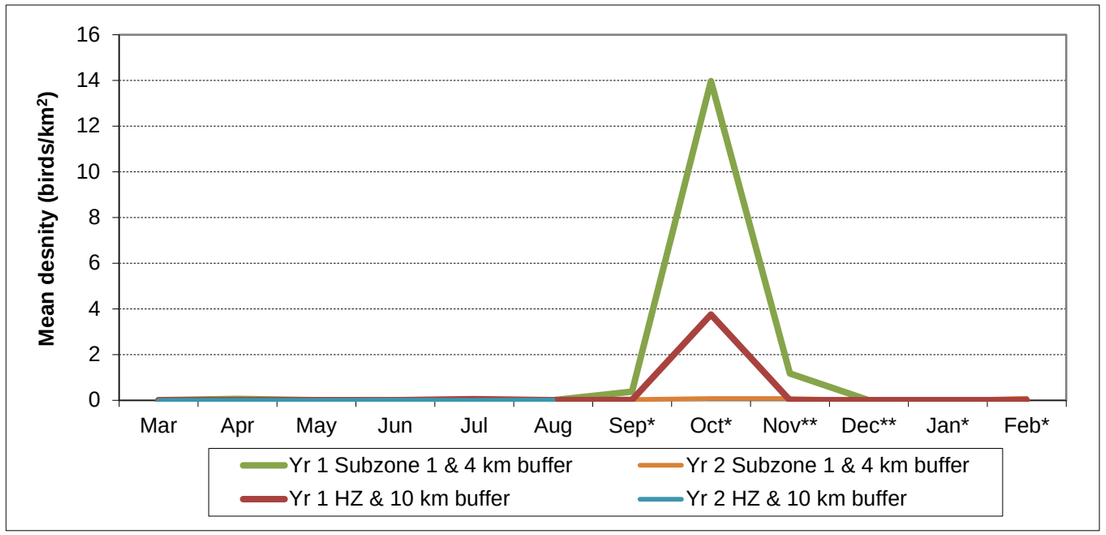


Figure 3.46 **Temporal distribution of mean density of little gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov**, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

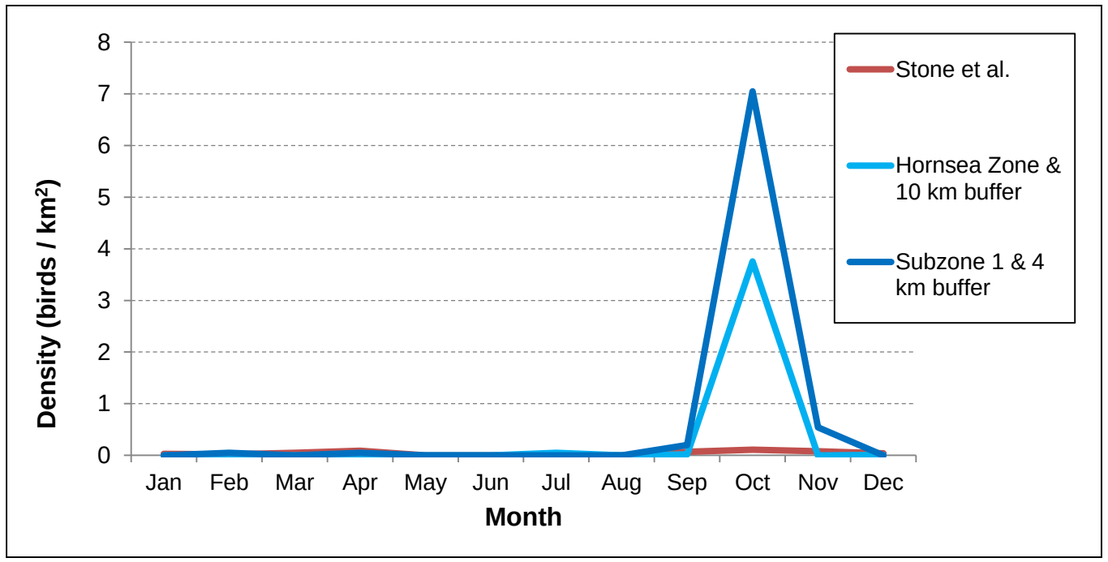


Figure 3.47 A comparison of temporal variation in density of little gull in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).

Behaviour and distribution

3.7.208 A total of 3,522 little gulls were recorded in flight on baseline surveys, with only 38 of those birds recorded at heights above 22.5 m, representing 1.1% (Table 3.2).

3.7.209 The majority of little gulls (81.3%) were unaged, with 745 adults, 12 immature birds and 186 juvenile birds recorded.

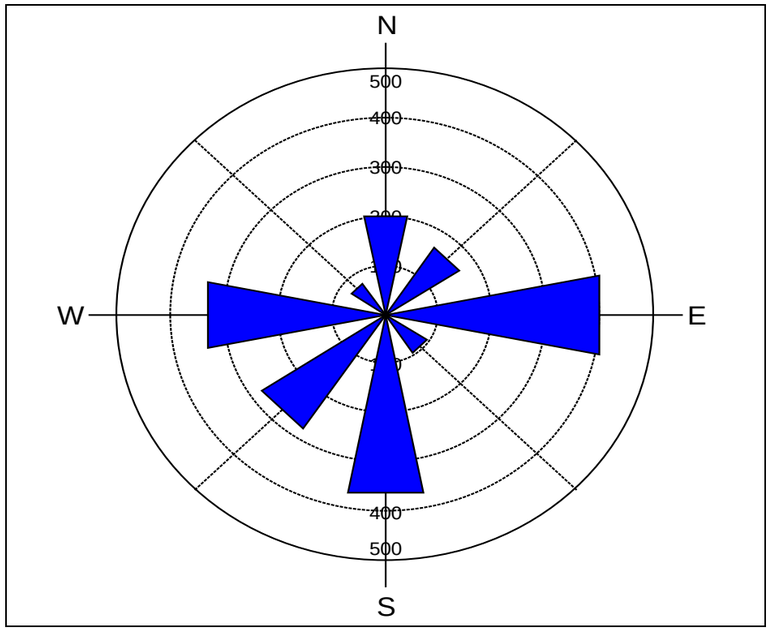
3.7.210 Foraging behaviour was recorded for 584 little gulls in the Hornsea Survey Area on baseline surveys, with three types of foraging behaviour recorded, and unspecified feeding activity recorded for a further 114 birds (Table 3.27). The majority of foraging birds were dip-feeding (57.3%) and actively searching (26.1%).

3.7.211 Flight direction was recorded for 1,915 little gulls between September and November on baseline surveys (Figure 3.48). The majority of birds (1,732) were recorded in October. Between September and November, there was no clear pattern of flight direction, with just over a fifth of birds flying east (21.1%), 19.1% of birds flying south, 17.5% flying west and 14.4% flying south-west. An additional 1,185 birds were recorded as circling on baseline surveys (not shown).

3.7.212 The density distribution maps for little gull cover the period September to November for Years 1 and 2 in Subzone 1 and for the Hornsea Zone (see Appendix B). Little gull were recorded throughout Subzone 1 and 4 km buffer, favouring the western half of the site. The preponderance of records in Subzone 1 and the 4 km buffer is likely influenced by survey effort. The high density of birds recorded during the autumn indicates regular use by individuals on passage.

Table 3.27 Little gull foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	182	26.1
Dipping	400	57.3
Surface pecking	2	0.3
Feeding – unspecified	114	28.6
Total	698	



Numbers shown on figure are number of birds recorded

Figure 3.48 Flight direction of little gulls in the Hornsea Survey Area, Years 1 and 2.

Sabine's Gull (*Larus sabini*)

Status overview

3.7.213 Sabine's gull is a scarce passage migrant in the North Sea, with most birds recorded in autumn (Stone *et al.*, 1995). Off the Yorkshire coast, it is classed as a scarce autumn migrant (Thomas, 2011). The species does not breed in the UK.

Hornsea Survey Area

3.7.214 In Year 1, one Sabine's gull was seen in the 4 km buffer in September, with another recorded in the north-east of the Hornsea Zone in October (Figure 3.49). Both birds were recorded on the water in transect. One was aged as an adult, and one was aged as a juvenile.

3.7.215 No Sabine's gulls were recorded in the Hornsea Survey Area in Year 2. The few sightings probably represent birds which strayed into the survey area

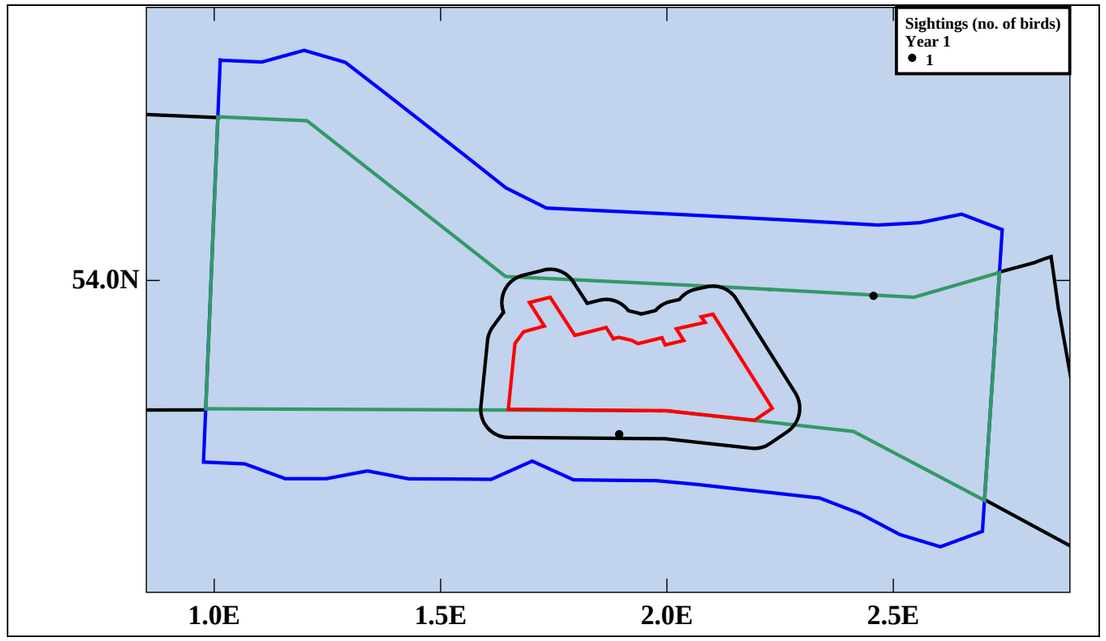


Figure 3.49 Spatial distribution of Sabine's gull sightings in the Hornsea Survey Area.

Black-headed Gull (*Larus ridibundus*)

Status overview

3.7.216 Black-headed gulls are common and widespread in the UK and occur both inland and on the coast, although they are rarely found far offshore. In summer, birds breed at inland and coastal colonies, with 127,907 pairs recorded in Britain during Seabird 2000 (Mitchell *et al.*, 2004).

3.7.217 Black-headed gull is amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009). Langston (2010) assessed the species as being at low risk of collision, displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms. Overall, black-headed gull was assessed as being at low risk from offshore wind developments Table 3.3).

3.7.218 Black-headed gull is listed as a qualifying interest species in the breeding season for two SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.28). These SPAs held 2.3% of the UK breeding population, and 0.2% of the biogeographic population at the time of designation (JNCC, 2012). Since designation, the population at Coquet Island has increased, while the population at Alde-Ore Estuary has decreased. However, there is now a very large breeding colony at Hamford Water SPA nearby (7,200 pairs in 2009) (SMP, 2012). The Hornsea Zone and Subzone 1 is outside the maximum known foraging range of this species (40 km) (Thaxter *et al.*, 2012).

Table 3.28 SPAs for black-headed gull on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeo graphic population at time of citation [1]	% of national population at time of citation [1]	Recent count (pairs) [2]	Year
Coquet Island	257.8	2,100	0.1	1.3	3,385	2009
Alde-Ore Estuary	190.4	1,582	0.1	1.0	90	2001
Total	-	3,682	0.2	2.3	3,475	-

JNCC (2011) – SPA online species accounts.

SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

3.7.219 In Year 1, a total of 96 black-headed gulls were recorded on surveys in the Hornsea Survey Area (Table 3.1), mostly between July and September. Although black-headed gulls were not recorded in Subzone 1 in Year 1, they were seen in low numbers in the 4 km buffer between June and October, with a peak count of five birds in July. A total of 83 birds were recorded in the Hornsea Zone and 10 km buffer, with 57 birds in July and 16 in August (Table A.2 and Table A.4).

3.7.220 Higher numbers of black-headed gulls were recorded in the Hornsea Survey Area in Year 2, with 332 birds recorded on surveys. A total of 148 birds were recorded in Subzone 1 and 4 km buffer, with a peak of 95 birds in October. In the Hornsea Zone and 10 km buffer, 184 birds were recorded, with a peak of 67 in July (Table A.3 and Table A.5)

3.7.221 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

3.7.222 Due to the low sample size of black-headed gulls recorded in Years 1 and 2, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. Peak mean abundance in Year 1 was 0.07 birds/km, recorded in the Hornsea Zone and 10 km buffer in July, while in Year 2, peak mean abundance was 0.22 birds/km in Subzone 1 and 4 km buffer area in October (Figure 3.51).

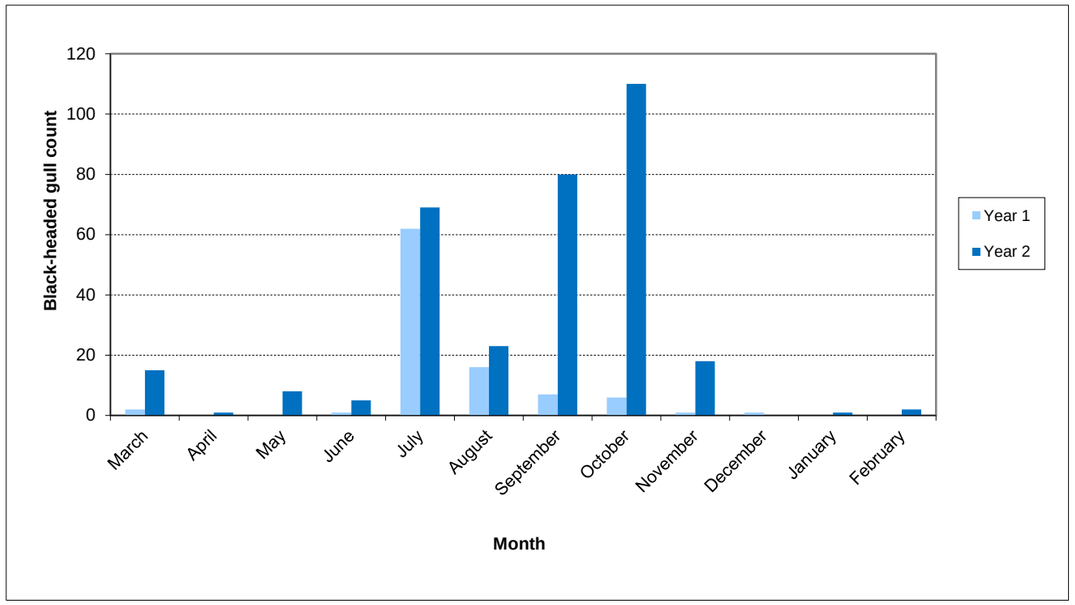


Figure 3.50 Temporal variation in raw counts of black-headed gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

Behaviour and distribution

3.7.223 A total of 388 black-headed gulls were recorded in flight on baseline surveys, but only one of those was recorded at a height above 22.5 m, at a height of 30 m (Table 3.1)

3.7.224 Of the 428 black-headed gulls recorded on baseline surveys, 302 birds were aged as adults, with 21 immature birds and 31 juvenile birds recorded. The remaining birds were unaged.

3.7.225 The abundance map for black headed gull covers the period July to October for Years 1 and 2 in the Hornsea Zone (Appendix B). Records are scattered throughout Subzone 1 and the 4 km buffer, with no pattern of site use.

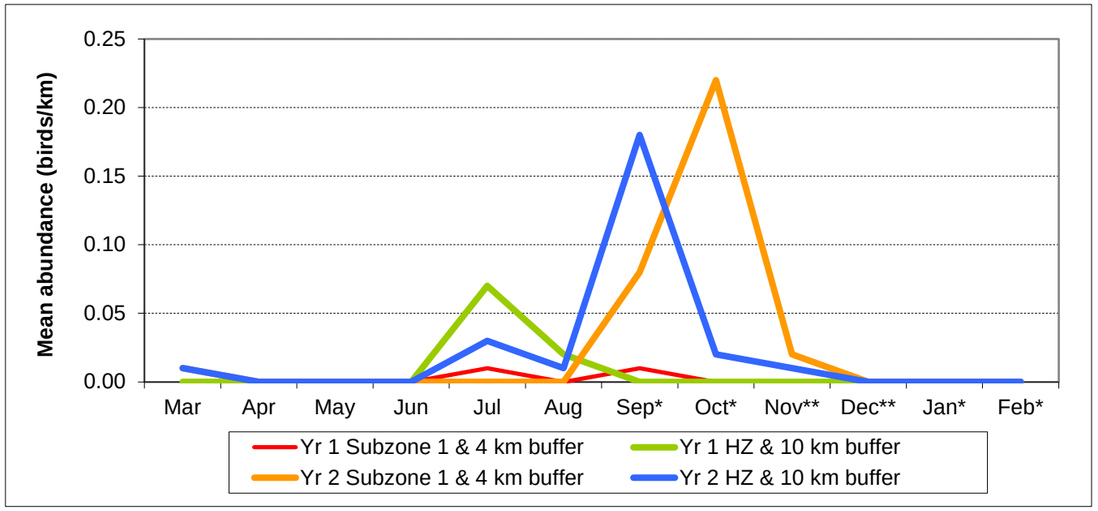


Figure 3.51 Temporal variation in mean abundance of black-headed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Common gull (*Larus canus*)

Status overview

3.7.226 Common gull is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.227 Common gulls are common and widespread in the UK in lowland, urban and coastal areas in winter, and at breeding colonies in coastal and inland locations in summer. Seabird 2000 recorded 48,163 pairs of common gulls breeding in Britain (Mitchell *et al.*, 2004). Common gulls typically feed on farmland, playing fields, estuaries and in coastal waters, and are comparatively uncommon offshore (Forrester *et al.*, 2007; Stone *et al.*, 1995).

3.7.228 Langston (2010) assessed common gull as being at low risk of collision with turbines, displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms. Overall, common gull was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.229 Common gull is listed as a qualifying interest species in the breeding season for one SPA in the UK; Tips of Corsemaul and Tom Mor SPA. This inland SPA held 18,000 pairs or 26.5% of the UK breeding population, and 14.5% of the biogeographic population at the time of designation (JNCC, 2012). A similar figure (18,136 pairs) was recorded in 1998, however no more recent data were available (SMP, 2012). The Hornsea Zone and Subzone 1 lie outside the known maximum foraging range for this species (50 km) (Thaxter *et al.*, 2012).

Hornsea Survey Area

3.7.230 In Year 1, a total of 302 common gulls were recorded on surveys in the Hornsea Survey Area, throughout the year (Table 3.1). In Subzone 1 and the 4 km buffer, 95 birds were recorded, with a peak of 18 birds in September. A total of 207 birds were recorded in the Hornsea Zone and 10 km buffer, with 27 in March, 29 in October and 47 in December (Table A.2 and Table A.4).

3.7.231 Higher numbers of common gulls were recorded in the Hornsea Survey Area in Year 2, with 564 birds recorded. Birds were recorded in all months except for December. A total of 142 birds were recorded in Subzone 1 and 4 km buffer, with a peak of 39 birds in April. In the Hornsea Zone and 10 km buffer, 422 birds were recorded, with a peak of 153 in April (Table A.3 and Table A.5).

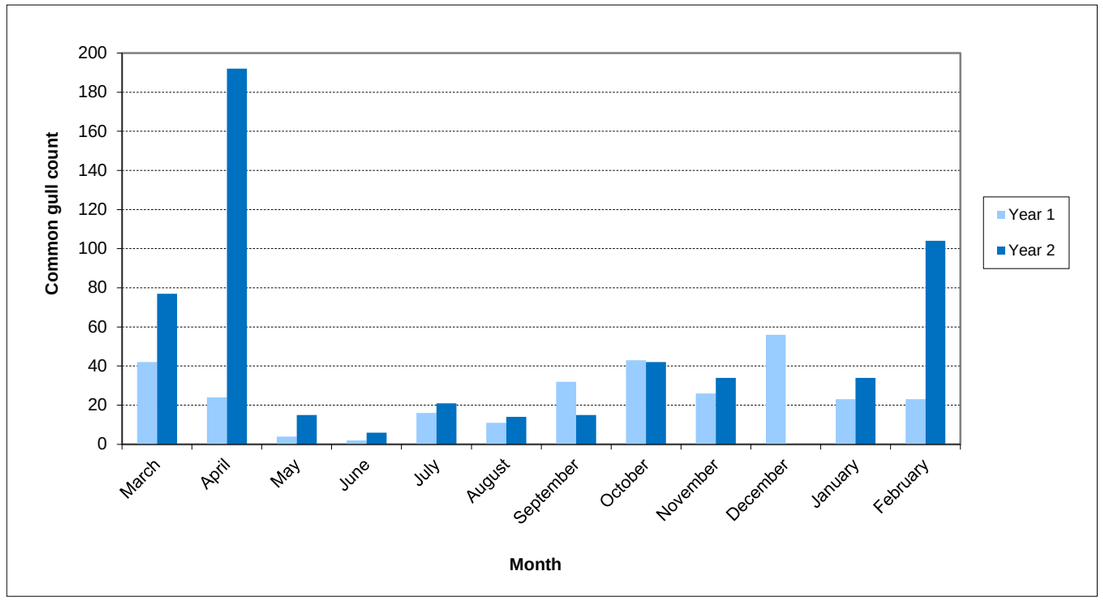


Figure 3.52 Temporal variation in raw counts of common gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

3.7.232 Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2.

3.7.233 Due to the low sample size of common gulls recorded in Years 1 and 2, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. The highest mean abundance of 0.07 birds/km was recorded in the Hornsea Zone and 10 km buffer in December of Year 1. In Year 2, highest mean abundance was 0.11 birds/km in April and February. Overall, mean monthly common gull abundance was very low on baseline surveys, and showed a similar pattern between Subzone 1 and the 4 km buffer and the Hornsea Zone and 10 km buffer (Figure 3.53).

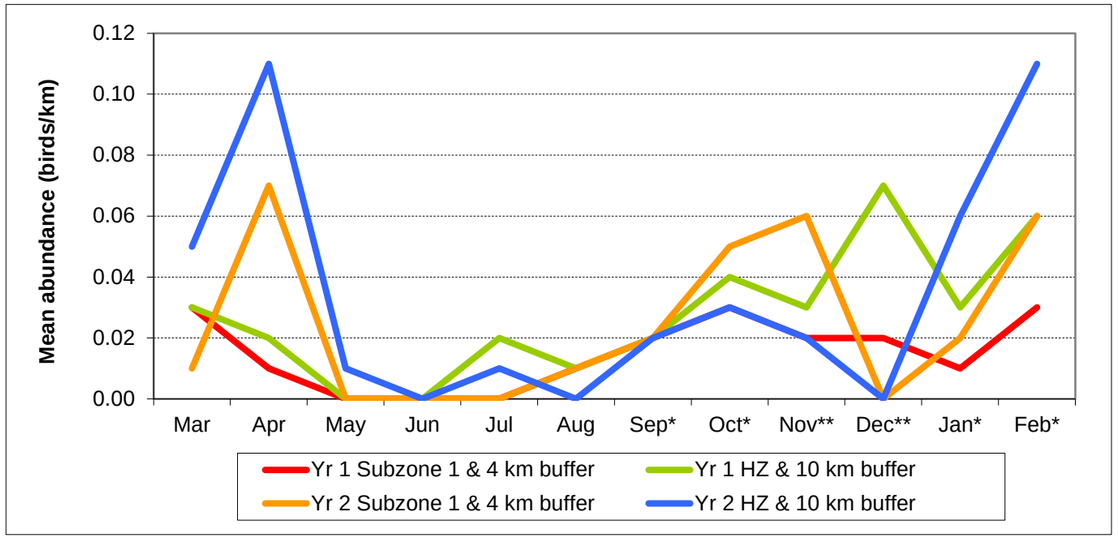


Figure 3.53 Temporal variation in mean abundance of common gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Behaviour and distribution

3.7.234 A total of 741 common gulls were recorded in flight on baseline surveys. A total of 50 birds were recorded flying above 22.5 m (representing 6.7% of all birds recorded in flight) at estimated heights of between 25 and 100 m (Table 3.2)

3.7.235 Of the 866 common gulls recorded on baseline surveys, 400 birds were aged as adults, with 256 immature birds and 80 juvenile birds recorded. The remaining 130 birds were unaged.

3.7.236 The abundance map for common gull covers the periods April to August and September to March for Years 1 and 2 in the Hornsea Zone (Appendix B). Common gull sightings were evenly distributed throughout the survey area. As peak numbers occurred between February and April, the site is most likely frequented by nonbreeding individuals. Although this species regularly uses the site, there is no indication that Subzone 1 and the 4 km buffer differs in habitat significance from the surrounding area

Lesser Black-backed Gull (*Larus fuscus*)

Status overview

3.7.237 Lesser black-backed gulls are common and widespread in the UK in summer, and breed in colonies in coastal and inland locations. Seabird 2000 recorded 111,835 pairs in Britain (Mitchell *et al.*, 2004). In winter, many birds leave northern areas between November and March, although some remain all year, particularly in the south-west (Forrester *et al.*, 2007). Lesser black backed gulls take a wide variety of prey and scavenged food, both at sea, and on farmland and refuse sites (Forrester *et al.*, 2007).

3.7.238 Lesser black-backed gull is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.239 Langston (2010) assessed lesser black-backed gull as being at moderate risk of collision. Displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were rated as low risk. Overall, lesser black-backed gull was assessed as being at high risk from offshore wind developments, when the importance of its UK breeding population was taken into account (Table 3.3).

3.7.240 Lesser black-backed gull is listed as a qualifying interest species in the breeding season for two SPAs on the UK east coast between Hermaness and Foreness Point. These SPAs held 29.6% of the UK breeding population, and 19.9% of the biogeographic population at the time of designation (JNCC, 2012). Since designation, the population at both SPAs has decreased. The distance between Subzone 1 and these two SPAs is beyond the maximum known foraging range of lesser black-backed gull (181 km, Figure 3.54) (Thaxter *et al.*, 2012).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.241 In Year 1, 1,299 lesser black-backed gulls were recorded on surveys in the Hornsea Survey Area (Table 3.1), with more than half of all birds (60.8%) occurring in the Hornsea Zone and 10 km buffer. The majority of birds were recorded in the summer months (Table A.2 and Table A.4).

3.7.242 Numbers of lesser black-backed gulls were similar in Year 2, with 1,342 birds recorded. Around one third (435 birds) were recorded in Subzone 1 and 4 km buffer with the remaining 907 recorded in the Hornsea Zone and 10 km buffer. The peak count was in April, when 409 birds were recorded (Table A.3 and Table A.5)

3.7.243 Survey coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February (Table 2.1).

3.7.244 During the Year 1 breeding season (May to August), peak estimated numbers of lesser black-backed gulls occurred in June, with 131 birds in Subzone 1 and 280 birds in the 4 km buffer, using data from 2 km transect surveys. In comparison, an estimated 1,231 birds were recorded in the Hornsea Zone and 10 km buffer in July, using data from 6 km transect surveys (Table 3.29).

3.7.245 During the Year 2 breeding season, peak estimated numbers of lesser black-backed gulls also occurred in June, with 94 birds in Subzone 1 and 203 birds when including the 4 km buffer, using data from 2 km transect surveys. In comparison, an estimated 2,156 birds were recorded in the Hornsea Zone and 10 km buffer in April, using data from 6 km transect surveys, which may comprise a mix of breeding and migratory birds. Peak estimates for both breeding seasons were considerably lower than the 1% international population importance threshold of 5,500 birds (Holt *et al.*, 2011).

3.7.246 In the Year 1 non-breeding season, peak estimated numbers of lesser black-backed gulls occurred in August (likely comprising non-breeders and breeders) with 154 birds in Subzone 1, and 330 birds including the 4 km buffer, using data from 2 km transect surveys. An estimated 852 birds were in the Hornsea Zone and 10 km buffer using data from 6 km transect surveys.

3.7.247 In the Year 2 non-breeding season, peak estimated numbers of lesser black-backed gulls occurred in September with 46 birds in Subzone 1, and 98 birds when including the 4 km buffer, using data from 2 km transect surveys. In comparison, an estimated 156 birds were estimated in the combined Subzone survey area for Projects 1 and 2 using data from 2 km transect surveys.

3.7.248 Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2. Estimates for this area are included to place the corresponding estimates for Subzone 1 in context (Table 2.1).

3.7.249 Data are also presented in Figure 3.55 and Figure 3.56.

Table 3.29 Estimated numbers of lesser black-backed gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer in Years 1 and 2.

Year	Month	Est. number on water Subzone1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km[1]	Est. total Subzone 1 and 4 km buffer[1]	Est. total Subzone 1[1]	Est. total in HZ and 10 km buffer[2]
1	March	0	0	0	0	0	0	153
1	April	29	10	85	29	58	27	786
1	May	29	7	124	29	58	27	260
1	June	208	46	942	72	280	131	732
1	July	29	10	85	158	187	87	1,231
1	August	171	51	580	159	330	154	852
1	September	0	0	0	0	0	0	87
1	October	29	5	161	0	29	14	0
1	November	0	0	0	0	0	0	0
1	December	0	0	0	58	58	27	61
1	January	0	0	0	0	0	0	0
1	February	10	2	54	0	10	5	0
2	March	8	2	45	0	8	4	258
2	April	95	46	198	30	125	58	2,156
2	May	90	33	243	88	178	83	1,352
2	June	159	21	1194	44	203	94	431
2	July	10	2	56	29	39	18	184
2	August	10	2	54	15	25	11	77
2	September	98	17	554	0	98	46	156[3]
2	October	10	2	55	30	40	18	10[3]
2	November	0	0	0	0	0	0	0[3]
2	December	0	0	0	0	0	0	-
2	January	38	12	122	42	80	37	80[3]
2	February	0	0	0	0	0	0	1[3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

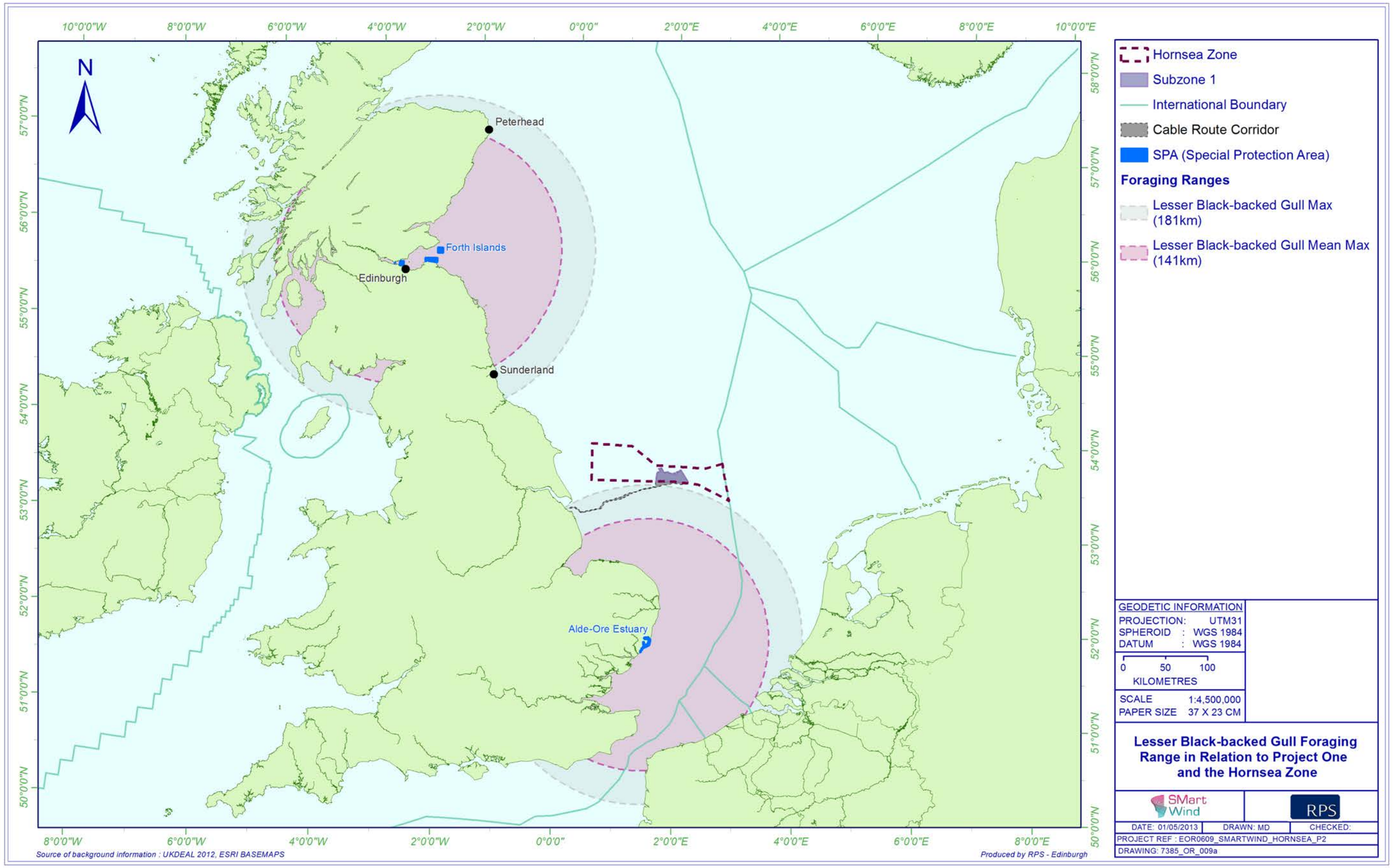


Figure 3.54 Lesser black-backed gull foraging range in relation to Project One and the Hornsea Zone.

Densities

3.7.250 Mean monthly lesser black-backed gull density was generally low in Years 1 and 2 (Figure 3.57). In Subzone 1 (and 4 km buffer) mean density peaked at 0.4 birds/km^2 in August of Year 1, while in Year 2, mean density was 0.2 birds/km^2 in June. In the Hornsea Zone and 10 km buffer, mean density peaked at 0.2 birds/km^2 in July of Year 1, while in Year 2 mean density was 0.4 birds/km^2 in April, although no data were available for September to February of Year 2.

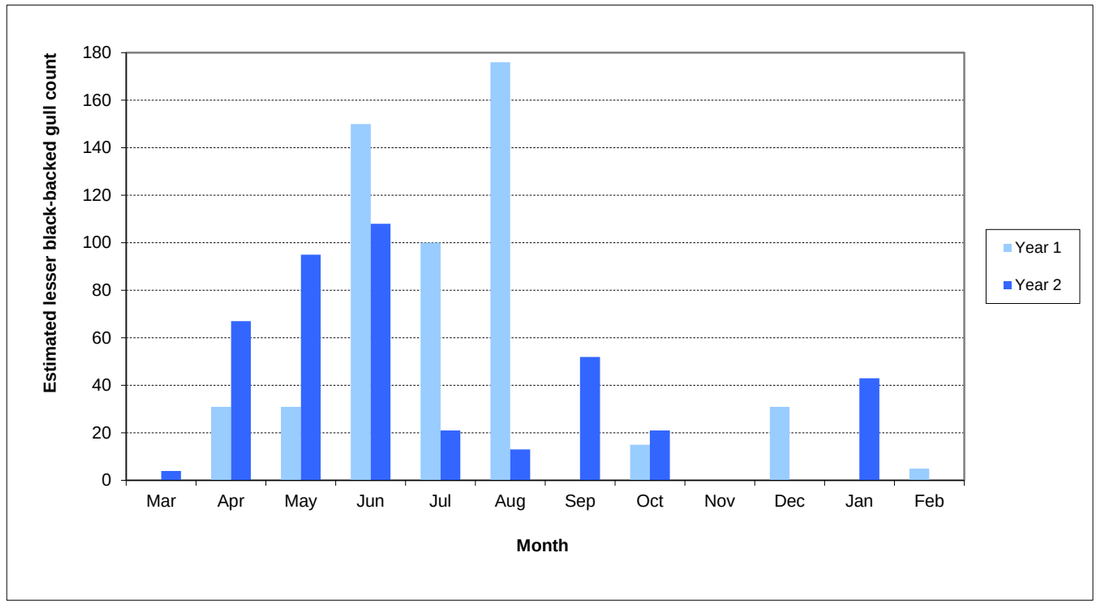


Figure 3.55 Temporal variation in distance-adjusted counts of lesser black-backed gull in Subzone 1 and 4 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

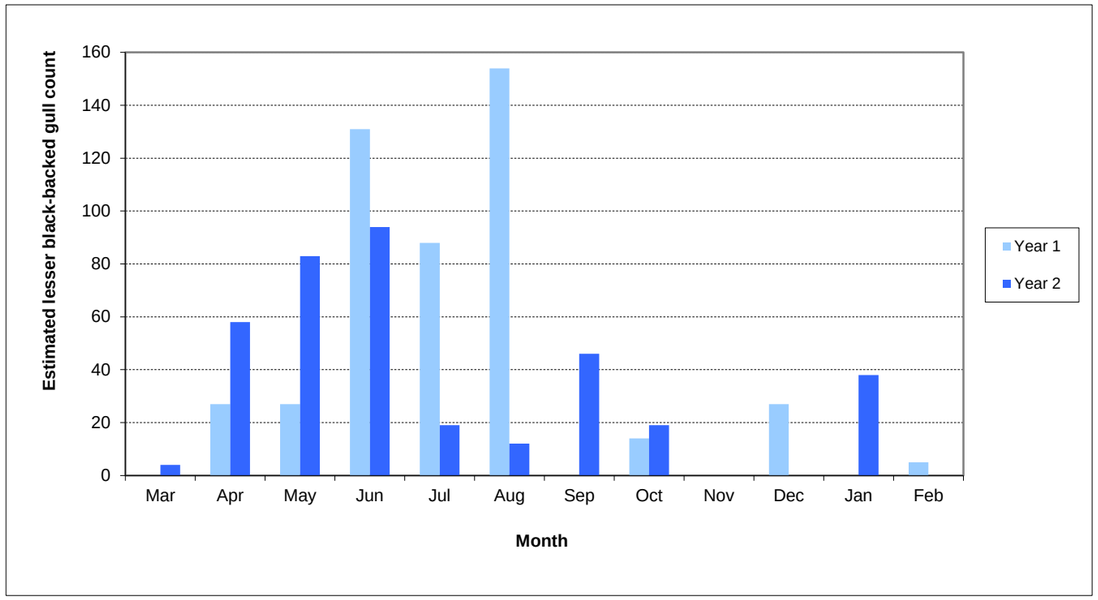


Figure 3.56 Temporal variation in distance-adjusted counts of lesser black-backed gull in Subzone 1.

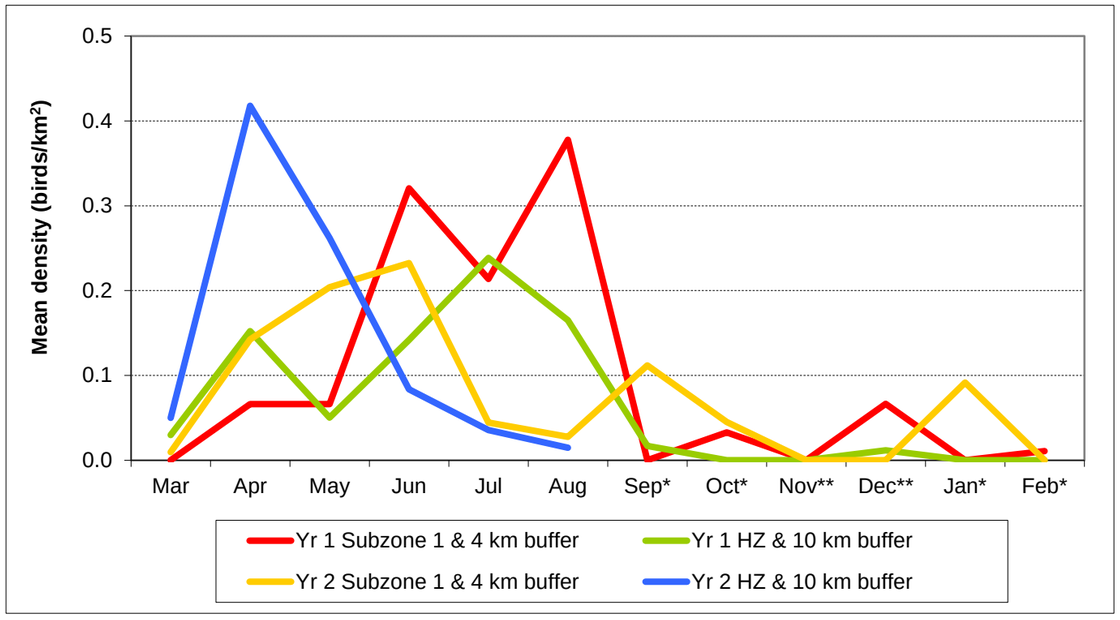


Figure 3.57 Temporal variation in mean densities of lesser black-backed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

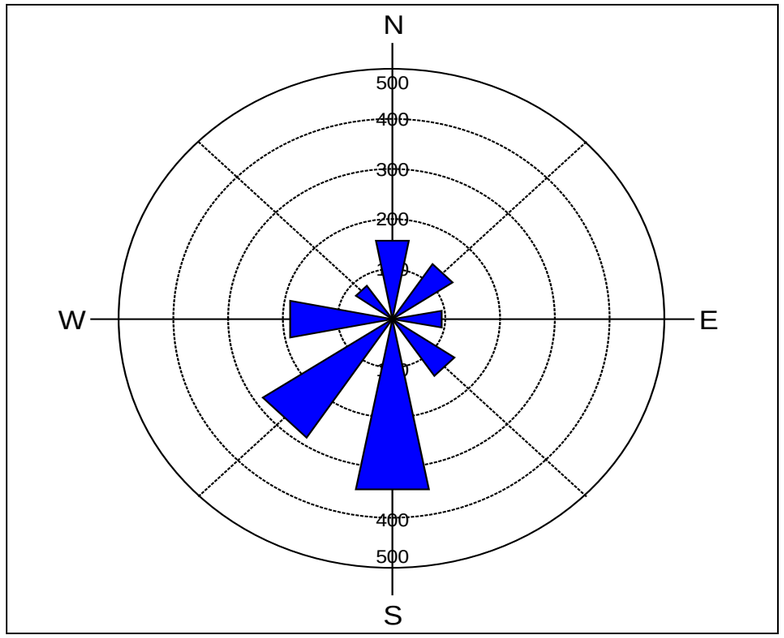
Behaviour and distribution

3.7.251 A total of 1,960 lesser black-backed gulls were recorded in flight on baseline surveys. A total of 364 birds (18.6%) were recorded flying above 22.5 m, at estimated heights of between 25 and 100 m (Table 3.2).

3.7.252 Flight direction was recorded for 1,424 lesser black-backed gulls between April and August on baseline surveys (Figure 3.58). An additional 158 birds were recorded as circling on baseline surveys (not shown). Numbers recorded in flight between September and March were low.

3.7.253 Between April and August, more than two fifths of recorded birds were flying south (24.3%) or south-west (19.9%), in the general direction of the large breeding colony at Outer Trial Bank in The Wash (1,457 pairs in 2009 – SMP, 2012), approximately 140 km from the centre of the Hornsea Zone. This distance is equal to the mean maximum foraging range of breeding lesser black backed gulls assessed by Thaxter *et al.* (2012), and within the maximum known foraging range of 181 km.

3.7.254 A total of 1,401 lesser black-backed gulls were aged on surveys in Year 1 (Table 3.30). Over the 12 months, the average percentage of non-adult (immature) birds was 34.3%, with 65.7% of aged birds classed as adults.



Numbers shown on figure are number of birds recorded.

Figure 3.58 Flight direction of lesser black-backed gulls in the Hornsea Survey Area between April and August, Years 1 and 2.

Table 3.30 Age breakdown of lesser black-backed gulls recorded in Years 1 and 2.

Month	Number of non-adults	Number of adults	Total aged birds	% of adult birds
March	15	76	91	83.5%
April	67	272	339	80.2%
May	135	188	323	58.2%
June	95	109	204	53.4%
July	61	87	148	58.8%
August	50	133	183	72.7%
September	22	9	31	29.0%
October	13	6	19	31.6%
November	3	1	4	25.0%
December	13	6	19	31.6%
January	3	25	28	89.3%
February	3	9	12	75.0%
Annual	**480**	**921**	**1,401**	**65.7%**

3.7.255 The density distribution maps for lesser black backed gull cover the periods April to August for Years 1 and 2 in Subzone 1 and 4 km buffer and for the Hornsea Zone (Appendix B). The species was recorded throughout the survey area, with slightly more records in the south eastern quadrant of Subzone 1 and the 4 km buffer. The lower numbers of records outside Subzone 1 and the 4 km buffer most likely reflect the disparity in survey effort.

Herring gull (*Larus argentatus*)

Status overview

3.7.256 Herring gull is currently red-listed on the UK Birds of Conservation Concern list (RSPB 2009).

3.7.257 Herring gulls are resident, common and widespread, breeding in colonies in coastal and inland locations. Seabird 2000 recorded 142,942 pairs in Britain (Mitchell *et al.*, 2004). There is a general movement southwards in winter months (Forrester *et al.*, 2007). Herring gulls exploit a wide range of food sources, including scraps and offal from trawlers, as well as on land at refuse dumps and farm land (Forrester *et al.*, 2007).Langston (2010) assessed herring gull as being at moderate risk of collision. Displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were rated as low risk. Overall, herring gull was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.258 Herring gull is listed as a qualifying interest species in the breeding season for eight SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.31). These SPAs held 22.5% of the UK breeding population, and 3.8% of the biogeographic population at the time of designation (JNCC, 2012). Since designation, the populations at these SPAs have decreased. The closest SPA, at Flamborough Head and Bempton Cliffs, has reduced from 1,110 pairs at citation to 711 pairs in 2008-11. The distance between Subzone 1 and these SPAs is greater than the maximum known foraging range for herring gull (92 km, Figure 3.59) (Thaxter *et al.*, 2012).

Table 3.31 SPAs for herring gull on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeo graphic population at time of citation [1]	% of national population at time of citation [1]	Recent count (pairs) [2]	Year
Buchan Ness to Collieston Coast	473.1	4,292	0.5	2.7	3,114	2007
East Caithness Cliffs	613.7	9,370	1.0	5.9	3,393	1999
Firth of Forth Islands	365.9	6,600	0.7	4.1	3,934	2006
Flamborough Head and Bempton Cliffs	123.4	1,110	0.1	0.7	711	2008-11
Fowlsheugh	434.5	3,190	0.3	2.0	214	2009
St Abb's Head to Fast Castle	325.5	1,160	0.1	0.7	258	2008
Troup, Pennan and Lion's Heads	524.5	4,200	0.5	2.6	1,687	2007
Alde-Ore Estuary	190.4	6,050	0.6	3.8	2,000	2003
Total	**-**	**35,972**	**3.8**	**22.5**	**15,311**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

Seasonal distribution and abundance

3.7.259 A total of 590 herring gulls were recorded on surveys in the Hornsea Survey Area in Year 1 (Table 3.1), with highest numbers recorded in December when numbers peaked at 64 birds in Subzone 1 and 4 km buffer and 156 birds in the Hornsea Zone and 10 km buffer. In addition, there were 23 birds of the Scandinavian and Baltic race *L. a. argentatus* recorded during Year 1 (Table A.2 and Table A.4).

3.7.260 Similar numbers were recorded in Year 2, with 562 herring gulls recorded, plus 13 birds of the Scandinavian and Baltic race. Peak numbers in Year 2 were 24 birds in Subzone 1 and 4 km buffer in November and 128 birds in the Hornsea Zone and 10 km buffer in March

3.7.261 Survey coverage in the Hornsea Zone and 10 km buffer between September and February was incomplete (Table 2.1).

3.7.262 During the Year 1 breeding season (April to August), the peak estimated number of herring gulls in Subzone 1 was three birds, with seven birds estimated when including the 4 km buffer, in May, using data from 2 km transect surveys. In comparison, an estimated 191 birds were recorded in the Hornsea Zone and 10 km buffer in July, using data from 6 km transect surveys (Table 3.32).

3.7.263 During the Year 2 breeding season, the peak estimated number of herring gulls in Subzone 1 was 18 birds, or 38 birds estimated when including the 4 km buffer, in April, using data from 2 km transect surveys. In comparison, an estimated 383 birds were recorded in the Hornsea Zone and 10 km buffer in April, using data from 6 km transect surveys.

3.7.264 Peak estimates in both breeding seasons were considerably lower than the 1% international population importance threshold of 7,300 birds (Holt *et al.*, 2011).

3.7.265 In the Year 1 non-breeding season (September to March), peak estimated number of herring gulls occurred in December, with 109 birds in Subzone 1, and 234 birds when including the 4 km buffer, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, the peak estimated number (1,034 birds) also occurred in December, using data from 6 km transect surveys.

3.7.266 In the Year 2 non-breeding season, peak estimated numbers of herring gulls occurred in March, with 24 birds in Subzone 1, and 51 birds when including the 4 km buffer, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, the peak estimated number (555 birds) also occurred in March, using data from 6 km transect surveys. Coverage in the Hornsea Zone and 10 km buffer was incomplete between September and February of Year 2, and was restricted to the combined Subzone survey area for Projects 1 and 2.

3.7.267 Data are presented in Figure 3.60, Figure 3.61 and Figure 3.62.

Table 3.32 Estimated numbers of herring gulls in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone and 10 km buffer, in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km[1]	Lower 95 % C.L.	Upper 95 % C.L.	Est. number flying Subzone 1 + 4 km[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	15	4	54	14	14	29	211
1	April	0	0	0	0	0	0	19
1	May	7	1	42	0	3	7	19
1	June	0	0	0	0	0	0	114
1	July	0	0	0	0	0	0	191
1	August	0	0	0	0	0	0	0
1	September	0	0	0	0	0	0	0
1	October	0	0	0	0	0	0	95
1	November	0	0	0	29	14	29	346
1	December	74	19	293	160	109	234	1,034
1	January	30	5	169	14	21	44	519
1	February	30	9	93	0	14	30	113
2	March	0	0	0	51	24	51	555
2	April	23	8	65	15	18	38	383
2	May	15	3	84	15	14	30	287
2	June	0	0	0	0	0	0	192
2	July	0	0	0	0	0	0	0
2	August	0	0	0	0	0	0	0
2	September	0	0	0	15	7	15	0 [3]
2	October	0	0	0	0	0	0	2 [3]
2	November	0	0	0	0	0	0	7 [3]
2	December	0	0	0	0	0	0	-
2	January	7	1	41	0	3	7	7 [3]
2	February	0	0	0	14	7	14	17 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

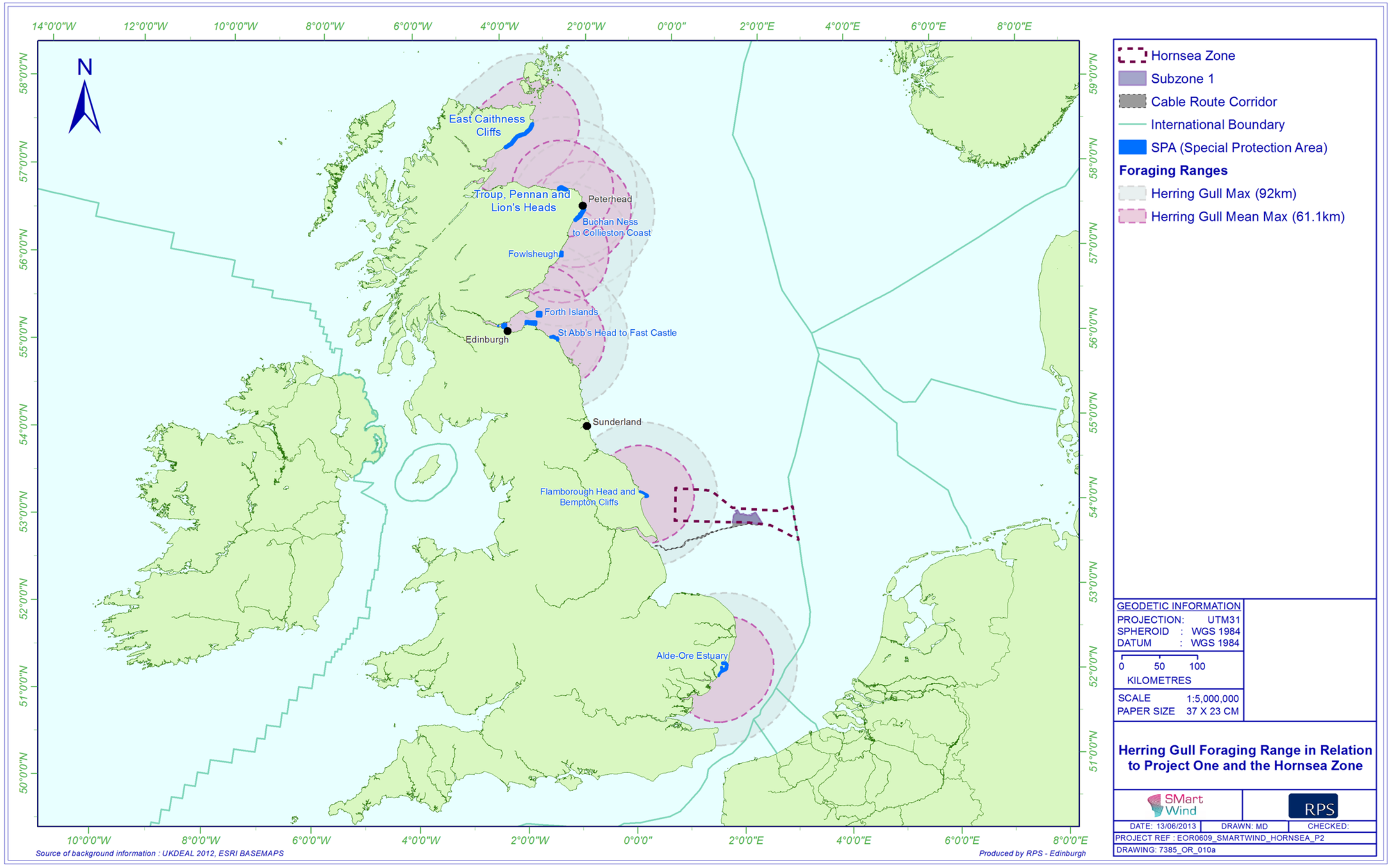


Figure 3.59 Herring gull foraging range in relation to Project One and the Hornsea Zone.

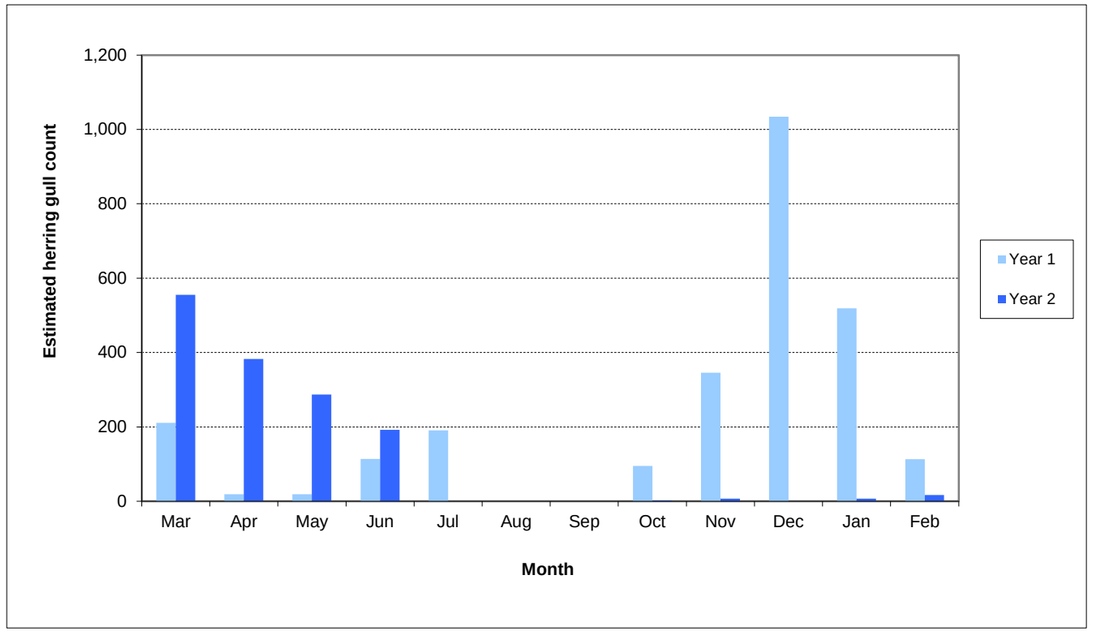


Figure 3.60 Temporal variation in distance-adjusted counts of herring gull in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

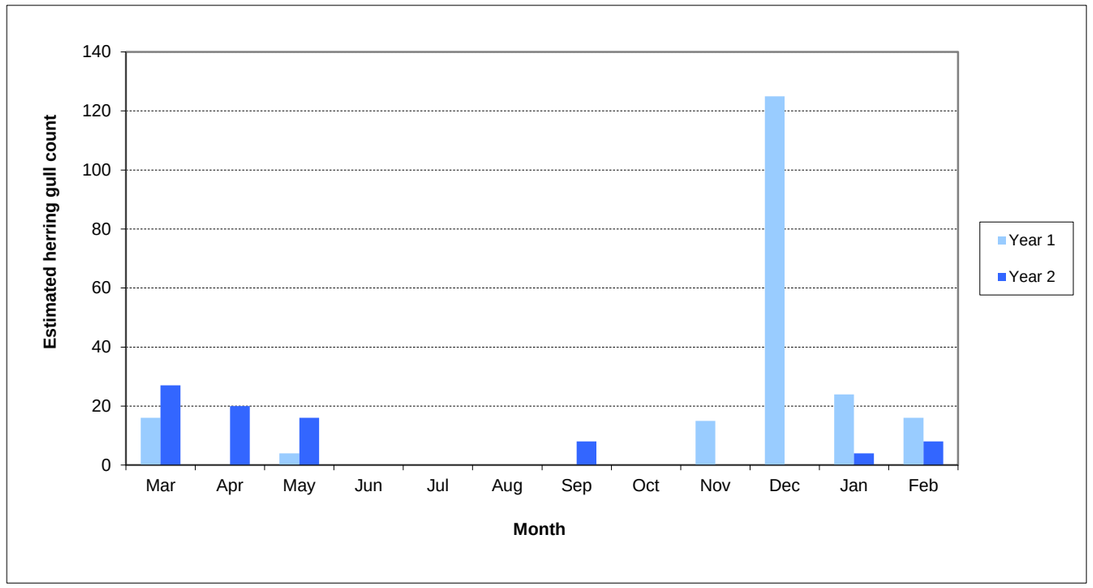


Figure 3.61 Temporal variation in distance-adjusted counts of herring gull in Subzone 1 and 4 km buffer.

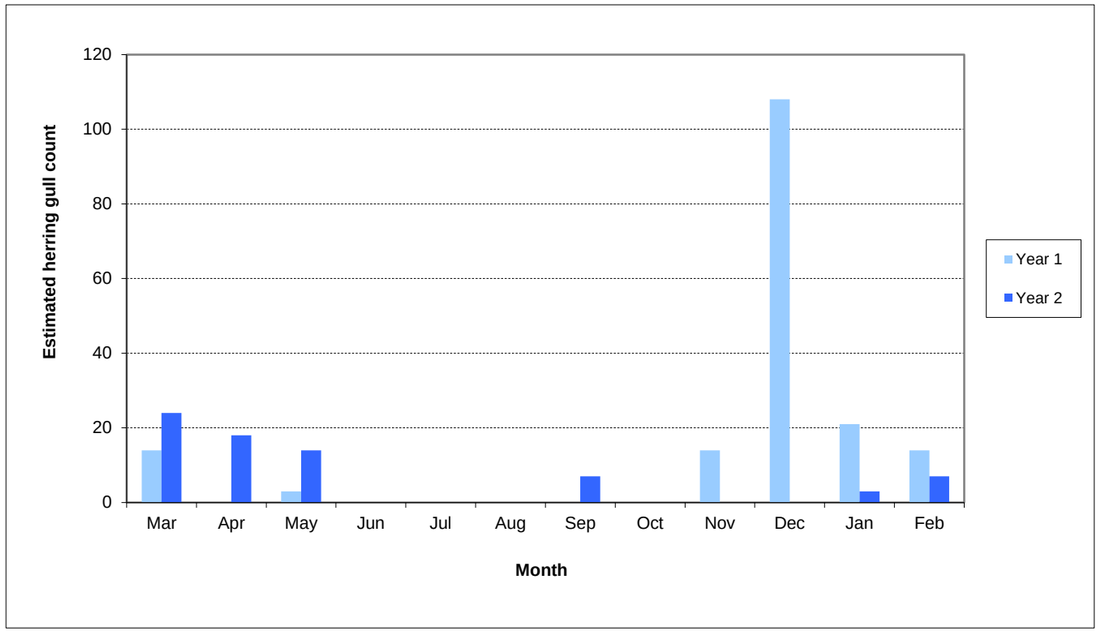


Figure 3.62 Temporal variation in distance-adjusted counts of herring gull in Subzone 1.

Densities

3.7.268 Mean monthly herring gull density was generally low in Years 1 and 2, with a slight increase in Subzone 1 (and 4 km buffer) and the Hornsea Zone (and 10 km buffer) in December of Year 1. ESAS mean density data for herring gull was highest in the winter months, with a peak of 5.3 birds/km^2 in January in the surrounding ¼ ICES rectangles, and 5.0 birds/km^2 in December in Regional Seas 1 and 2 (Figure 3.63).

Behaviour and distribution

3.7.269 A total of 940 herring gulls were recorded in flight on baseline surveys. A total of 273 birds (26.2%) were recorded flying above 22.5 m, at estimated heights of between 25 and 120 m (Table 3.2).

3.7.270 Flight direction was recorded for 218 herring gulls on baseline surveys in the breeding season (April to July), with direction recorded for 544 herring gulls in the non-breeding season (August to March) (Figure 3.64). A further 128 birds were recorded as circling (not shown).

3.7.271 In the breeding season, just under a third (30.7%) of all birds recorded were flying south, with 19.7% of birds flying north. In the non-breeding season a similar pattern was recorded, with a quarter of all birds recorded flying south (25.6%), and 22.4% flying north, although sample sizes were small for this species.

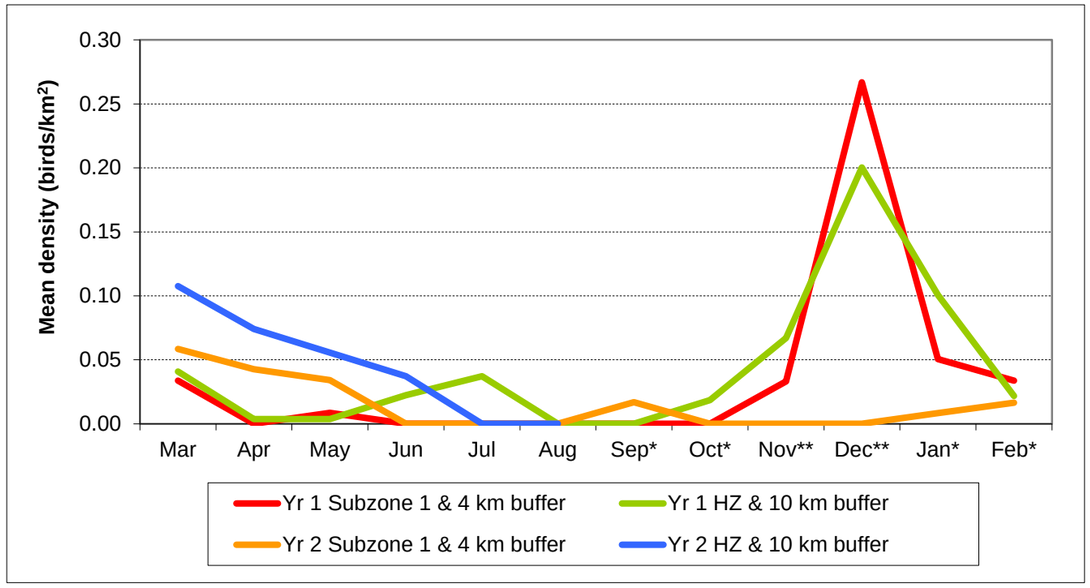
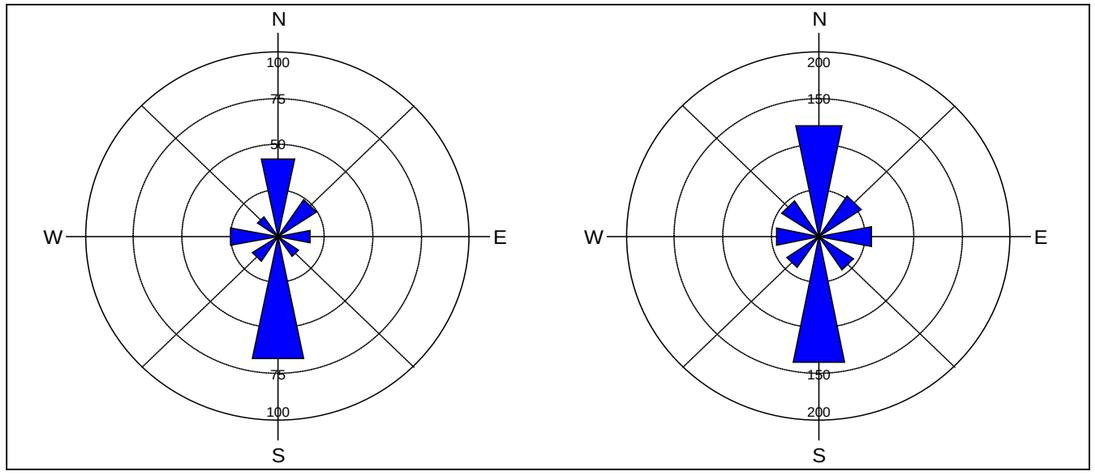


Figure 3.63 Temporal variation in mean density of herring gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**



April to July (n=220 birds) September to March (n=197 birds)

Numbers shown on figures are number of birds recorded.

Figure 3.64 Flight direction of herring gulls in the Hornsea Survey Area in Years 1 and 2.

3.7.272 Of the 1,152 herring gulls recorded on baseline surveys, 298 were aged as adults, with 373 immature birds and 77 juvenile birds recorded. The remaining 368 birds were unaged.

3.7.273 The density distribution maps for Herring Gull cover the periods April to July and August to March for Years 1 and 2 in Subzone 1 and 4 km buffer and for the Hornsea Zone (Appendix B). The greatest densities were recorded in the autumn, indicating site use by individuals on passage. These birds were evenly distributed throughout the survey area, while birds during the winter and spring favoured the southern edge of Subzone 1 and 4 km buffer and were only present in small numbers, indicating that the site is unlikely to be important to this species outside of the autumn passage.

Great Black-backed Gull (*Larus marinus*)

Status overview

3.7.274 Great black-backed gull is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.275 Great black-backed gull is a common resident species in the UK, occurring in coastal areas. Seabird 2000 recorded 17,394 pairs in Britain, with largest numbers on western coasts (Mitchell *et al.*, 2004). Great black-backed gulls are omnivorous, foraging at sea, on estuaries and beaches, and less commonly at rubbish dumps (Forrester *et al.*, 2007).

3.7.276 Langston (2010) assessed great black-backed gull as being at moderate risk of collision. Displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were rated as low risk. Overall, great black-backed gull was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.277 Great black-backed gull is listed as a qualifying interest species in the breeding season for four SPAs between Hermaness and Foreness Point. However, none of these sites fall within foraging range of the Hornsea Zone (Figure 3.65) (JNCC, 2012).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.278 Great black-backed gull is a relatively common breeding species in Great Britain. During the pre-breeding and breeding season their distribution tends to be limited to coastal areas. During the winter they are a much more widely dispersed species and often travel long distances in pursuit of discards from fishing vessels (Stone *et al.,* 1995). The flyway population in the North Sea is estimated at 480,000 birds with 5.2% of the biogeographic population flying over the southernmost part of this area (Steinen *et al.,* 2007).

3.7.279 During March and April the highest densities are found in the northern isles of Scotland and by July the overwintering birds have all returned to breeding grounds in Fenno Scandia and Iceland, leaving low densities along the east coast. During the post-breeding period of August to October, distribution is more widespread along the east coast with densities of five birds/km^2 recorded to the north of the Humber estuary (Stone *et al.,* 1995). In November to February great black-backed gulls are widespread over much of the North Sea with high densities near the Dogger Bank and the southern North Sea.

3.7.280 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show that small numbers of great black-backed gulls were recorded throughout the year during surveys of the Greater Wash survey blocks GW2, GW9 and GW10, with a peak mean of 11 birds in December. A similar number of the species group 'Black-backed gulls' was also recorded with the peak mean also occurring in December (14 birds). Another species group defined as 'Large gull spp.' also showed similar numbers, but this time with the peak mean occurring in March (24 birds). Much more frequent was the species group 'Gull spp.' with a mean peak of 166 birds in March.

3.7.281 A total of 3,147 great black-backed gulls were recorded on surveys in the Hornsea Survey Area in Year 1 (Table 3.1), with just under three quarters of birds (73.8%) occurring in the Hornsea Zone and 10 km buffer area. Peak numbers in Subzone 1 and 4 km buffer occurred in January (163 birds), while in the Hornsea Zone and 10 km buffer, peaks of 429 birds in January and 430 birds in October were recorded (Table A.2 and Table A.4). Numbers of great black-backed gulls in the Hornsea Survey Area in Year 2 were slightly higher, with 3,682 birds recorded on surveys. Peak numbers were 165 birds in Subzone 1 and 4 km buffer in September and 606 birds in the Hornsea Zone and 10 km buffer in November (Table A.3 and Table A.5).

3.7.282 During the Year 1 main breeding season (April to July), peak estimated numbers of great black-backed gulls were recorded in May and July, with 13 birds in Subzone 1 and 29 birds estimated when including the 4 km buffer. In comparison, an estimated 789 birds were recorded in the Hornsea Zone and 10 km buffer in July of Year 1. This estimate exceeded the 1% threshold of national population importance (760 birds) (Holt *et al.*, 2011) (Table 3.33).

3.7.283 During the Year 2 breeding season, peak estimated numbers of great black-backed gulls were recorded in April, with 120 birds in Subzone 1 and 258 birds estimated when including the 4 km buffer. In comparison, an estimated 535 birds were recorded in the Hornsea Zone and 10 km buffer in July of Year 2. This estimate was below the 1% threshold of national population importance.

3.7.284 In the Year 1 non-breeding season (August to March), peak estimated number of great black-backed gulls occurred in January, with 221 birds in Subzone 1, and 474 birds when including the 4 km buffer. In the Hornsea Zone and 10 km buffer, the peak estimated number (3,970 birds) also occurred in January. However, the January and December estimates were probably inflated by the presence of fishing vessels in the Hornsea Zone, with large numbers of great black-backed gulls associating with them, and so these estimates should be treated with caution.

3.7.285 In the Year 2 non-breeding season, peak estimated numbers of great black-backed gulls occurred in Subzone 1 in September (265 birds), with 571 birds estimated when including the 4 km buffer, also in September. In the Hornsea Zone and 10 km buffer, the peak estimated number (2,764 birds) occurred in March. Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2. Estimates for the non-breeding season in both Years 1 and 2 were below the 1% threshold of international importance (4,400 birds) (Holt *et al.*, 2011).

3.7.286 These data are also presented in Figure 3.66, Figure 3.67 and Figure 3.68.

Densities

3.7.287 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area. The highest density estimates occur in the winter with the mean for all three areas being between 0.8 and 1.68 birds/km^2 between October and February. During the breeding season these figures drop significantly, even to zero in Area 2 in June.

3.7.288 Great black-backed gull densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in (Table 3.34) (along with data from Subzone 1 and 4 km buffer for comparison).

3.7.289 Mean monthly great black-backed gull density showed a similar pattern between Subzone 1 and 4 km buffer and the Hornsea Zone and 10 km buffer, although generally low mean densities recorded in Years 1 and 2. Peak mean density of 0.8 birds/km^2 was recorded in the Hornsea Zone and 10 km buffer in January of Year 1 (Figure 3.69).

3.7.290 A comparison of the temporal distribution of great black-backed gull density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.70. The temporal pattern is very similar for both the Hornsea Survey Area and the wider North Sea, suggesting that the Hornsea Survey Area is no more important for great black-backed gulls that the area of ocean in which it sits.

3.7.291 ESAS mean density data for great black-backed gull was also highest in the winter months, with a peak of 9.3 birds/km^2 in January in the surrounding ¼ ICES rectangles, and 2.3 birds/km^2 in December in Regional Seas 1 and 2. ESAS mean density data were very low in the breeding season.

Table 3.33 Estimated numbers of great black-backed gulls in Subzone 1, 4 km buffer and Hornsea Zone and 10 km buffer in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km[1]	Lower 95 % C.L.	Upper 95 % C.L.	Est. number flying Subzone 1 + 4 km[1]	Est. total Subzone 1[1]	Est. total subzone 1 and 4 km buffer[1]	Est. total in HZ and 10 km buffer[2]
1	March	79	27	229	43	57	122	1,704
1	April	0	0	0	0	0	0	498
1	May	0	0	0	29	13	29	76
1	June	0	0	0	0	0	0	105
1	July	0	0	0	29	13	29	789
1	August	0	0	0	87	40	87	664
1	September	218	41	1159	65	132	283	1,713
1	October	28	7	118	15	20	43	2,744
1	November	49	20	122	72	57	121	1,674
1	December	53	21	137	131	86	184	3,448
1	January	257	119	554	217	221	474	3,970
1	February	197	100	387	101	139	298	2,242
2	March	238	102	556	166	188	404	2,764
2	April	169	95	301	89	120	258	2,845
2	May	177	73	429	44	103	221	521
2	June	149	26	848	15	76	164	249
2	July	0	0	0	58	27	58	535
2	August	9	2	52	0	4	9	120
2	September	409	110	1519	162	265	571	437[3]
2	October	151	42	548	326	222	477	317[3]
2	November	75	34	165	29	49	104	386[3]
2	December	187	28	1267	128	147	315	-
2	January	231	126	422	169	186	400	310[3]
2	February	96	46	202	87	85	183	141[3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

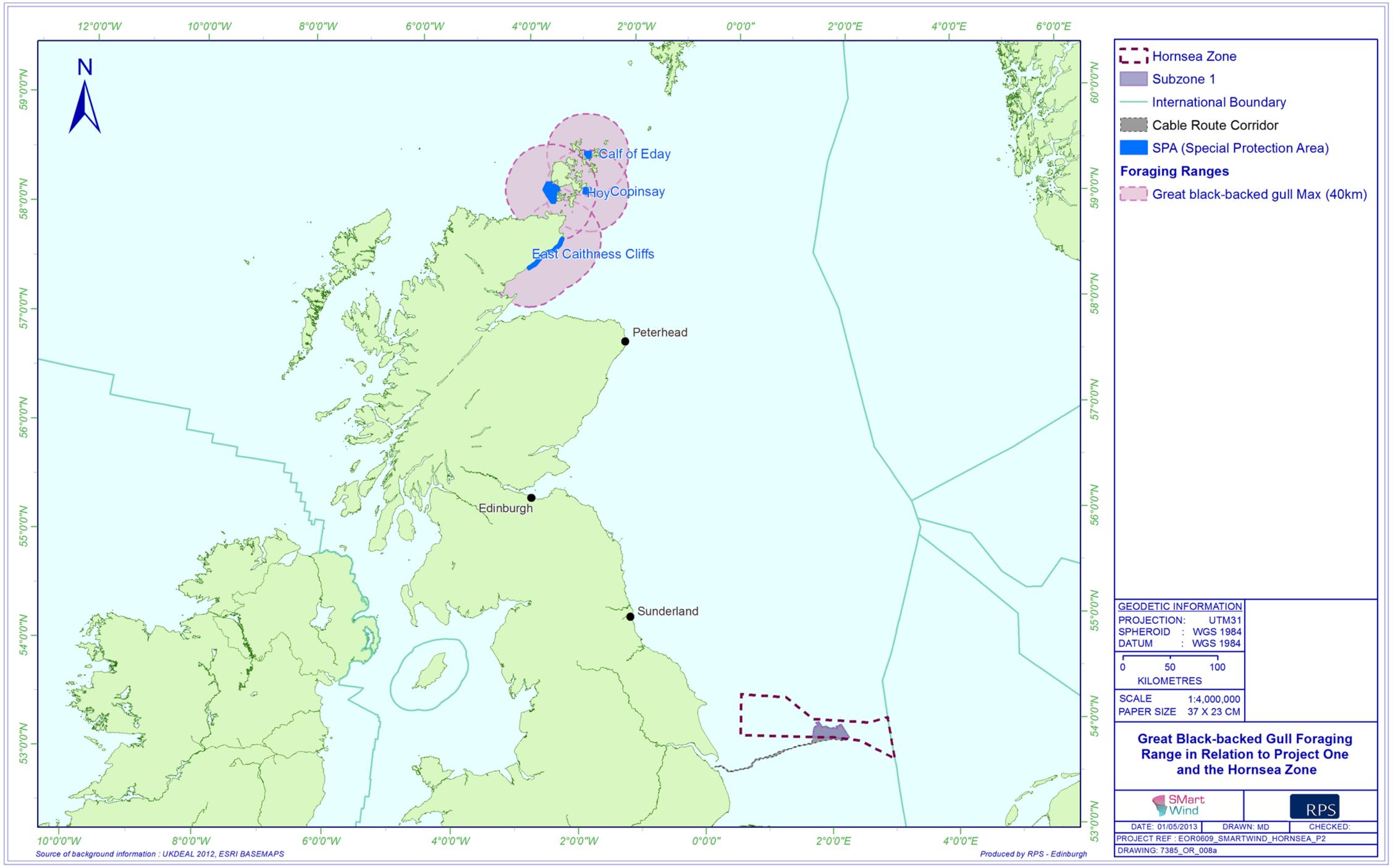


Figure 3.65 Great black-backed gull foraging range in relation to Project One and the Hornsea Zone.

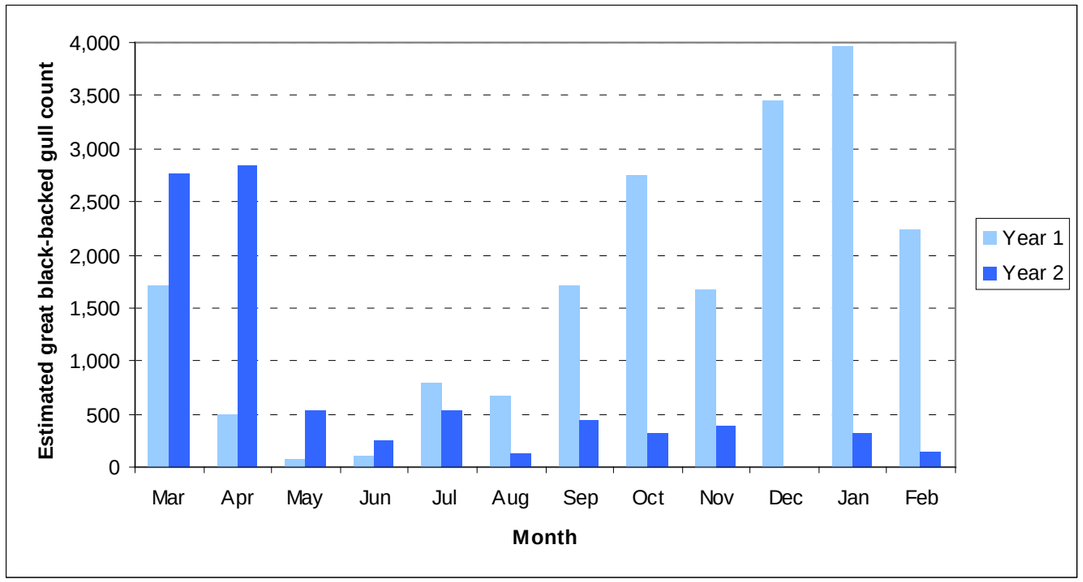


Figure 3.66 **Temporal variation in distance-adjusted counts of great black-backed gull in the Hornsea Survey Area. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

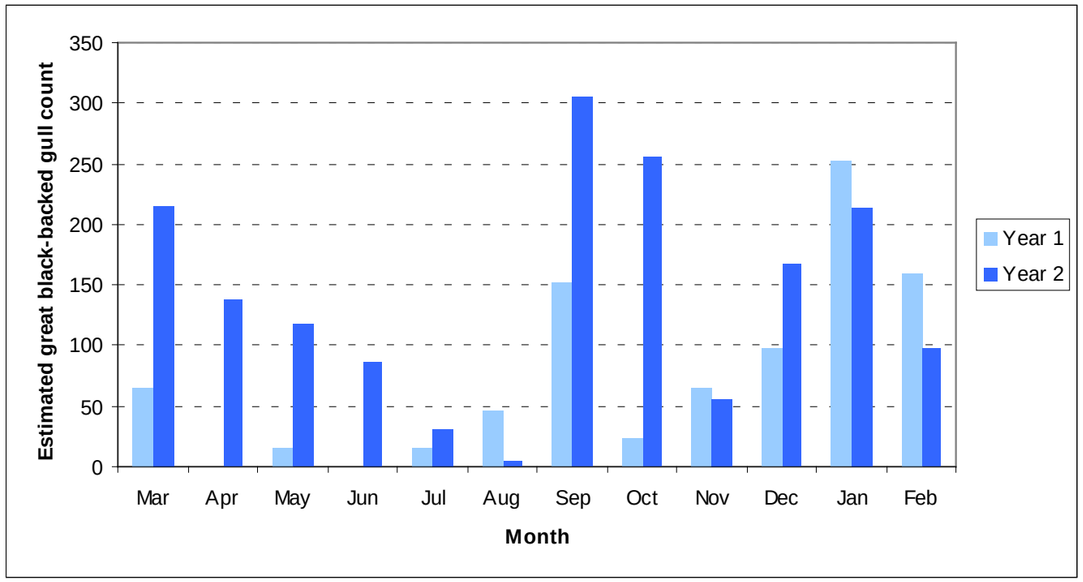


Figure 3.67 **Temporal variation in distance adjusted counts of great black-backed gull in Subzone 1 and 4 km buffer**

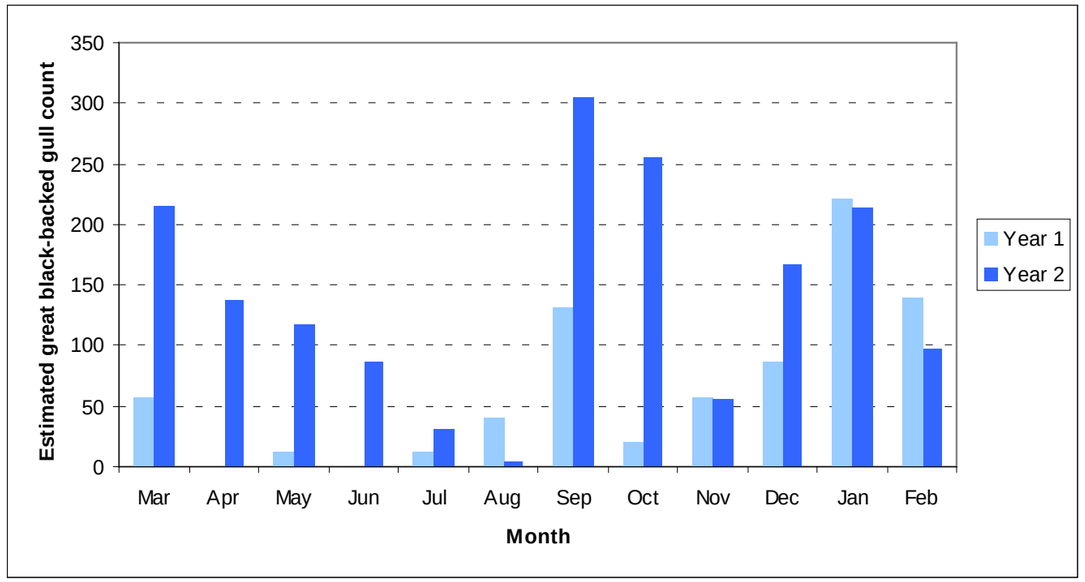


Figure 3.68 **Temporal variation in distance adjusted counts of great black-backed gull in Subzone 1.**

Table 3.34 **North Sea great black-backed gull densities from Stone *et al*. (1995).**

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0.56	0.9	1.11	0.86	0.50
February	2.06	0.33	0.87	1.09	0.28
March	0.03	0.49	0.40	0.31	0.30
April	0.19	0.44	0.24	0.29	0.15
May	0.01	0.01	0.09	0.04	0.14
June	0.03	0	0.03	0.02	0.09
July	0.03	0.01	0.08	0.04	0.05
August	0.27	0.11	0.15	0.18	0.05
September	1.01	0.53	0.56	0.70	0.49
October	1.64	0.51	0.82	0.99	0.30
November	0.67	0.62	1.14	0.81	0.13
December	2.18	1.43	1.44	1.68	0.29

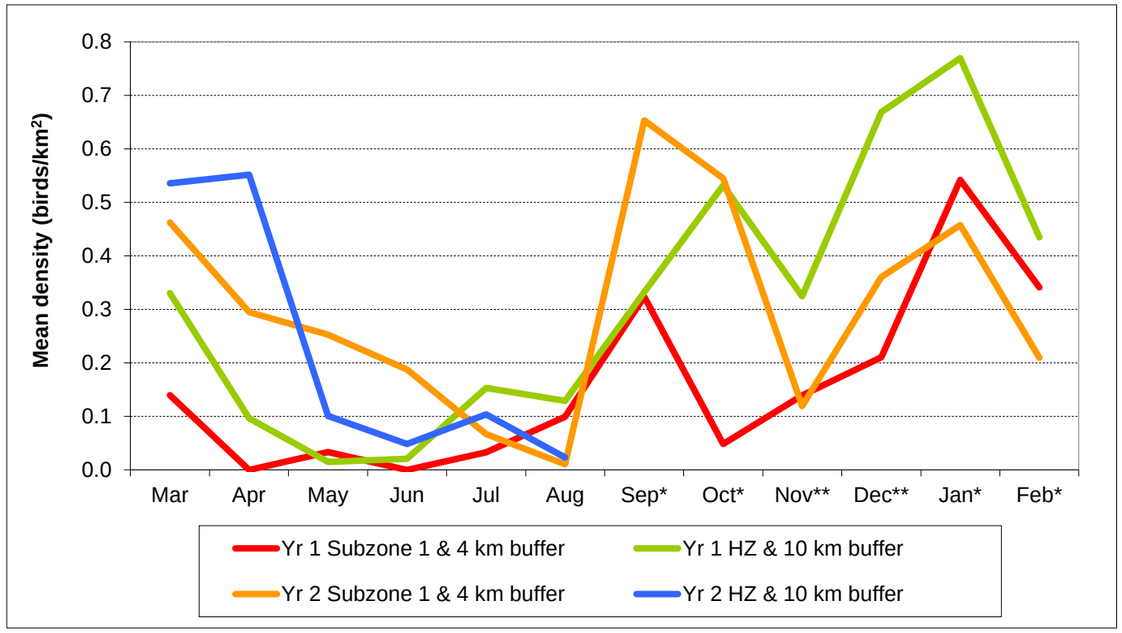


Figure 3.69 Temporal variation in mean densities of great black-backed gull in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Behaviour and distribution

3.7.292 A total of 4,906 great black-backed gulls were recorded in flight on baseline surveys. A total of 1,374 birds (28%) were recorded flying above 22.5 m, at estimated heights of between 25 and 100 m (Table 3.2).

3.7.293 Of the 6,829 great black-backed gulls recorded on baseline surveys, 1,512 were aged as adults, with 2,297 immature birds and 694 juvenile birds recorded. The remaining 2,326 birds were unaged.

3.7.294 Flight direction was recorded for 1,049 great black backed gulls on baseline surveys in the breeding season (April to August), with direction recorded for 3,031 great black backed gulls in the non-breeding season (September to March) (Figure 3.71). An additional 619 birds were recorded as circling (not shown).

3.7.295 In the breeding season, just under a fifth of all birds recorded were flying west (19.0%), with 17.3% of birds flying south and 16.0% of birds flying north. In the non-breeding season, just over one fifth of all birds recorded were flying south (22.5%), with 19.4% of birds flying north.

3.7.296 Foraging behaviour was recorded for 462 great black-backed gulls in the Hornsea Survey Area on baseline surveys, with nine types of foraging behaviour recorded, and unspecified feeding behaviour was recorded for a further 68 birds (Table 3.35). The majority of foraging birds were actively searching (70.0%).

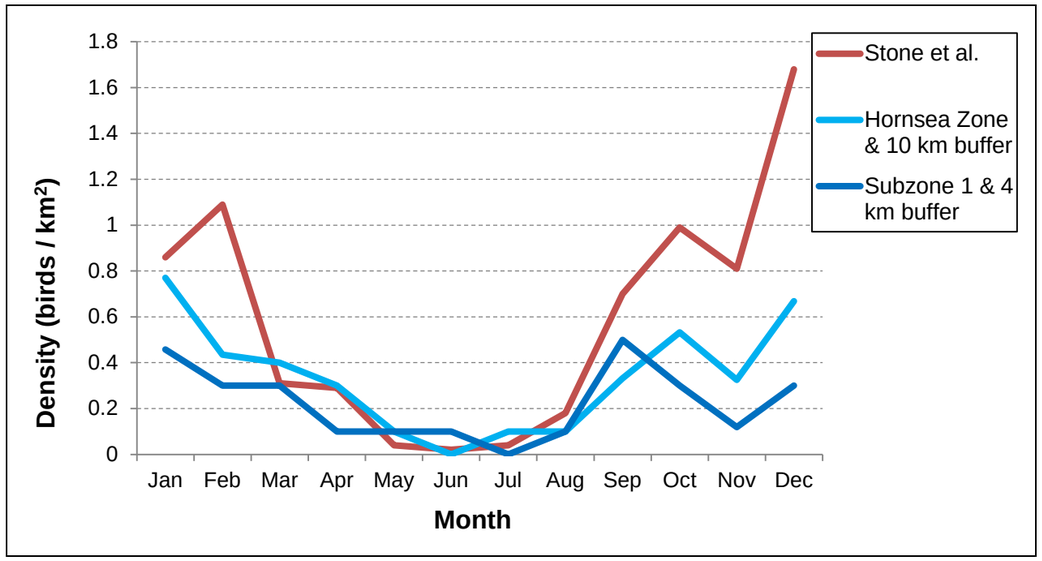
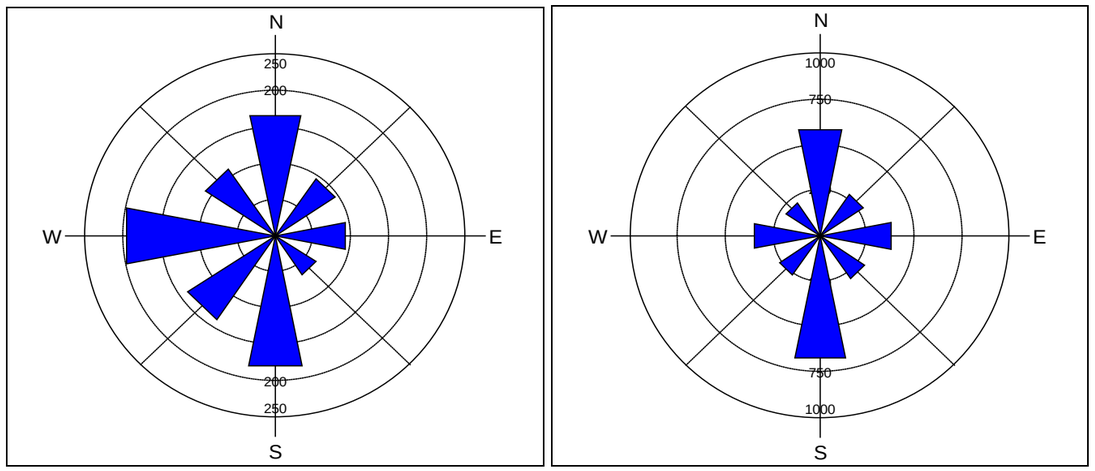


Figure 3.70 A comparison of temporal variation in density of great black-backed gull in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).



April to August (n=1,049 birds) September to March (n=3,031 birds)

Numbers shown on figures are number of birds recorded.

Figure 3.71 Flight direction of great black-backed gulls in the Hornsea Survey Area in Years 1 and 2.

3.7.297 The density distribution maps for great black backed gull cover the periods April to August and September to March for Years 1 and 2 in Subzone 1 and 4 km buffer (Appendix B). Records were distributed evenly throughout the site, with no spatial variation between seasons. This shows a regular pattern of site use by the species.

Table 3.35 Great black-backed gull foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	371	70.0
Aerial pursuit	16	3.0
Dipping	5	0.9
Holding fish	4	0.8
Scavenging	18	3.4
Scavenging at fishing vessel	10	1.9
Shallow plunging	14	2.6
Surface pecking	18	3.4
Surface seizing	6	1.1
Feeding – unspecified	68	12.8
Total	**530**	

Kittiwake (*Rissa tridactyla*)

Status overview

3.7.298 Kittiwake is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.299 Kittiwakes are some of the commonest seabirds in the UK, breeding in large colonies on coastal cliff habitat. Seabird 2000 recorded 366,835 pairs in the UK, with largest numbers on the east coast (Mitchell *et al.*, 2004). The nearest large colony to the Hornsea Zone is at Flamborough Head and Bempton Cliffs. Kittiwakes mostly prey on small fish such as sandeels as well as fishery discards (Forrester *et al.*, 2007).

3.7.300 Langston (2010) assessed kittiwake as being at moderate risk of collision. Displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms were rated as low risk. Overall, kittiwake was assessed as being at low risk from offshore wind developments (Table 3.3).

3.7.301 Kittiwake is listed as a qualifying interest species in the breeding season for 20 SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.36). These SPAs held 67.2% of the UK breeding population, and >10.1% of the biogeographic population at the time of designation (JNCC, 2011). Recent counts are included for comparison, where available (SMP, 2012, and Flamborough Head and Bempton Cliffs SPA review from Natural England).

3.7.302 Flamborough Head and Bempton Cliffs is the closest SPA to the Hornsea Survey Area. Subzone 1 is just within the maximum foraging range of 120 km, and the Hornsea Zone overlaps with the mean maximum foraging range of 60 km (Thaxter *et al.*, 2012) (Figure 3.72). All other SPAs lie outside mean maximum foraging range.

Hornsea Survey Area

Seasonal distribution and abundance

3.7.303 The southern North Sea holds around 5% of the biogeographic population of kittiwake, with numbers in excess of 30,000 individuals being found here at some point during the year (Stienen *et al.*, 2007). During April to July, kittiwakes are dispersed widely around the coast of Britain, with relatively low densities throughout the southern North Sea, compared to more northerly areas, where the main breeding colonies are located (Stone *et al.*, 1995). In east England, particularly south of Flamborough Head, kittiwake colonies are rare, due to the lack of suitable cliff-face breeding habitats.

3.7.304 From August to October, kittiwakes begin to disperse across the North Sea, although the predominant distribution still reflects the location of breeding colonies. From November to March, birds are dispersed over much larger areas of the North Sea, and in the southern parts, numbers peak during this period. This reflects the kittiwake's preference for pelagic habitats in winter.

3.7.305 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show kittiwake numbers in the Greater Wash survey blocks GW2, GW9 and GW10, peaked during chick-rearing (Jul) with a peak mean of 1162 birds recorded in GW9 and GW10. The second highest peak occurred during incubation (May) with a mean of 722 birds and the third highest was during incubation (May) with a mean of 693 birds. Lower numbers were recorded between August and February.

3.7.306 Kittiwake was the second most frequently recorded seabird in the Hornsea Survey Area in Year 1, with a total of 28,818 birds recorded on surveys (Table 3.1). Birds were recorded in all months. Just over half of all kittiwakes (57.8%) were recorded in the Hornsea Zone and 10 km buffer. The highest numbers were recorded in late summer and autumn, with a peak of 3,281 birds in Subzone 1 and the 4 km buffer in September and 5,487 birds in the Hornsea Zone and 10 km buffer in July (Table A.2 and Table A.4).

3.7.307 Higher numbers of kittiwakes were recorded in the Hornsea Survey Area in Year 2, with 41,896 birds on surveys. Birds were recorded in all months. A total of 10,271 kittiwakes were recorded on surveys in Subzone 1 and 4 km buffer in Year 2, with a peak of 3,254 birds in September. A total of 31,625 birds were recorded on surveys in the Hornsea Zone and 10 km buffer, with a peak of 8,860 birds in August (Table A.3 and Table A.5).

3.7.308 Survey coverage in the Hornsea Zone and 10 km buffer between September and February was incomplete (Table 2.1).

3.7.309 During the Year 1 breeding season (March to July), peak estimated numbers of kittiwakes were recorded in June, with 1,907 birds in Subzone 1 and 4,095 birds estimated when including the 4 km buffer, using data from 2 km transect surveys (Table 3.37). In comparison, an estimated 33,449 kittiwakes were recorded in the Hornsea Zone and 10 km buffer in July, using data from 6 km transect surveys. This estimate corresponds to 4.6% of the British breeding population (366,835 pairs) (Mitchell *et al.*, 2004).

3.7.310 During the Year 2 breeding season, peak estimated numbers of kittiwakes were recorded in July, with 1,799 birds in Subzone 1 and 3,862 birds estimated when including the 4 km buffer, using data from 2 km transect surveys. In comparison, an estimated 14,702 kittiwakes were recorded in the Hornsea Zone and 10 km buffer in June, using data from 6 km transect surveys. This estimate corresponds to 2.0% of the British breeding population (366,835 pairs) (Mitchell *et al*., 2004).

3.7.311 In the Year 1 post-breeding period (August and September), peak estimated number of kittiwakes occurred in August, with 9,476 birds in Subzone 1 and 20,347 birds estimated when including the 4 km buffer, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, the peak estimate of kittiwakes was 30,634 birds in August, using data from 6 km transect surveys Table 3.37. This estimate corresponds to 4.2% of the UK breeding population (366,835 pairs) (Mitchell *et al.*, 2004).

3.7.312 In the Year 2 post-breeding period (August and September), peak estimated number of kittiwakes occurred in September, with 24,659 birds in Subzone 1 and 52,946 birds estimated when including the 4 km buffer, using data from 2 km transect surveys. The estimate for Subzone 1 is approximately 3.4% of the UK breeding population (366,835 pairs), while the estimate for the 4 km buffer is approximately 7.2 % of the UK breeding population (Mitchell *et al.*, 2004).

3.7.313 In comparison, an estimated 45,207 kittiwakes were recorded in the combined Subzone survey area for Projects 1 and 2 in September, using data from 2 km transect surveys. Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2. Estimates for this area are included to place the corresponding estimates for Subzone 1 in context. The September estimate for the combined Subzone survey area for Projects 1 and 2 is approximately 6.2% of the UK breeding population (366,835 pairs) (Mitchell *et al.*, 2004).

3.7.314 In the Year 1 non-breeding season (October to March) peak estimated number of kittiwakes occurred in October, with 1,120 birds in Subzone 1, and 2,404 birds estimated when including the 4 km buffer, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, the peak estimate of kittiwakes was 8,414 birds in March, with 8,361 birds estimated for October, using data from 6 km transect surveys.

3.7.315 Estimated numbers were lower in the Year 2 non-breeding season and peaked in March, with 540 birds in Subzone 1, and 1,159 birds estimated when including the 4 km buffer, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, the peak estimate of kittiwakes was 11,663 birds in March. Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2.

3.7.316 These data are also presented in Figure 3.73, Figure 3.74 and Figure 3.75.

Table 3.36 SPAs for kittiwake on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeographic population at time of citation [1]	% of national population at time of citation [1]	Recent count (pairs) [2]	Year
Buchan Ness to Collieston Coast	473.1	30,452	0.96	6.2	14,133	2007
Calf of Eday	644.4	1,717	<0.1	0.4	401	2002
Copinsay	607.4	3,610	0.1	0.7	4,364	1999
East Caithness Cliffs	613.7	31,930	1	6.5	40,410	1999
Fair Isle	698.1	9,660	0.3	2.0	5,399	2005
Farne Islands	280.7	6,236	0.2	1.3	3,699	2009
Firth of Forth Islands	365.9	9,380	0.3	1.9	3,654	2009
Flamborough Head and *Bempton Cliffs*	*123.4*	*83,370*	*2.6*	*17.0*	*44,520*	*2008-11*
Foula	717.3	3,840	0.1	0.8	997	2007
Fowlsheugh	434.5	34,870	1.1	7.1	9,454	2009
Hermaness, Saxa Vord and Valla Field	771.8	1,710	<0.1	0.4	173	1999
Hoy	616.9	3,000	<0.1	0.6	795	1999
Marwick Head	657.6	7,110	0.2	1.5	2,018	2009
North Caithness Cliffs	613.7	15,650	0.5	3.2	8,834	Seabird 2000
Noss	702.6	4,270	0.1	0.9	1,427	2005
Rousay	646.3	4,900	0.2	1.0	2,713	1999
St Abb's Head to Fast Castle	325.5	19,600	0.6	4.0	5,298	2008
Sumburgh Head	676.5	1,366	<0.1	0.3	354	2009
Troup, Pennan and Lion's Heads	524.5	31,660	1	6.5	17,171	2007
West Westray	655.7	24,000	0.8	4.9	4,693	2004
Total	-	328,331	>10.1	67.2	170,507	-

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Sites in italics lie within the maximum known foraging range of 120 km. (Thaxter *et al.*, 2012).

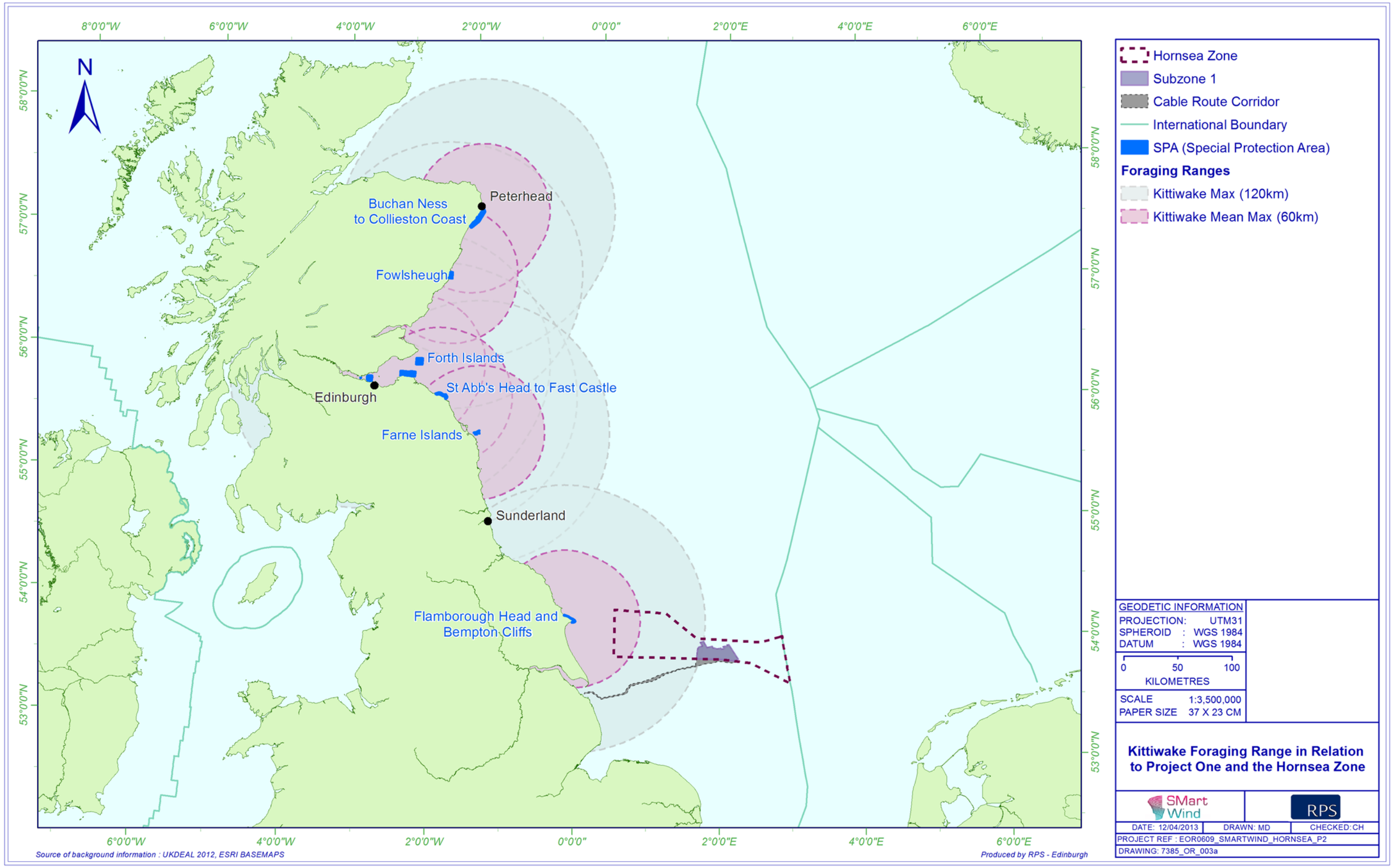


Figure 3.72 Kittiwake foraging ranges from SPAs in relation to the Hornsea Survey Area.Note Northern Isles SPAs not shown on map.

Table 3.37 Estimated numbers of kittiwakes in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Year 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer [1]	Lower 95% C.L.	Upper 95 %C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	1625	1079	2448	507	993	2,132	8,414
1	April	624	347	1122	159	365	783	7,248
1	May	60	18	199	101	75	161	1,218
1	June	3241	2404	4368	854	1,907	4,095	10,446
1	July	834	302	2301	590	663	1424	33,449
1	August	19406	8496	44325	941	9,477	20,347	30,634
1	September	5535	2801	10937	742	2,924	6,277	3,948
1	October	2244	729	6912	160	1,120	2,404	8,361
1	November	925	634	1351	1305	1,038	2,230	5,302
1	December	175	96	318	290	217	465	4,795
1	January	243	120	491	376	289	619	6,091
1	February	585	320	1068	448	481	1033	5,817
2	March	814	465	1425	345	540	1159	11,663
2	April	1504	1043	2168	177	783	1681	10,547
2	May	212	118	384	15	106	227	11,310
2	June	2383	1216	4668	394	1,293	2,777	14,702
2	July	2239	1349	3717	1623	1,799	3,862	13,672
2	August	999	360	2773	262	587	1261	5,283
2	September	52710	4522	61441	236	24,659	52,946	45,207 [3]
2	October	62	26	149	607	312	669	247 [3]
2	November	112	16	774	440	257	552	182 [3]
2	December	492	99	2446	128	289	620	-
2	January	274	99	754	226	233	500	327 [3]
2	February	174	78	388	188	169	362	522 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

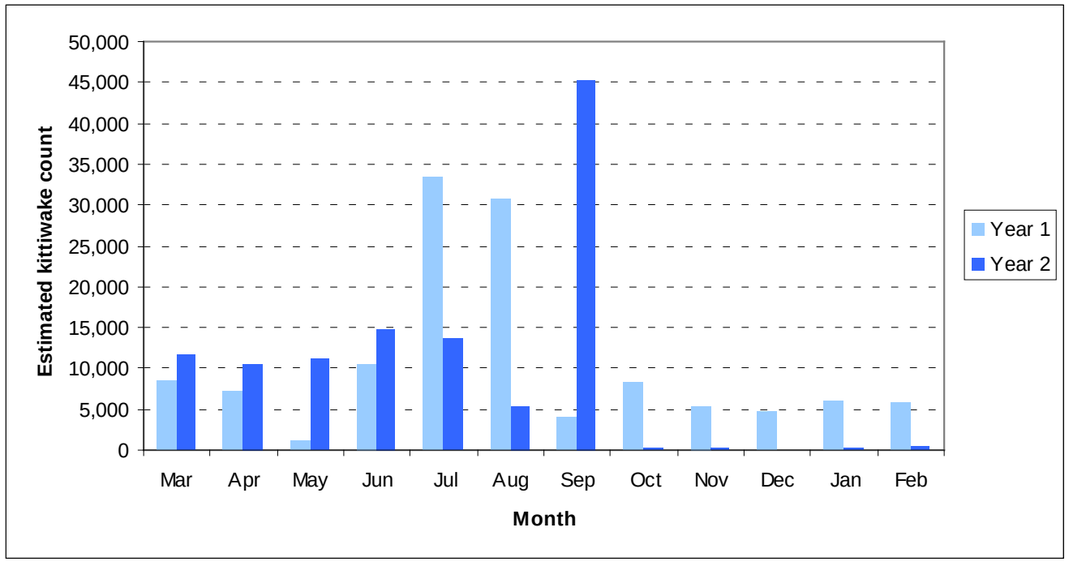


Figure 3.73 Temporal variation in distance-adjusted counts of kittiwake in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

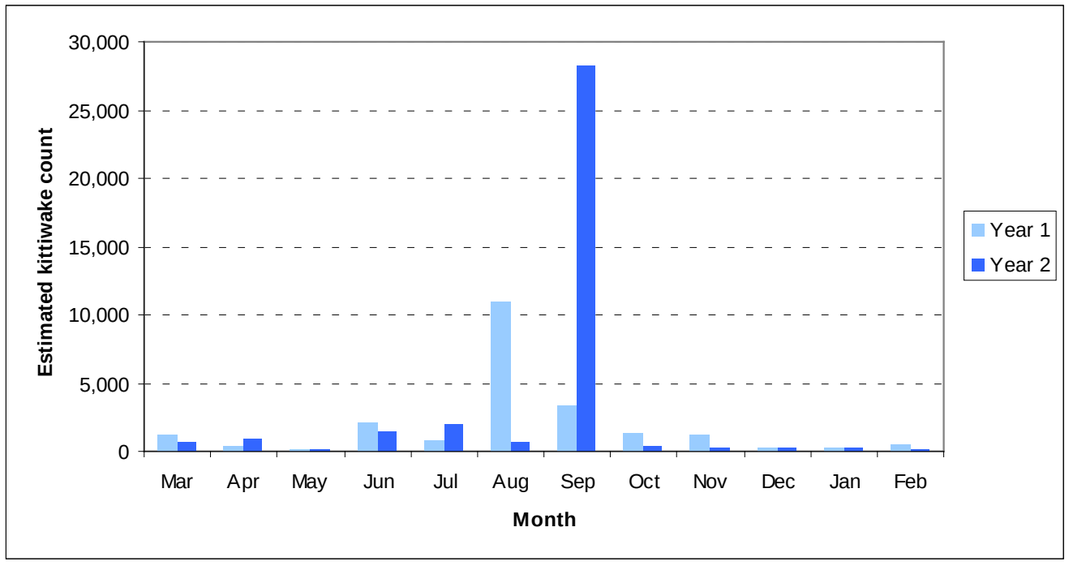


Figure 3.74 Temporal variation in distance-adjusted counts of kittiwake in Subzone 1 and 4 km buffer.

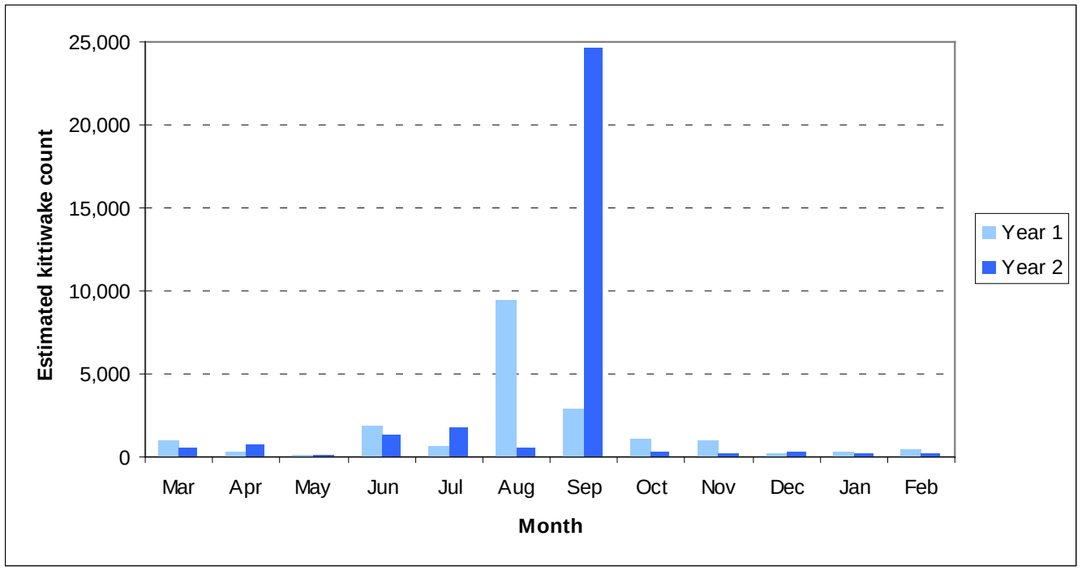


Figure 3.75 Temporal variation in distance-adjusted counts of kittiwake in Subzone 1.

Densities

3.7.317 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area. The population of kittiwake in the southern North Sea increases sharply during the post-breeding months (August to November), with densities in the three sectors overlapping with the Hornsea Survey Area ranging from 0.1 to 4.4 birds/km^2. These are among the higher densities in north-western European waters during this period, although smaller than densities around Shetland and the north-west Atlantic (up to 7.3 birds/km^2).

3.7.318 Kittiwake densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.38.

3.7.319 In Year 1, mean density in Subzone 1 and 4 km buffer peaked in August (23.3 birds/km^2) and was much higher than the peak mean density recorded in the Hornsea Zone and 10 km buffer at this time (5.9 birds/km^2). Similarly in Year 2, mean density in Subzone 1 and 4 km buffer peaked in September (60.5 birds/km^2) (Figure 3.76).

Table 3.38 North Sea kittiwake densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km²)	Area 5 – central and north North Sea (km²)	Area 6 – south and east North Sea (km²)	Mean (km²)	Subzone 1 and 4 km buffer
January	0.56	0.9	1.11	0.86	0.64
February	2.06	0.33	0.87	1.09	0.80
March	0.03	0.49	0.40	0.31	1.88
April	0.19	0.44	0.24	0.29	1.41
May	0.01	0.01	0.09	0.04	0.22
June	0.03	0	0.03	0.02	3.93
July	0.03	0.01	0.08	0.04	3.02
August	0.27	0.11	0.15	0.18	12.35
September	1.01	0.53	0.56	0.70	33.86
October	1.64	0.51	0.82	0.99	1.76
November	0.67	0.62	1.14	0.81	1.59
December	2.18	1.43	1.44	1.68	0.62

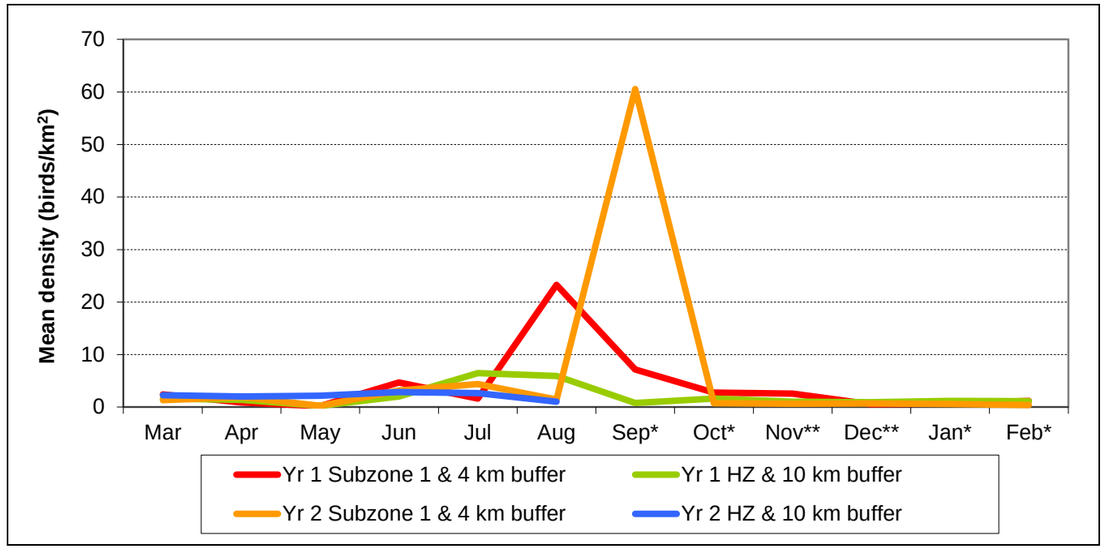


Figure 3.76 Temporal variation in mean estimated density of kittiwake in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively.)**

3.7.320 Similar to the wider North Sea area, peak mean density within the Survey Area in both years peaked in the post-breeding season. In Year 1, mean density in Subzone 1 and 4 km buffer peaked in August (23.3 birds/km²) and was much higher than the peak mean density recorded in the Hornsea Zone and 10 km buffer (5.9 birds/km²), or the surrounding North Sea sectors at this time. Similarly in Year 2, mean density in Subzone 1 and 4 km buffer peaked in September (60.5 birds/km²), compared to much lower values on the Hornsea Zone and wider North Sea. Although this suggests that Subzone 1 may be of particular importance to the species during this period, it should be noted that abundance, particularly in smaller sample areas, is influenced greatly by large flock sizes within transect, and so the density estimates may be a reflection of the chance location of large, ephemeral flocks within transect rather than any actual importance of the site. In the subsequent winter months, densities within the Hornsea Zone and Subzone 1 are similarly low as those recorded in Stone *et al.*'s (1995) wider North Sea sectors.

3.7.321 A comparison of the temporal distribution of kittiwake density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.77.

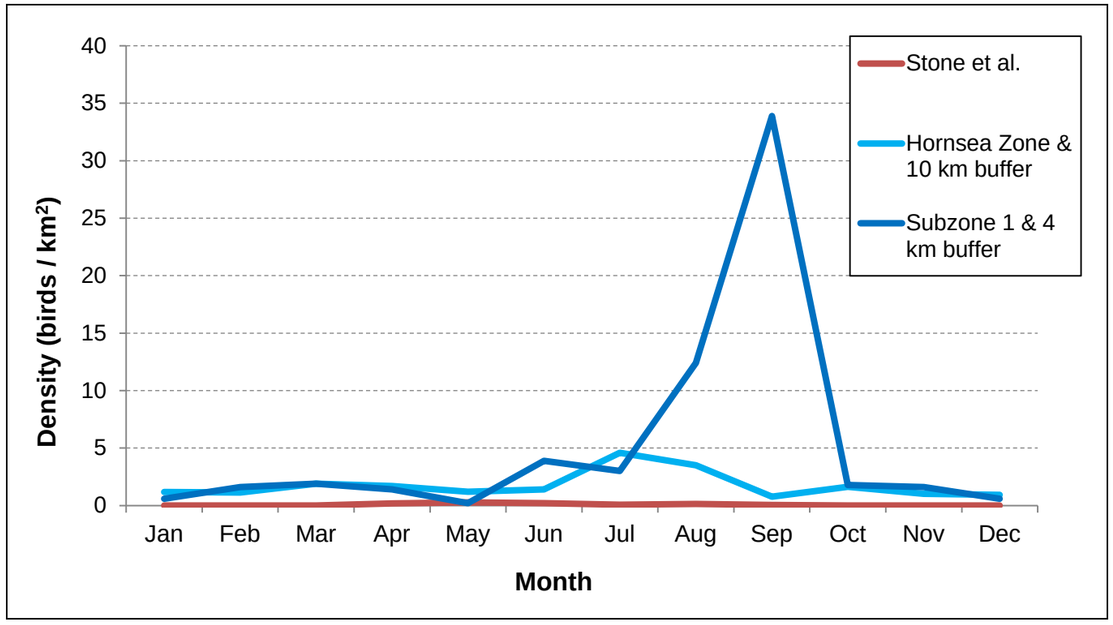


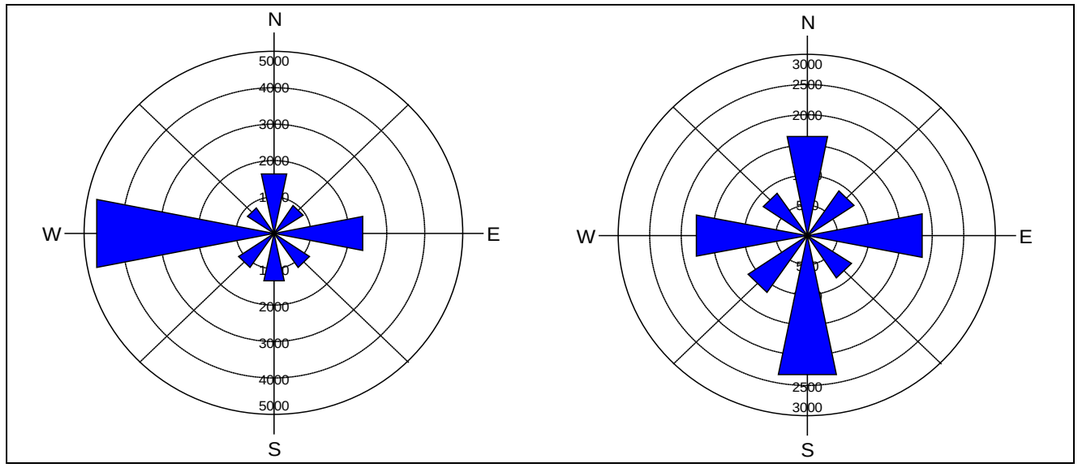
Figure 3.77 A comparison of temporal variation in density of kittiwake in the Hornsea Survey Area and wider figures from Stone *et al.* (1995).

3.7.322 ESAS mean density data for kittiwake was highest in the summer months, with a peak of 7.1 birds/km^2 in July in the surrounding ¼ ICES rectangles, and 3.6 birds/km^2 in June in Regional Seas 1 and 2. In the winter months, mean density peaked at 6.7 birds/km^2 in January in the surrounding ¼ ICES rectangles, and 3.2 birds/km^2 in November in Regional Seas 1 and 2.

Behaviour and distribution

3.7.323 A total of 37,325 kittiwakes were recorded in flight on baseline surveys, with the majority of birds (97.2%) recorded flying below 22.5 m in height. A total of 1,042 birds (2.8%) were recorded flying above 22.5 m (Table 3.44).

3.7.324 Flight direction was recorded for 14,173 kittiwakes on baseline surveys in the breeding season (April to July), and 11,386 kittiwakes in the non-breeding season. In the breeding season, approximately a third of all birds recorded were flying west (33.6%), in the direction of the breeding colony at Flamborough Head and Bempton Cliffs. In the non-breeding season, the pattern was less clear, with around 20% of birds flying south, 16% east, 16% west and 15% north (Figure 3.78).



April to September (n=14,173 birds) October to March (n=11,386 birds)

Numbers shown on figures are number of birds recorded.

Figure 3.78 Flight direction of kittiwake in the Hornsea Survey Area in Years 1 and 2.

3.7.325 Foraging behaviour was recorded for 5,836 kittiwakes in the Hornsea Survey Area on baseline surveys, with nine types of foraging behaviour recorded, and unspecified feeding behaviour recorded for a further 3,072 birds (Table 3.39). The most common behaviours recorded were actively searching (45.1%) and dip feeding (31.8%).

3.7.326 A total of 23,189 kittiwakes were aged on baseline surveys (Table 3.40). Over the 12 months, the average percentage of non-adult (immature) birds was 18.6%, with 81.4% of aged birds classed as adults.

Table 3.39 Kittiwake foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	4,019	45.1
Deep plunging	1	0.0
Dipping	2,836	31.8
Holding fish	7	0.0
Pursuit plunging	23	0.3
Scavenging	10	0.1
Shallow plunging	1,346	15.1
Surface pecking	666	7.5
Surface seizing	129	1.4
Feeding – unspecified	3,072	34.5
Total	**8,908**	

Table 3.40 Age breakdown of kittiwakes recorded on surveys in Years 1 and 2.

Month	Number of non-adults	Number of adults	Total aged birds	% of adult birds
March	373	1,419	1,792	79.2%
April	555	1,212	1,767	68.6%
May	419	483	902	53.5%
June	596	4,495	5,091	88.3%
July	256	6,135	6,391	96.0%
August	792	1,499	2,291	65.4%
September	296	582	878	66.3%
October	262	554	816	67.9%
November	284	873	1,157	75.5%
December	216	351	567	61.9%
January	105	462	567	81.5%
February	157	813	970	83.8%
Annual	**4,311**	**18,878**	**23,189**	**81.4%**

3.7.327 The density distribution maps for Kittiwake cover the periods April to July, August to September and October to March for Years 1 and 2 in Subzone 1 and 4 km buffer and for the Hornsea Zone (Appendix B). Kittiwake was observed throughout Subzone 1 during both survey years, with no distinct spatial patterns in distribution.

Unidentified Large Gulls

3.7.328 Gulls are often difficult to identify to species level at sea, especially immature birds (Stone *et al.*, 1995).

3.7.329 In Year 1 a total of 4,190 unidentified large gulls were recorded, 1372 in Subzone 1 and 4 km buffer, and 2818 in the Hornsea zone and 10 km buffer. In Year 2 fewer were recorded, with only 471 in Subzone 1 and 4 km buffer, and 2,036 in the Hornsea Zone and 10 km buffer, giving a total of 2,507.

3.7.330 In Subzone 1 and 4 km buffer in Year 1, the peak count was 44 birds in July. In the non-breeding season this was higher at 510 birds in September. In Year 2 the breeding season peak count was similar at 42 birds, this time in April, and the non-breeding peak count was in September with 248 birds recorded.

3.7.331 In the Hornsea Zone and 10 km buffer in Year 1, the peak breeding season count was in June (367 birds). The peak non-breeding season count was in October (907 birds). In Year 2 the breeding season peak count was in April, with 475 birds recorded, and the non-breeding peak was in August, with 622 recorded.

3.7.332 'Unidentified large gull' densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.41. Density figures are consistently low for the mean of the three areas, with the peak being 0.18 birds/km^2 in October. The highest density overall is seen in Area 4 ('western North Sea') with a peak of 0.38 birds/km^2 in December.

Behaviour and spatial distribution

3.7.333 A total of 2,564 unidentified large gulls were recorded in flight, with just under 12% flying at heights above 22.5m.

Unidentified Small Gulls

3.7.334 Gulls are often difficult to identify to species level at sea, especially immature birds (Stone *et al.*, 1995).

3.7.335 In Year 1 a total of 107 unidentified small gulls were recorded, 106 in Subzone 1 and 4 km buffer, and 1 in the Hornsea zone and 10 km buffer. In Year 2 slightly fewer were recorded, with 26 in Subzone 1 and 4 km buffer, and 70 in the Hornsea Zone and 10 km buffer, giving a total of 96.

3.7.336 In the Year 1 breeding season, in Subzone 1 and 4 km buffer birds were only recorded in June (6 birds) and during the non-breeding season birds were only recorded in November (100 birds). In the Year 2 breeding season, birds were only recorded in May (1 bird) and during the non-breeding season birds were only recorded in August (25 birds).

Table 3.41 North Sea 'large gull' densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)
January	0.04	0.12	0.01	0.06
February	0.24	0.01	0	0.08
March	0.04	0.10	0	0.05
April	0.05	0	0	0.02
May	0.02	0	0.06	0.03
June	0.01	0	0	0
July	0.01	0	0.10	0.04
August	0.03	0	0.03	0.02
September	0.14	0	0.09	0.08
October	0.51	0.01	0.02	0.18
November	0.11	0	0.08	0.06
December	0.38	0	0	0.13

3.7.337 In Year 1 the Hornsea Zone and 10 km buffer, the only bird recorded was a single individual in March. In the Year 2 breeding season, birds were only recorded in April (30 birds) and during the non-breeding season birds were only recorded in August (40 birds).

3.7.338 'Unidentified gull' densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.42. Density figures are consistently low for the mean of the three areas, with the peak being 0.40 birds/km^2 in November. The highest density overall is seen in Area 6 ('south and east North Sea') with a peak of 1.18 birds/km^2 in November.

3.7.339 A total of 111 unidentified small gulls were recorded in flight, with only one of those recorded as flying at heights above 22.5 m.

Table 3.42 North Sea 'unidentified gull' densities from Stone *et al.* (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)
January	0	0.03	0.12	0.05
February	0.04	0	0.37	0.14
March	0	0	0	0
April	0.46	0.23	0.05	0.25
May	0	0	0.04	0.01
June	0.02	0.01	0.10	0.04
July	0	0	0.02	0.01
August	0.14	0.01	0.05	0.07
September	0.05	0	0.24	0.10
October	0	0	0.08	0.03
November	0.02	0	1.18	0.40
December	0	0	0.01	0

Sandwich Tern (*Sterna sandvicensis*)

Status overview

3.7.340 Sandwich tern is listed on Annex I of the EU Birds Directive (2009/147/EEC), and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.341 Sandwich terns are summer visitors to Britain, breeding in coastal colonies. Seabird 2000 recorded 10,536 pairs in Britain (Mitchell *et al.*, 2004).

3.7.342 Langston (2010) assessed Sandwich tern as being at moderate risk of collision and habitat loss or changes in prey distribution resulting from offshore wind farms. Displacement and barrier effects were rated as low risk. Overall, Sandwich tern was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.343 Sandwich tern is listed as a qualifying interest species in the breeding season for eight SPAs on the UK east coast between Hermaness and Foreness Point (Table 3.43). These SPAs held 62.7% of the UK breeding population, and >6.6% of the biogeographic population at the time of designation (JNCC, 2011). Recent counts are included for comparison, where available (SMP, 2012). The distance between these SPAs and Subzone 1 is beyond the maximum foraging range of Sandwich terns (54 km) (Thaxter *et al.*, 2012).

Table 3.43 SPAs for Sandwich tern on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeo graphic populati on at time of citation [1]	% of national population at time of citation [1]	Recent count (pairs) [2]	Year
Loch of Strathbeg	466.2	530	0.4	3.8	0	2009
Ythan Estuary, Sands of Forvie and Meikle Loch	437.4	600	0.5	4.3	674	2010
Firth of Forth islands	365.9	22	<0.1	0.2	1	2008
Farne Islands	280.7	2,070	1.6	14.8	1,415	2009
Coquet Island	257.8	1,590	1.2	11.4	873	2009
North Norfolk Coast	104.3	3,457	2.6	24.7	3,100	2009
Alde-Ore Estuary	190.4	169	0.1	1.2	0	Seabird 2000
Foulness	256.1	320	0.2	2.3	0	2000
Total	**-**	**8,758**	**> 6.6**	**62.7**	**6,063**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Hornsea Survey Area

3.7.344 One Sandwich tern was recorded in Subzone 1 and 4 km buffer in September of Year 1. In Year 2 six sandwich terns were recorded between March and August, with five in Subzone 1 and 4 km buffer and one in the Hornsea Zone and 10 km buffer (Figure 3.79). Seven Sandwich terns were recorded in flight, all below 22.5 m in height.

3.7.345 This species was predominantly recorded at the western edge of Subzone 1 and the 4 km buffer. However, the low numbers indicate that these are most likely incidental records, and do not represent regular species use of this site.

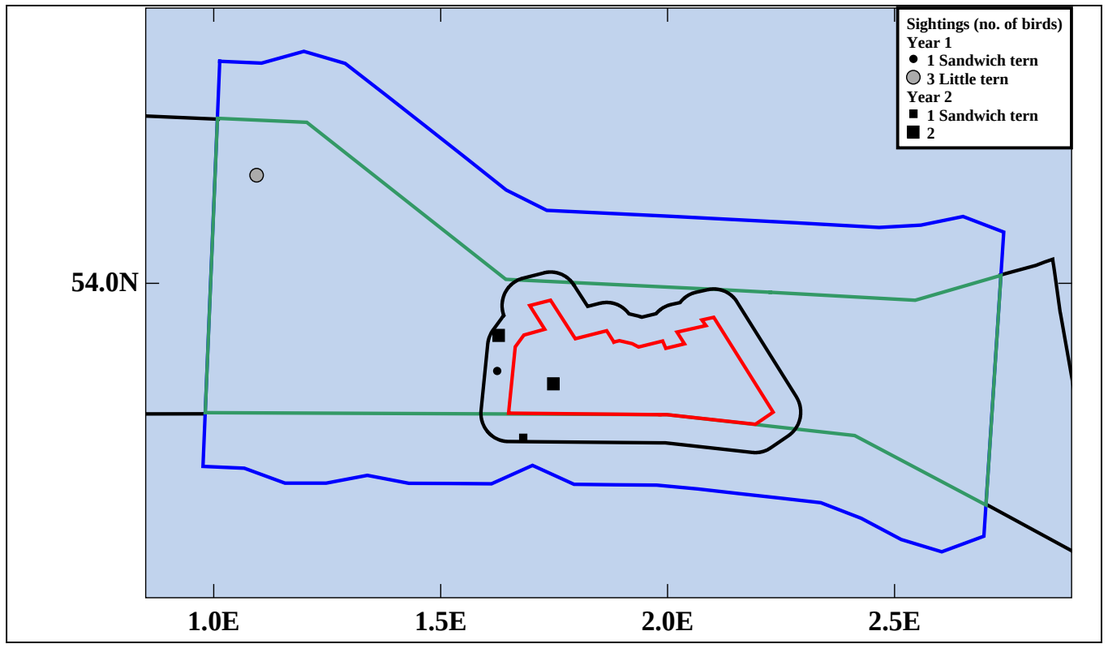


Figure 3.79 Spatial distribution of Sandwich tern and little tern sightings in the Hornsea Survey Area.

Common Tern (*Sterna hirundo*)

Status overview

3.7.346 Common tern is listed on Annex I of the EU Birds Directive, and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.347 Common terns are summer visitors to Britain, breeding in colonies at coastal sites and also inland. Seabird 2000 recorded 10,308 pairs in Britain (Mitchell *et al.,* 2004). The closest large colonies to the Hornsea Zone are Coquet Island, the Farne Islands and Scolt Head. In autumn, common terns migrate south to the west coast of Africa, returning the following spring (Wernham *et al.*, 2002). Common terns have a broad diet compared to other terns that includes sandeels, clupeid and gadoid fish (Mitchell *et al.*, 2004).

3.7.348 Langston (2010) assessed common tern as being at moderate risk of collision, habitat loss or changes in prey distribution resulting from offshore wind farms. Displacement and barrier effects were rated as low risk. Overall, common tern was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.349 Common tern is listed as a qualifying interest species in the breeding season for 11 SPAs on the UK east coast. These SPAs held 34.5% of the UK breeding population and 2.2% of the biogeographic population at the time of designation (JNCC, 2011). Subzone 1 lies beyond the maximum foraging range from these SPAs (30 km, Figure 3.80) (Thaxter *et al.*, 2012) and therefore common tern occurs only on passage through Hornsea with no connectivity to SPAs where they are a breeding feature.

Hornsea Survey Area

Seasonal distribution and abundance

3.7.350 Common terns breed in the UK in colonies at coastal sites and also inland. Seabird 2000 recorded 10,308 pairs in Britain (Mitchell *et al.,* 2004). It is likely that the common terns recorded were on passage through Hornsea on their migration between breeding colonies and wintering grounds, with birds from UK breeding colonies as well as others in northern Europe (Wernham *et al.*, 2002).

3.7.351 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show the common/Arctic tern numbers in the Greater Wash survey blocks GW2, GW9 and GW10 were low, with a peak mean of 20 birds during the breeding season (May). A similar number of birds recorded as 'Tern spp.' were also seen, with a peak mean of 22 birds also in May.

3.7.352 A total of 1,404 common terns were recorded on surveys in the Hornsea Survey Area between April and October of Year 1. Just over half of all birds (53.4%) occurred in Subzone 1 and 4 km buffer, with highest numbers in September (Table A.2 and Table A.4). In Year 2, 2,440 birds were recorded in the Hornsea Survey Area between April and September. Most birds (88.0%) were recorded in the Hornsea Zone and 10 km buffer, with highest numbers in August (Table A.3 and Table A.5).

3.7.353 A further 1,627 unidentified common/Arctic terns were recorded in Year 1, with 5,931 unidentified common/Arctic terns seen on surveys in Year 2 (Table 3.1). Peak numbers of unidentified common/Arctic terns in Year 1 occurred in September (1,564), and in August in Year 2 (5,510).

3.7.354 In Year 1, peak estimated numbers of common terns occurred in September, with 624 birds in Subzone 1 and 1,339 birds estimated when including the 4 km buffer, using data from 2 km transect surveys (Table 3.44). In comparison, an estimated 7,456 common terns occurred in the Hornsea Zone and 10 km buffer in September, using data from 6 km transect surveys. This estimate corresponds to 36.2% of the British breeding population (10,308 pairs) (Mitchell *et al.*, 2004).

3.7.355 In Year 2 peak estimated numbers of common terns in Subzone 1 and the 4 km buffer were recorded in May, with 27 birds estimated in Subzone 1 and 58 when including the 4 km buffer. In comparison, peak estimated numbers of common terns in the Hornsea Zone and 10 km buffer were recorded in August (5,035 birds).

3.7.356 These data are presented in Figure 3.81, Figure 3.82 and Figure 3.83.

Table 3.44 Estimated numbers of common terns in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	0	0	0	0	0	0	0
1	April	0	0	0	0	0	0	88
1	May	0	0	0	0	0	0	0
1	June	23	4	129	29	24	52	96
1	July	0	0	0	0	0	0	0
1	August	0	0	0	0	0	0	398
1	September	791	305	2055	548	624	1339	7,456
1	October	23	6	83	102	58	125	19
1	November	0	0	0	0	0	0	0
1	December	0	0	0	0	0	0	0
1	January	0	0	0	0	0	0	0
1	February	0	0	0	0	0	0	0
2	March	0	0	0	0	0	0	0
2	April	0	0	0	0	0	0	0
2	May	58	15	227	0	27	58	29
2	June	0	0	0	0	0	0	29
2	July	0	0	0	0	0	0	96
2	August	23	6	85	15	17	38	5,035
2	September	0	0	0	0	0	0	-
2	October	0	0	0	0	0	0	-
2	November	0	0	0	0	0	0	-
2	December	0	0	0	0	0	0	-
2	January	0	0	0	0	0	0	-
2	February	0	0	0	0	0	0	-

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

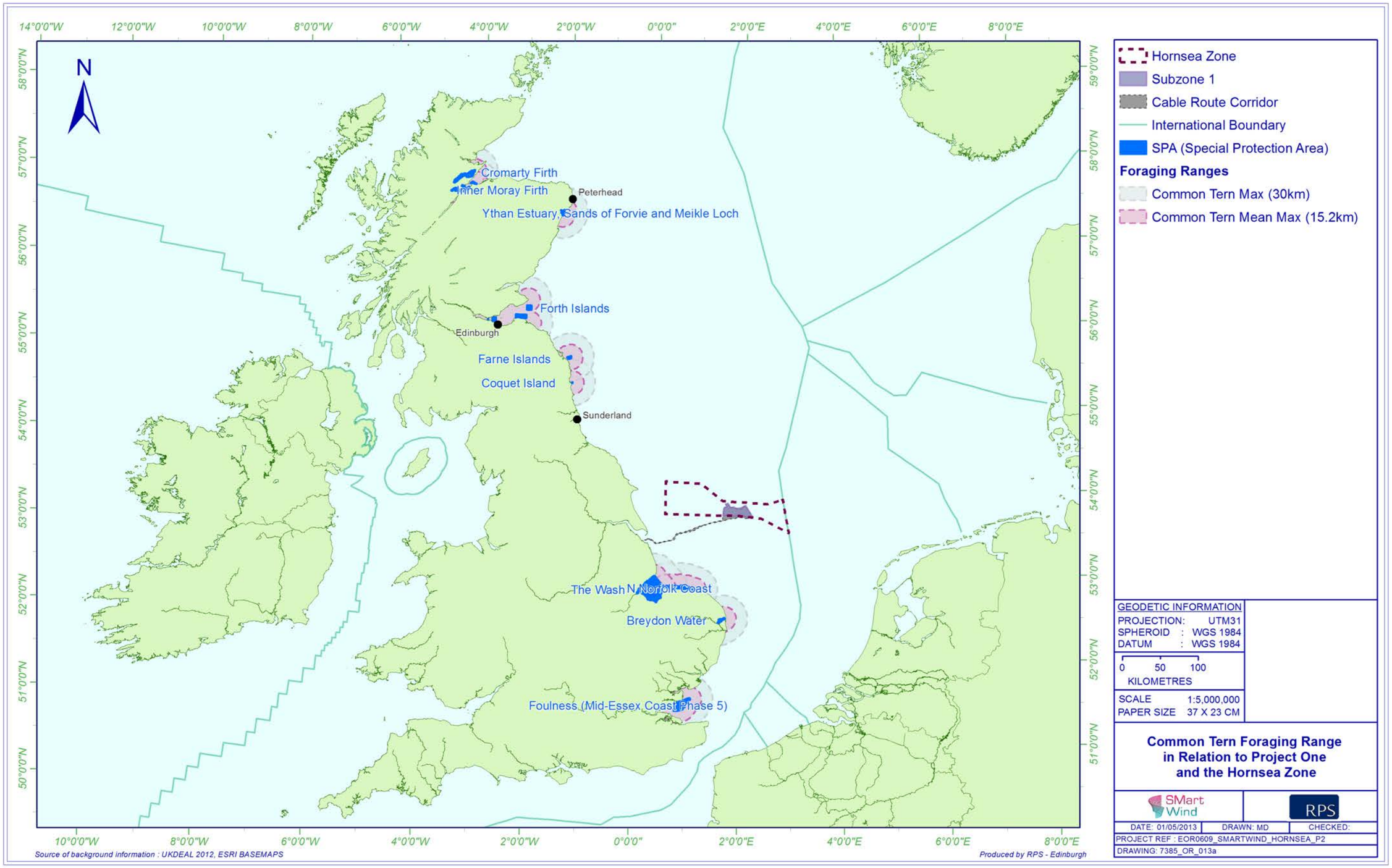


Figure 3.80 Common tern foraging range in relation to Project One and the Hornsea Zone.

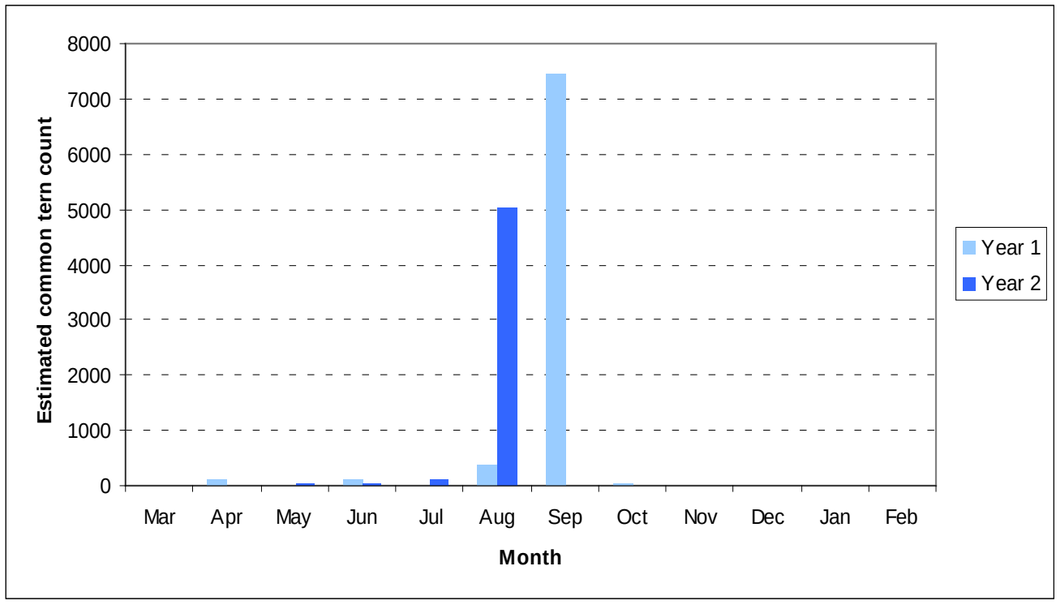


Figure 3.81 Temporal variation in raw counts of common tern in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

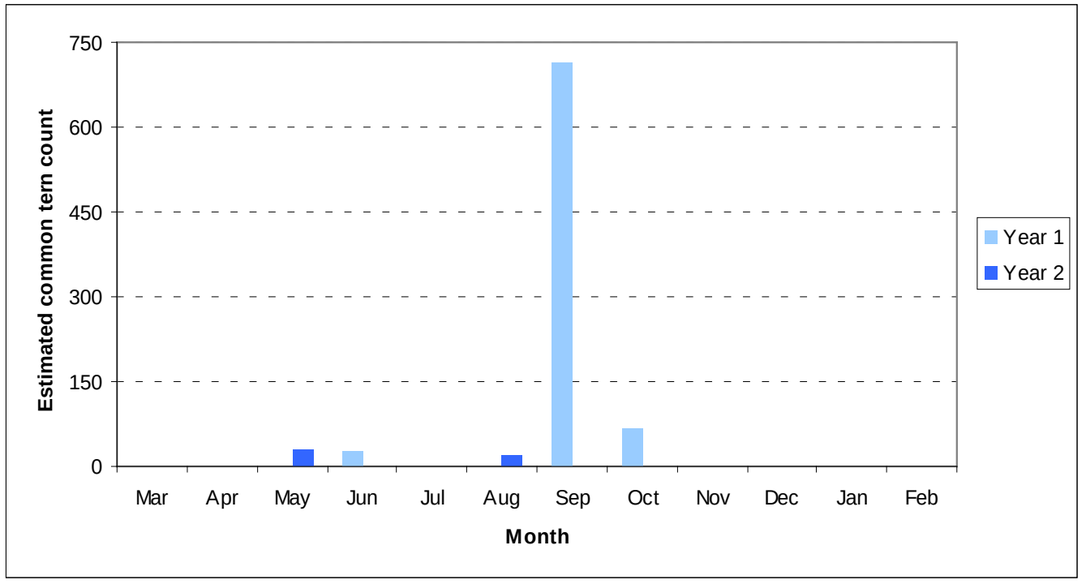


Figure 3.82 Temporal variation in raw counts of common tern in Subzone 1 and 4 km buffer.

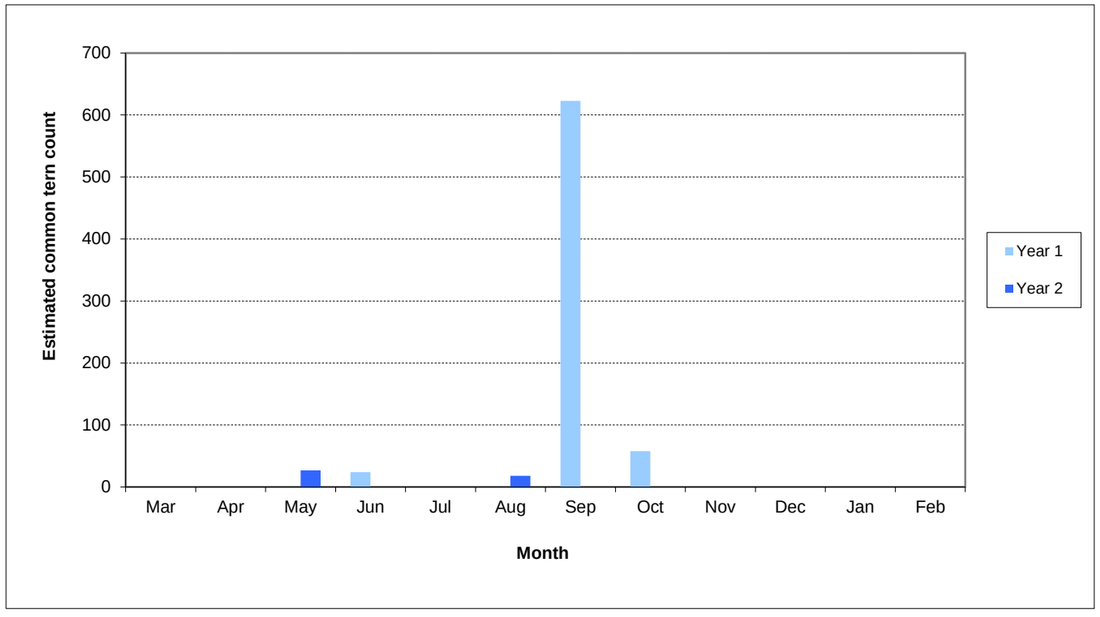


Figure 3.83 Temporal variation in raw counts of common tern in Subzone 1.

Densities

3.7.357 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area. Individual common and Arctic tern densities are not given but are pooled as 'commic terns' due to the difficulty in distinguishing these two species. The highest density estimates occur in the summer with the peak mean for all three areas being 0.17 birds/km^2 in May. Densities drop away to zero from October to March.

3.7.358 'Commic tern' densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.45.

3.7.359 Mean monthly common tern densities showed a similar seasonal pattern to that seen for 'commic terns' in the wider North Sea, but the peak density was higher, particularly in Year 1, when the peak density was 1.5 birds/km^2 in September in Subzone 1 and 4 km buffer. In Year 2, mean density in Subzone and the 4 km buffer was low throughout the summer months, while a peak of 1.0 birds/km2 was recorded in the Hornsea Zone and 10 km buffer in August (Figure 3.84).

3.7.360 A comparison of the temporal distribution of common tern density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean 'commic tern' density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.85. This suggests that the Hornsea Survey Area is particularly important for common tern in early autumn when birds are beginning their autumn migration.

Table 3.45 North Sea 'commic tern' densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km²)	Area 5 – central and north North Sea (km²)	Area 6 – south and east North Sea (km²)	Mean (km²)
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0.01	0.36	0.12
May	0.03	0.02	0.45	0.17
June	0.23	0.03	0.14	0.13
July	0.10	0.02	0.08	0.06
August	0.06	0.02	0.27	0.12
September	0.04	0.01	0.07	0.04
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0

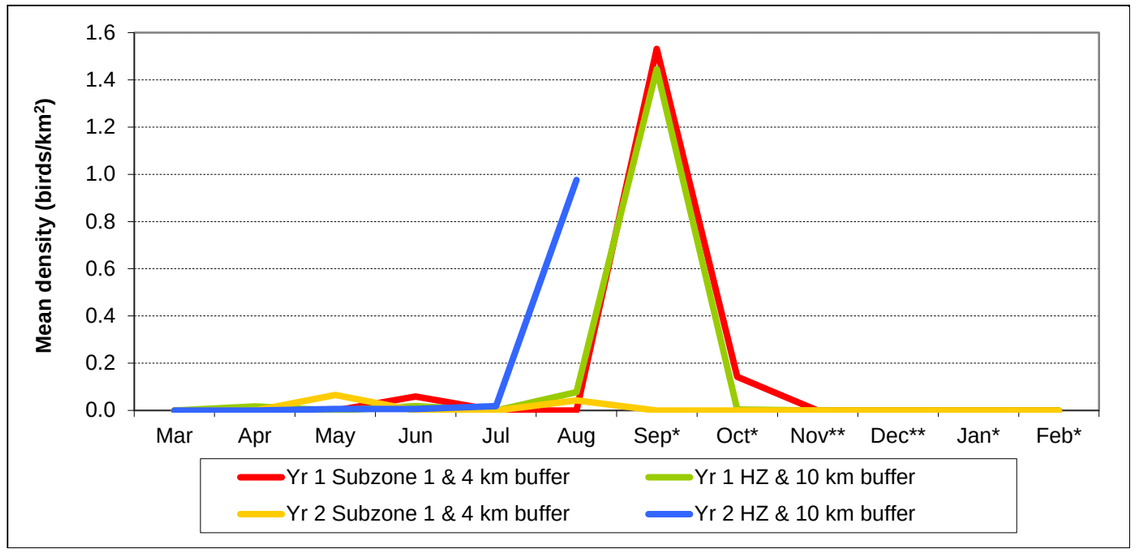


Figure 3.84 Temporal variation in estimated density of common tern in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

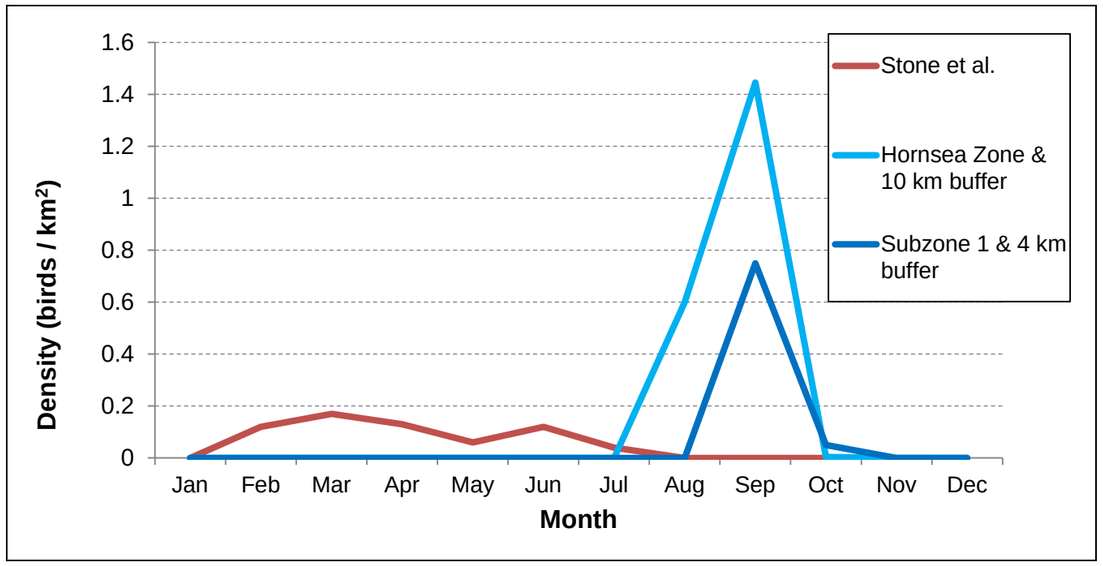


Figure 3.85 A comparison of temporal variation in density of common tern in the Hornsea Survey Area and wider 'commic tern' figures from Stone *et al*. (1995).

Behaviour and distribution

3.7.361 A total of 3,410 common terns were recorded in flight on baseline surveys, with 98.6% of birds were recorded flying below 22.5 m. A total of 49 birds (1.4%) were recorded flying above this height (Table 3.2).

3.7.362 Flight height was recorded for a further 6,116 unidentified common/Arctic terns. The majority of birds (97.3%) were recorded flying below 22.5 m in height.

3.7.363 Foraging behaviour was recorded for 714 common terns in the Hornsea Survey Area on baseline surveys, with four types of foraging behaviour recorded, the most common being was dip feeding (65.4%) (Table 3.46).

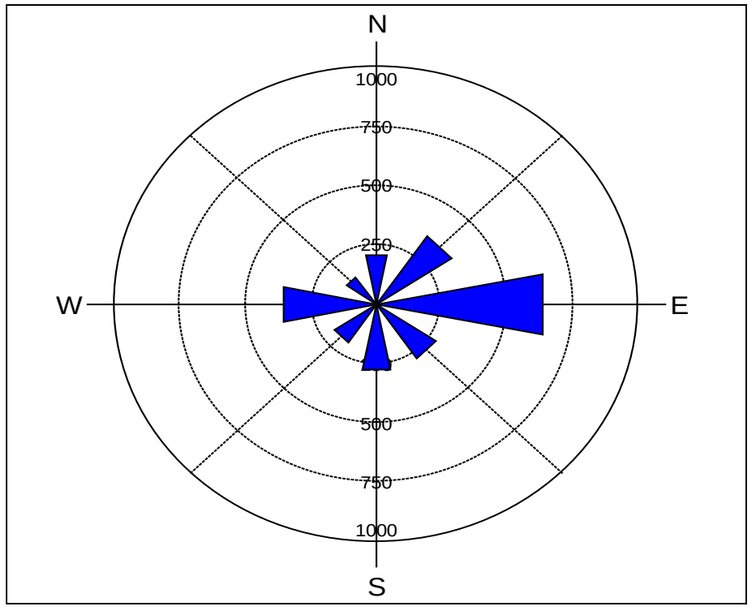
3.7.364 The majority of birds on baseline surveys (75.8%) were unaged, however 744 adults, three immature birds and 185 juvenile birds were recorded.

3.7.365 Flight direction was recorded for 2,437 common terns between August and October on baseline surveys (Figure 3.86). An additional 393 birds were recorded as circling (not shown). Between August and October, just over a quarter of recorded birds were flying east (26.5%), with 14.8% flying west, and 14.0 flying north-east.

3.7.366 Density maps for common tern cover August and September of 2010 and 2011 (Appendix B). Both maps show a lack of site-wide spatial distribution patterns. This, combined with low overall numbers and high year-to-year variability, indicates a lack of habitual activity in Subzone 1 and the 4 km buffer by this species.

Table 3.46 Common tern foraging behaviour in the Hornsea Survey Area.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	190	26.6
Dipping	467	65.4
Holding fish	8	1.1
Shallow plunging	49	6.9
Total	714	



Numbers shown on figure are number of birds recorded

Figure 3.86 Flight direction of common terns in the Hornsea Survey Area between August and October, Years 1 and 2.

Arctic Tern (*Stercorarius parasiticus*)

Status overview

3.7.367 Arctic tern is listed on Annex I of the EU Birds Directive, and the species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.368 Arctic terns are summer visitors to Britain, breeding in coastal colonies, predominantly in the north. Seabird 2000 recorded 52,621 pairs in Britain (Mitchell *et al.*, 2004). In autumn, Arctic terns migrate down the west coast of Europe and Africa to the Antarctic seas for the winter, returning the following spring (Wernham *et al.*, 2002). The closest large colonies to the Hornsea Zone are the Farne Islands, Coquet Island and Long Nanny, Northumberland. Sandeels are the major prey species (Mitchell *et al.*, 2004).

3.7.369 Langston (2010) assessed Arctic tern as being at moderate risk of collision and habitat loss or changes in prey distribution resulting from offshore wind farms. Displacement and barrier effects were rated as low risk. Overall, Arctic tern was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.370 Arctic tern is listed as a qualifying interest species in the breeding season for 14 SPAs on the UK east coast, between Hermaness and Foreness Point (Table 3.47). These SPAs held 35.1% of the UK breeding population, and >1.3% of the biogeographic population at the time of designation (JNCC, 2011). Recent counts are included for comparison, where available (SMP, 2012). Subzone 1 lies beyond the maximum known foraging range of Arctic terns from these SPAs (30 km, Figure 3.88) (Thaxter *et al.*, 2012).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.371 Seabird 2000 recorded 52,621 pairs of Arctic tern in Britain (Mitchell *et al.*, 2004). In autumn, Arctic terns migrate down the west coast of Europe and Africa to the Antarctic seas for the winter, returning the following spring (Wernham *et al.*, 2002).

3.7.372 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show the common/Arctic tern numbers in the Greater Wash survey blocks GW2, GW9 and GW10 were low, with a peak mean of 20 birds during the breeding season (May). A similar number of birds recorded as 'Tern spp.' were also seen, with a peak mean of 22 birds also in May.

3.7.373 In Year 1 237 Arctic terns were recorded on surveys in the Hornsea Survey Area between May and October. A total of 96 Arctic terns were recorded in Subzone 1 and 4 km buffer between May and October, with a peak count of 89 birds in August, using data from 2 km transect surveys. In the Hornsea Zone and 10 km buffer, 141 Arctic terns were recorded between May and September, with a peak of 134 birds in August, using data from 6 km transect surveys Table A.2 and Table A.4).

3.7.374 Higher numbers of Arctic terns were recorded in Year 2, with 538 birds on surveys in the Hornsea Survey Area between April and October. Most birds (77.3%) were recorded in the Hornsea Zone and 10 km buffer. Peak counts occurred in May in Subzone 1 and 4 km buffer (94 birds) and July in the Hornsea Zone and 10 km buffer (256 birds). The peak count for the total Hornsea Survey Area was in July (259 birds) (Table A.3 and Table A.5).

Table 3.47 SPAs for Arctic tern on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation[1]	% of biogeo graphic population at time of citation[1]	% of national population at time of citation[1]	Recent count (pairs)[2]	Year
Auskerry	620.8	780	0.1	1.8	667	2007
Coquet Island	257.8	700	0.1	1.6	1,259	2009
Fair Isle	698.1	1,120	0.1	2.6	283	2009
Farne Islands	280.7	2,840	0.3	6.5	2,198	2009
Fetlar	746.2	520	<0.1	1.2	213	2007
Firth of Forth Islands	365.9	540	<0.1	1.2	365	2009
Foula	717.3	1,100	0.1	2.5	95	2007
Mousa	692.2	767	<0.1	1.7	925	2009
Papa Stour	736.6	1,000	0.1	2.3	0	1999-2001
Papa Westray (North Hill and Holm)	662.6	1,950	0.2	4.4	667	2009
Pentland Firth Islands	597.4	1,200	0.1	2.7	667	2009
Rousay	646.3	1,000	0.1	2.3	79	2006
Sumburgh Head	676.5	700	<0.1	1.6	203	2000
West Westray	655.7	1,200	0.1	2.7	699	2009
Total	-	15,417	>1.3	35.1	8,320	-

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

3.7.375 As mentioned above, a further 1,627 unidentified common/Arctic terns were recorded in Year 1, with 5,931 unidentified common/Arctic terns seen on surveys in Year 2 (Table 3.1). Peak numbers of unidentified common/Arctic terns in Year 1 occurred in September (1,564), and in August in Year 2 (5,510).

3.7.376 The majority of birds were recorded in July and August, and it is likely that these birds were passing south through the Hornsea Survey Area on their southward autumn migration at the end of the breeding season, and would involve birds from UK breeding colonies as well as from other breeding colonies in northern Europe (Wernham *et al.*, 2002).

3.7.377 Due to the low sample size of Arctic terns recorded on baseline surveys, it was not possible to conduct Distance analysis on the data. Simple abundance rates (birds/km) were calculated instead. In Year 1, highest abundance of 0.16 birds/km was recorded in both Subzone 1 and 4 km buffer and the Hornsea Zone and 10 km buffer in August. In Year 2, highest abundance of 0.16 birds/km was recorded in Subzone 1 and 4 km buffer in May.

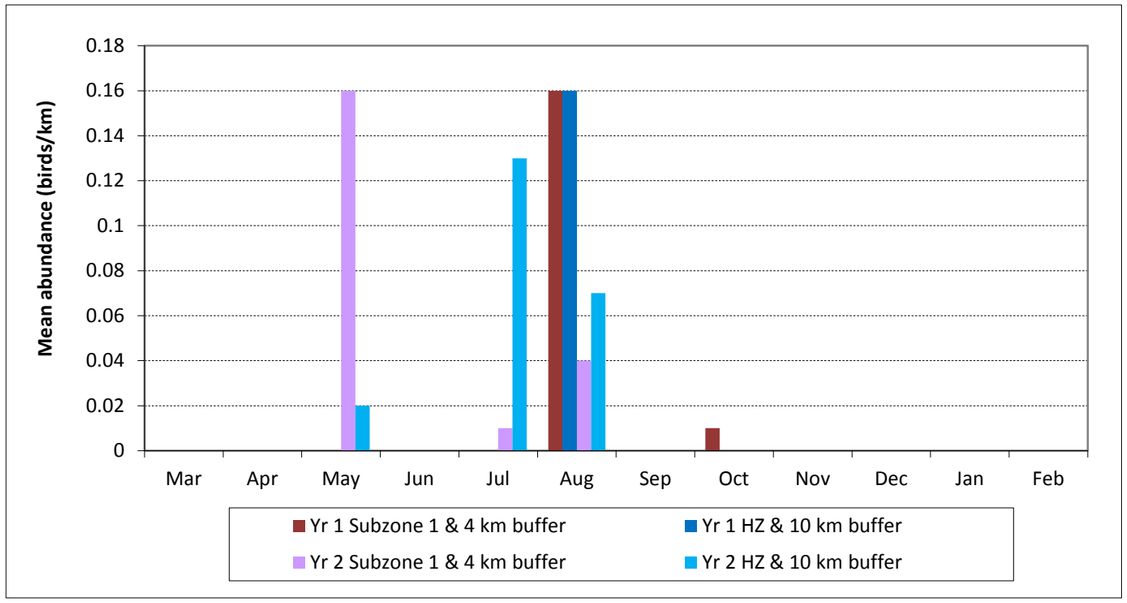


Figure 3.87 Temporal variation in mean abundance of Arctic tern in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

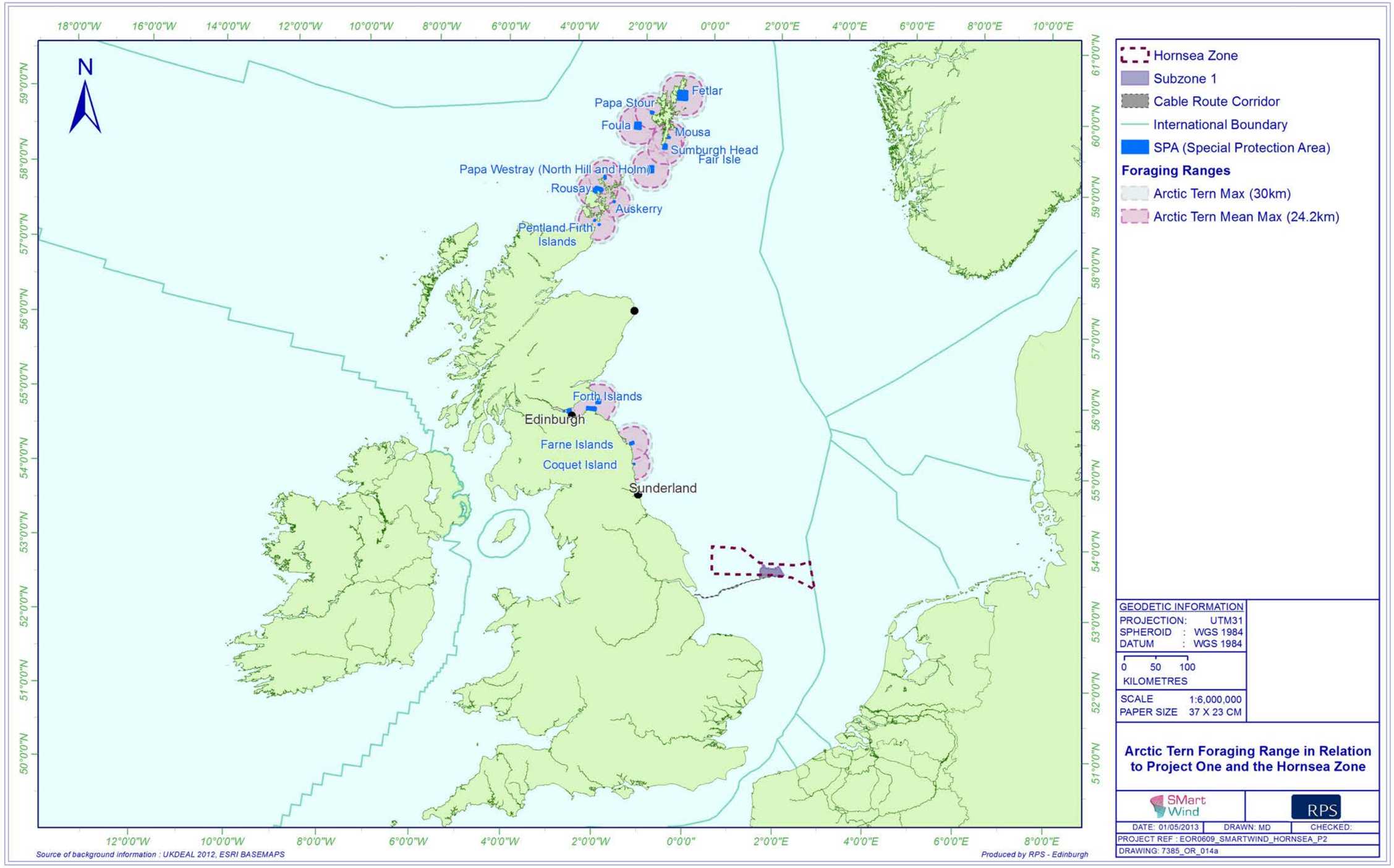


Figure 3.88 Arctic tern foraging range in relation to Project One and the Hornsea Zone.

Behaviour and distribution

3.7.378 A total of 634 Arctic terns were recorded in flight on baseline surveys, with all birds flying below 22.5 m in height (Table 3.2).

3.7.379 Foraging behaviour was recorded for 235 Arctic terns in the Hornsea Survey Area on baseline surveys, with four types of foraging behaviour recorded. The most commonly recorded foraging behaviours were dip-feeding (57.3%) and actively searching (33.9%) (Table 3.48).

Table 3.48 Arctic tern foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	81	33.9
Dipping	137	57.3
Shallow plunging	16	6.7
Surface seizing	1	0.4
Feeding method unspecified	4	1.7
Total	**239**	

3.7.380 Just under half of all birds on baseline surveys (42.3%) were unaged, however 346 adults, one immature bird and 100 juvenile birds were recorded.

3.7.381 The distribution map for Arctic tern covers the period May to October for Years 1 and 2 in the Hornsea Zone (Appendix B). Low numbers of Arctic tern were observed throughout Subzone 1 and 4 km buffer, with no distinct patterns of spatial distribution.

Common/Arctic Tern (*Sterna hirundo/Stercorarius parasiticus)*

3.7.382 In addition to the positively identified common and Arctic terns recorded, a further 1,627 unidentified common/Arctic terns were recorded in Year 1, and 5,931 in Year 2. Peak numbers of unidentified common/Arctic terns in Year 1 occurred in September (1,564), and in August in Year 2 (5,510).

3.7.383 The majority of these birds were recorded flying at heights below 22.5 m, with only 2.7% of flights occurring above this height.

Little Tern (Sterna albifrons)

Status overview

3.7.384 Little tern is listed on Annex I of the EU Birds Directive and Schedule 1 of the Wildlife and Countryside Act. The species is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.385 Little terns are summer visitors to Britain, breeding in coastal colonies. Seabird 2000 recorded 1,947 pairs in Britain (Mitchell *et al.*, 2004). The closest large colonies to the Hornsea Zone are at Blakeney Point and Great Yarmouth (Norfolk), with smaller colonies at Gibraltar Point, Easington (Humberside) and Beadnell Bay (Northumberland).

3.7.386 Langston (2010) assessed little tern as being at moderate risk of habitat loss or changes in prey distribution resulting from offshore wind farms. Collision, displacement and barrier effects were rated as low risk. Overall, little tern was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.387 Although little tern is listed as a qualifying interest species in the breeding season for 18 SPAs on the UK east coast (JNCC, 2012), these SPAs were not considered in this report as the species was not recorded within Subzone 1 or the 4 km buffer on baseline surveys. Subzone 1 is beyond the maximum known foraging range from any UK SPA for little terns (11 km) (Thaxter *et al.*, 2012).

Hornsea Survey Area

3.7.388 Three little terns were recorded flying at a height of 5 m in the north-west of the Hornsea Zone in May of Year 1. No little terns were recorded on Year 2 surveys (Table A.4).

Guillemot (*Uria aalge*)

Status overview

3.7.389 Guillemot is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.390 Guillemots are one of the commonest seabird species in Britain, breeding in large colonies on suitable coastal cliff habitat. Seabird 2000 recorded 1,322,830 individuals at breeding colonies in Britain (Mitchell *et al.*, 2004). The closest large colonies to the Hornsea Zone are at the Farne Islands and Bempton Cliffs (including Flamborough Head). Guillemots mostly prey on small fish species such as lesser sandeels, sprat and gadoid fish (Mitchell *et al.*, 2004).

3.7.391 Langston (2010) assessed guillemot as being at moderate risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms, while collision risk was rated as low risk. Overall, guillemot was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.392 Guillemot is listed as a qualifying interest species in the breeding season for 20 SPAs on the UK east coast, between Hermaness and Foreness Point. These SPAs held 65.2% of the UK breeding population, and 20.4% of the biogeographic population at the time of designation (JNCC, 2011). The closest colony at Flamborough Head and Bempton Cliffs SPA held 41,607 pairs in 2008-11.

3.7.393 The distance between Subzone 1 and one SPA (Flamborough Head and Bempton Cliffs SPA) lies within the maximum foraging range (135 km) for guillemot, but is outside the mean maximum foraging range (84.2 km, Figure 3.89) (Thaxter *et al.*, 2012).

Hornsea Survey Area

3.7.394 The southern North Sea is important for guillemots throughout the year with high densities in all months. With a total flyway population of 1,990,000 birds, 1.5 to 3.0% of the biogeographic population reside in or fly over the southern North Sea (Steinen *et al.,* 2007).

3.7.395 From March to June guillemot densities are high in the southern North Sea, notably in the Dogger Bank area. These densities of between two and five birds/km^2 reflect both high levels of pre-breeding activity, when birds are foraging more widely in the area from further afield, than local colonies to more concentrated foraging activity at the start of the breeding season. This is evident in the Flamborough Head area (Stone *et al.,* 1995). During July and August chicks are departing the colonies with their parents and high densities of more than five birds/km^2 were found in both these months around Flamborough Head and Dogger Bank. These high densities remain throughout the winter months from October to February (Stone *et al.,* 1995).

3.7.396 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show guillemot numbers in the Greater Wash survey blocks GW2, GW9 and GW10 were very low, with a peak mean of six birds during the breeding season (May). A higher number of birds recorded as 'Auk spp.' were seen, however, with a peak mean of 693 in March and 722 in May respectively. Numbers were lower throughout the rest of the year, but this was still one of the most frequently recorded species groups during aerial surveys.

3.7.397 Guillemot was the most frequently recorded seabird in the Hornsea Survey Area in Year 1, with a total of 46,403 birds recorded on surveys (Table 3.1). Just over half of all birds (52.0%) were in Subzone 1 and 4 km buffer. The highest numbers were recorded between July and November (Table A.2 and Table A.4).

3.7.398 Similar numbers of guillemots were recorded in Year 2, with a total of 47,632 birds recorded on surveys. The majority of birds (75.6%) were recorded in the Hornsea Zone and 10 km buffer, with highest numbers recorded in August and September (Table A.3 and Table A.5).

3.7.399 Survey coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete (Table 2.1).

3.7.400 During the main part of the Year 1 breeding season (April to June), peak estimated numbers of guillemots were recorded in June, with 2,220 birds in Subzone 1 and 4,767 birds estimated for the 4 km buffer, using data from 2 km transect surveys (Table 3.50).

3.7.401 In comparison, an estimated 28,297 guillemots were recorded in the Hornsea Zone and 10 km buffer in April of Year 1, using data from 6 km transect surveys. This estimate corresponds to 2.1% of the British breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004) and 0.5% of the biogeographic wintering population of c. 4,300,000 individuals (Birdlife International, 2012).

3.7.402 During the main part of the Year 2 breeding season (April to June), peak estimated numbers of guillemots were recorded in June, with 3,211 birds in Subzone 1 and 6,895 birds estimated when including the 4 km buffer, using data from 2 km transect surveys.

3.7.403 In comparison, an estimated 57,031 guillemots were recorded in the Hornsea Zone and 10 km buffer in April of Year 2, using data from 6 km transect surveys. This estimate corresponds to 4.3% of the British breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004).

3.7.404 Peak numbers of fledged but still dependant guillemot chicks were recorded in July. The period from July to October was considered the post-breeding season, when adult birds were no longer at the breeding colonies, but were still attending chicks at sea.

3.7.405 In the Year 1 post-breeding season (July to October), the peak estimated number of guillemots in Subzone 1 was 19,578 birds in October, with an estimated 42,034 birds when including the 4 km buffer, also in October. The Subzone 1 estimate for October corresponds to approximately 1.5% of the UK breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004). The estimate for Subzone 1 plus 4 km buffer corresponds to approximately 1.7% of the UK breeding population.

3.7.406 In the Hornsea Zone and 10 km buffer, the peak estimate of guillemots in the post-breeding season (July to October) was 110,080 birds in August. This estimate corresponds to approximately 8.3% of the UK breeding population (1,322,830 individuals) (Mitchell *et al.,* 2004).

3.7.407 In the Year 2 post-breeding season (July to October), the peak estimated number of guillemots in Subzone 1 was 8,500 birds in September, with an estimated 18,251 birds when including the 4 km buffer, also in September. The Subzone 1 estimate for September corresponds to approximately 0.6% of the UK breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004). The estimate for Subzone 1 plus the 4 km buffer corresponds to approximately 0.7% of the UK breeding population.

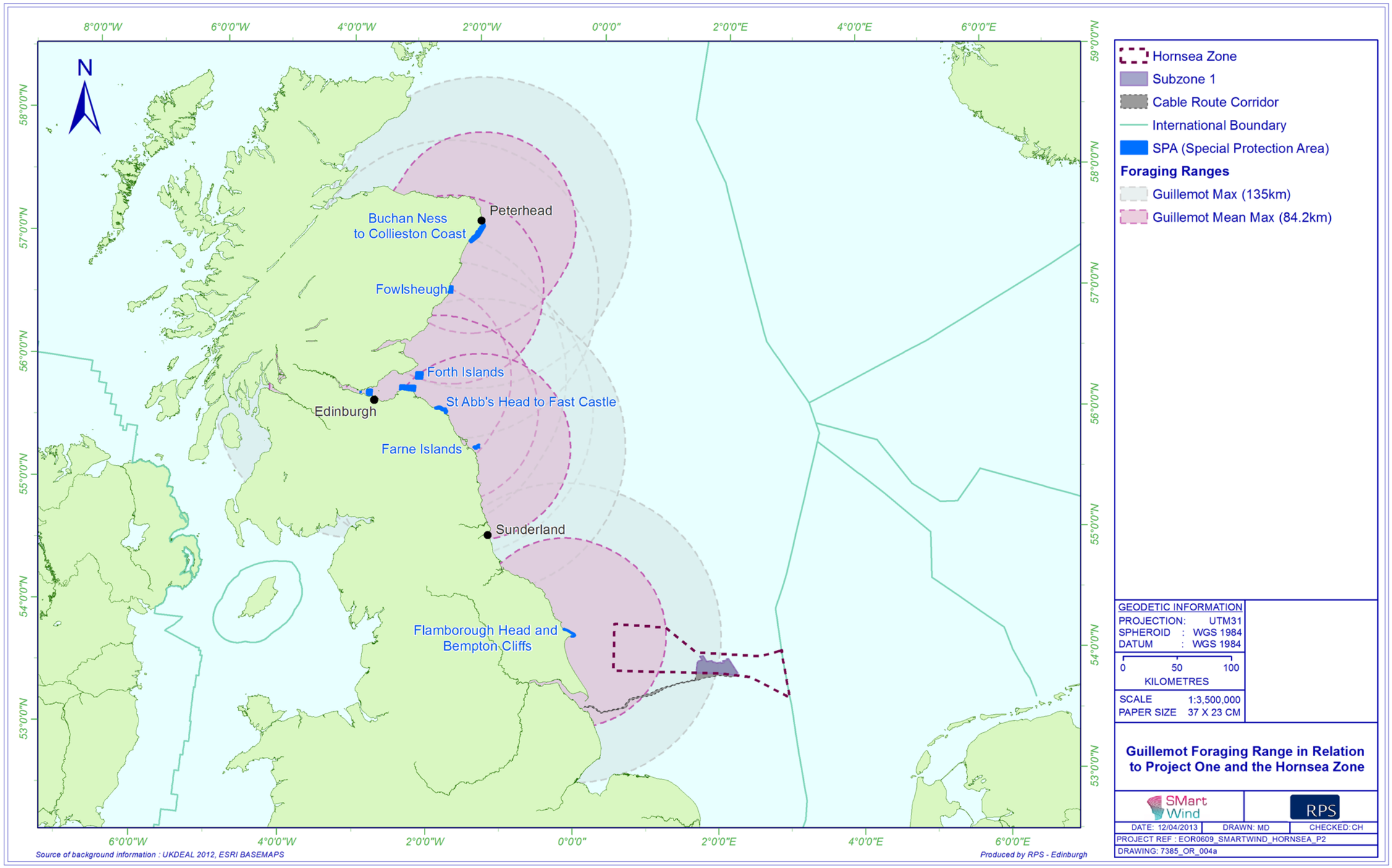


Figure 3.89 Guillemot foraging ranges from SPAs in relation to the Hornsea Survey Area.

Table 3.49 SPAs for guillemot on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeographic population at time of citation [1]	% of national population at time of citation [1]	Recent count (individuals) [2]
Buchan Ness to Collieston Coast	473.1	8,640	0.4%	1.2%	20,858
Calf of Eday	644.4	8,241	0.4%	1.2%	1,841
Copinsay	607.4	13,333	0.6%	1.9%	14,593
East Caithness Cliffs	613.7	71,509	3.2%	10.2%	158,985
Fair Isle	698.1	25,165	1.1%	3.6%	27,320
Farne Islands	280.7	23,499	1.0%	3.3%	49,076
Firth of Forth Islands	365.9	22,452	1.0%	3.2%	22,553
Flamborough Head and Bempton Cliffs	*123.4*	*16,150*	*0.7%*	*2.3%*	*83,214*
Foula	717.3	25,125	1.1%	3.6%	41,500
Fowlsheugh	434.5	40,140	1.8%	5.7%	44,920
Hermaness, Saxa Vord and Valla Field	771.8	11,363	0.5%	1.6%	5,205
Hoy	616.9	13,400	0.6%	1.9%	21,777
Marwick Head	657.6	24,388	1.1%	3.5%	16,817
North Caithness Cliffs	613.7	26,994	1.2%	3.8%	36,109
Noss	702.6	30,169	1.4%	4.4%	22,065
Rousay	646.3	7,102	0.3%	1.0%	6,205
St Abb's Head to Fast Castle	325.5	20,971	0.9%	3.0%	34,415
Sumburgh Head	676.5	10,752	0.5%	1.5%	7,931
Troup, Pennan and Lion's Heads	524.5	29,902	1.3%	4.3%	17,598
West Westray	655.7	28,274	1.3%	4.0%	25,237
Total		**457,569**	**20.4%**	**65.2%**	**658,219**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database, except for Flamborough Head and Bempton Cliffs SPA (JNCC/Natural England figures).

Sites in italics lie within the maximum known foraging range of 135 km. (Thaxter *et al.*, 2012).

Table 3.50 Estimated numbers of guillemots in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	2110	1539	2893	406	1,172	2,516	5,735
1	April	4570	3100	6738	29	2,142	4,599	28,297
1	May	2763	2260	3378	43	1,307	2,806	22,859
1	June	4709	3865	5738	58	2,220	4,767	22,097
1	July	11544	9525	13990	29	5,390	11,573	69,933
1	August	13802	11601	16420	0	6,428	13,802	110,080
1	September	25147	21468	29457	7	11,715	25,154	103,069
1	October	41947	33312	52820	87	19,577	42,034	73,376
1	November	14477	11740	17853	145	6,810	14,622	43,300
1	December	8616	7169	10356	436	4,216	9,052	39,545
1	January	3448	2425	4903	883	2,017	4,331	20,246
1	February	3260	2370	4485	130	1,579	3,390	24,931
2	March	2417	1788	3268	205	1,221	2,622	17,262
2	April	3618	2813	4653	30	1,699	3,648	57,031
2	May	5681	4361	7400	74	2,680	5,755	20,285
2	June	6880	5747	8237	15	3,211	6,895	48,652
2	July	13348	11620	15333	146	6,285	13,494	67,567
2	August	6337	4998	8036	0	2,951	6,337	106,760
2	Sept	18163	13146	25096	88	8,500	18,251	23,458 [3]
2	October	9672	6436	14534	104	4,553	9,776	9,551 [3]
2	November	1553	1083	2225	15	730	1,568	2,278 [3]
2	December	4136	1946	8788	128	1,986	4,264	-
2	January	1325	988	1776	99	663	1,424	2,596 [3]
2	February	2153	1701	2726	274	1,131	2,427	3,872 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

3.7.408 In the Hornsea Zone and 10 km buffer, the peak estimate of guillemots in the Year 2 post-breeding season (July to October) was 106,760 birds in August. This estimate corresponds to approximately 8.1% of the UK breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004).

3.7.409 In the Year 1 non-breeding season (November to March), the peak estimated number of guillemots in Subzone 1 was 6,811 birds, with an estimated 14,622 birds when including the 4 km buffer, both in November. The Subzone 1 estimate corresponds to approximately 0.5% of the UK breeding population (1,322,830 individuals) (Mitchell *et al.*, 2004). The estimate for Subzone 1 and 4 km buffer corresponds to 1.1% of the UK breeding population. In the Hornsea Zone and 10 km buffer, the peak estimate of guillemots was 43,300 birds also in November. This estimate corresponds to 3.3% of the UK breeding population.

3.7.410 In the Year 2 non-breeding season (November to March), the peak estimated number of guillemots in Subzone 1 was 1,986 birds, with an estimated 4,264 birds when including the 4 km buffer, both in November. In the Hornsea Zone and 10 km buffer, the peak estimate of guillemots was 17,262 birds in March, although coverage in the Hornsea Zone and 10 km buffer between November and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2. The March estimate corresponds to 1.3% of the UK breeding population.

3.7.411 These data are presented in Figure 3.90, Figure 3.91 and Figure 3.92.

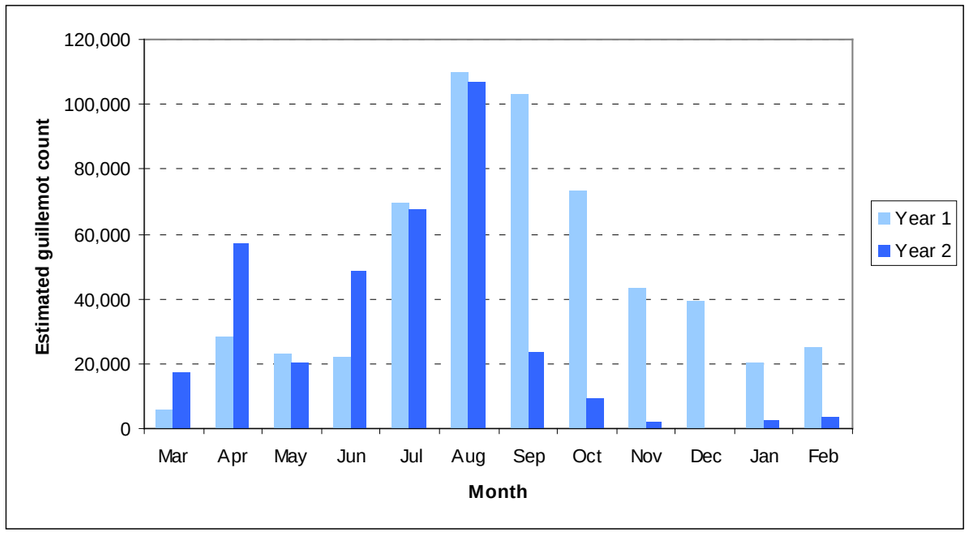


Figure 3.90 Temporal variation in distance-adjusted counts of guillemot in the Hornsea Zone plus 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

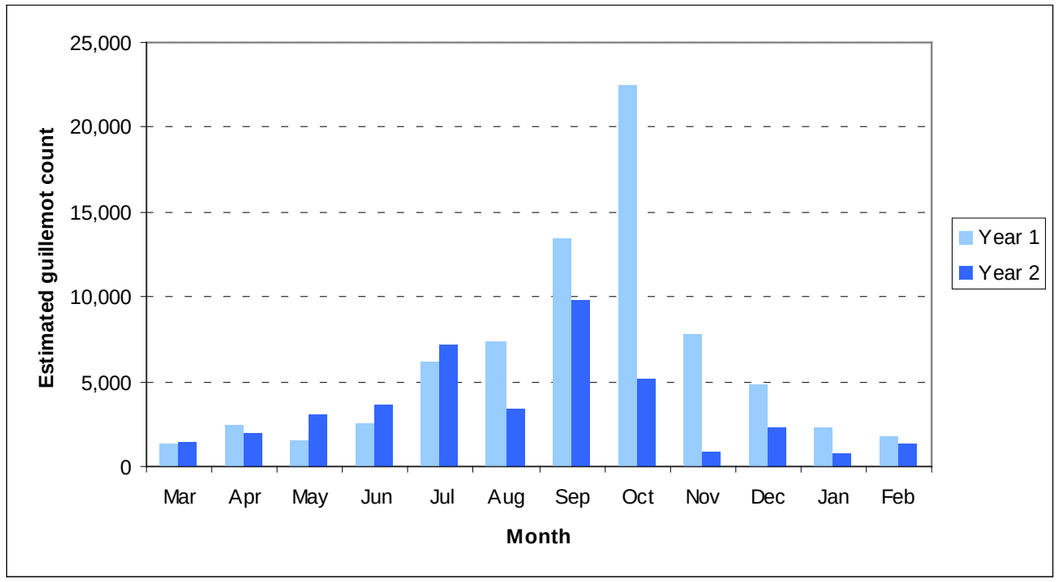


Figure 3.91 Temporal variation in distance-adjusted counts of guillemot in Subzone 1 and 4 km buffer.

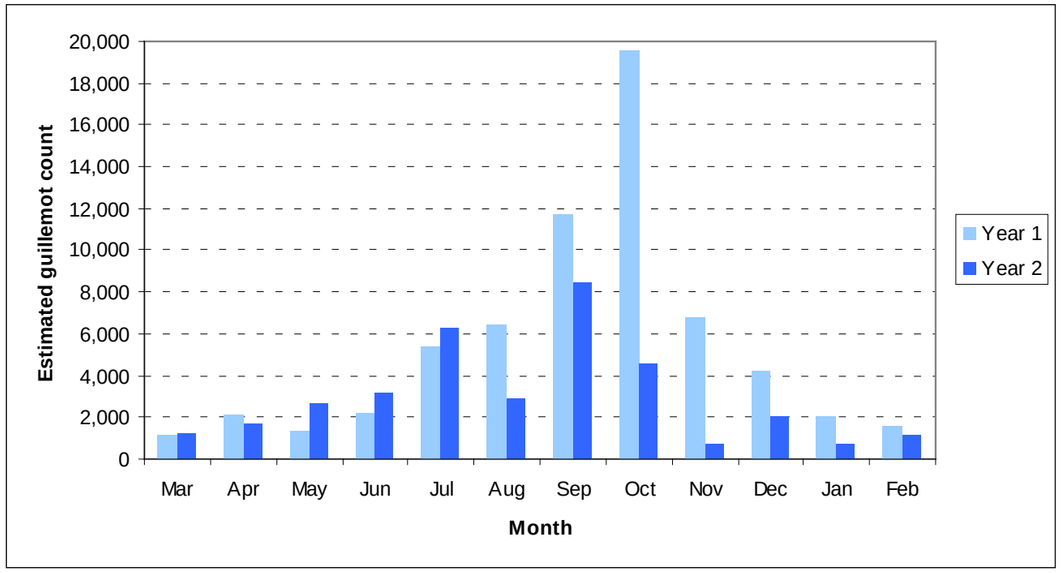


Figure 3.92 Temporal variation in distance-adjusted counts of guillemot in Subzone 1.

Densities

3.7.412 Guillemot densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.51. Densities are fairly high compared to other species in this area with the highest densities seen post-breeding, from around July to November when values of up to 5.72 birds/km^2 were estimated.

Table 3.51 North Sea guillemot densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	1.89	1.85	1.53	1.76	3.29
February	4.04	1.73	2.7	2.82	3.33
March	2.43	1.15	0.94	1.51	2.94
April	1.03	0.97	0.37	0.79	4.71
May	1.86	0.34	0.24	0.81	4.89
June	7.65	0.07	0.34	2.69	6.67
July	7.51	1.45	0.17	3.04	14.33
August	14.38	1.47	1.31	5.72	11.51
September	10.32	2.83	0.45	4.53	24.81
October	10.48	2.01	1.59	4.69	29.62
November	4.45	2.8	2.52	3.26	9.25
December	1.81	0.4	2.23	1.48	7.61

3.7.413 Mean monthly guillemot density showed a similar pattern between Subzone 1 and 4 km buffer and the Hornsea Zone and 10 km buffer from March to August and December to February of Year 1. However, mean density in Subzone 1 and 4 km buffer between September and November was higher than recorded in the Hornsea Zone and 10 km buffer over the same period, with a peak of 48.1 birds/km^2 in October, compared to the peak of 20.0 birds/km^2 in the Hornsea Zone and 10 km buffer in September. Mean densities were lower in Year 2, with a peak of 20.9 birds/km^2 in Subzone 1 and 4 km buffer in September, compared to a peak of 20.7 birds/km^2 in the Hornsea Zone and 10 km buffer in August (Figure 3.93).

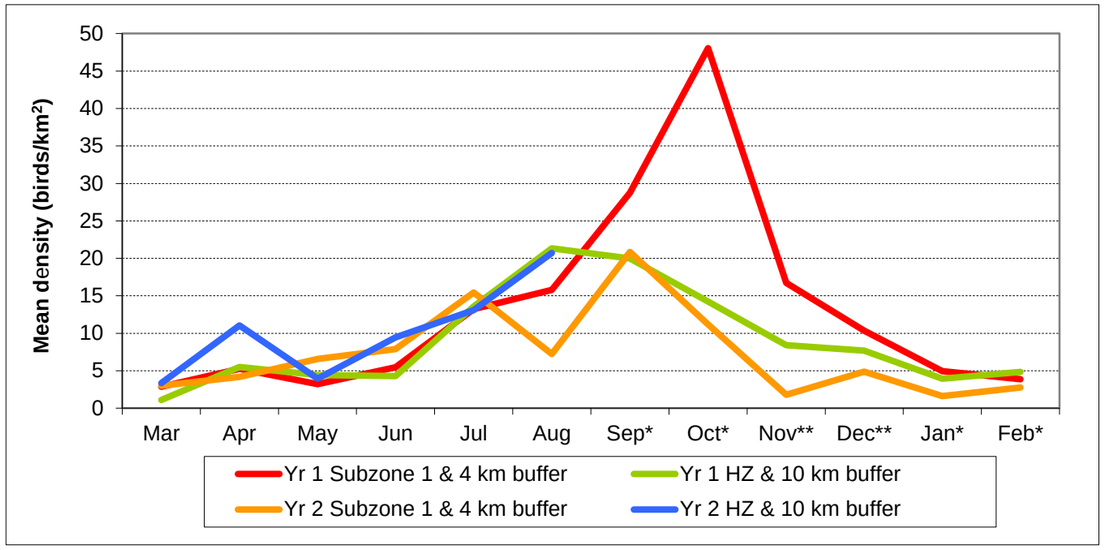


Figure 3.93 Temporal variation in mean estimated density of guillemot in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

3.7.414 A comparison of the temporal distribution of guillemot density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.94. The temporal pattern from Stone *et al.* is similar to that which was seen in the Hornsea Survey Area, but the density estimates become increasing higher in the Hornsea Zone and 10 km buffer and, to an even greater extent, Subzone 1 and 4 km buffer. This suggests that the Hornsea Survey Area is more important that the surrounding area for guillemots, particularly in the post-breeding and non-breeding seasons.

Behaviour and distribution

3.7.415 A total of 9,701 guillemots were recorded in flight on baseline surveys, with only two birds (representing less than 0.1%) recorded flying above 22.5 m in height (Table 3.2).

3.7.416 Foraging behaviour was recorded for 1,951 guillemots in the Hornsea Survey Area, with seven types of foraging behaviour recorded, and unspecified feeding behaviour recorded for a further 568 birds (Table 3.52). The most commonly recorded foraging behaviour was pursuit diving (49.5%) and actively searching (23.3%).

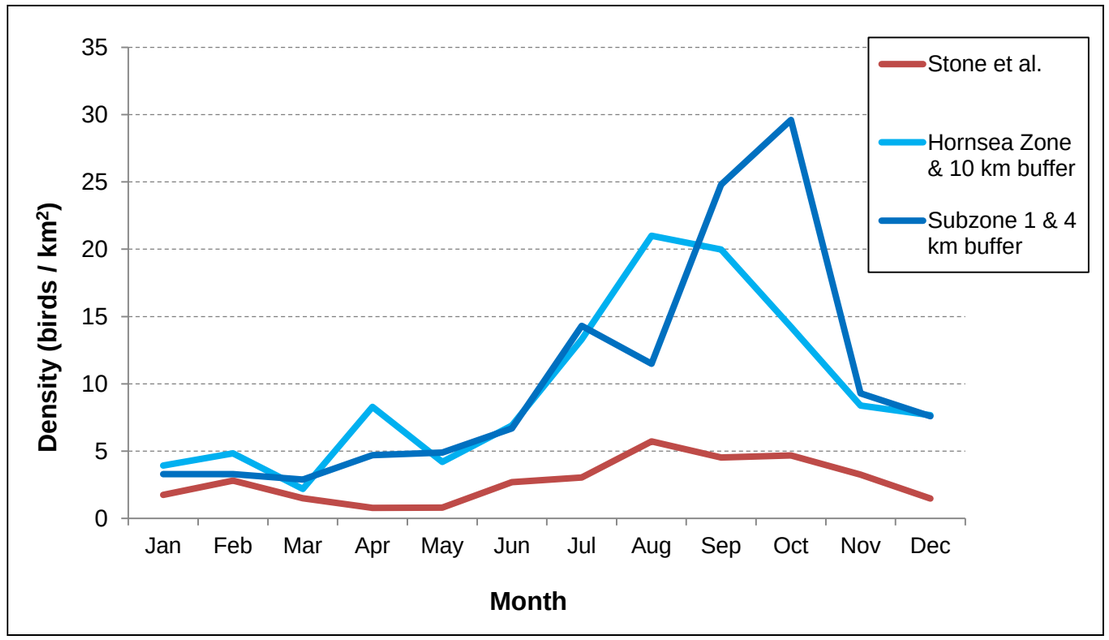


Figure 3.94 A comparison of temporal variation in density of guillemot in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).

Table 3.52 Guillemot foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

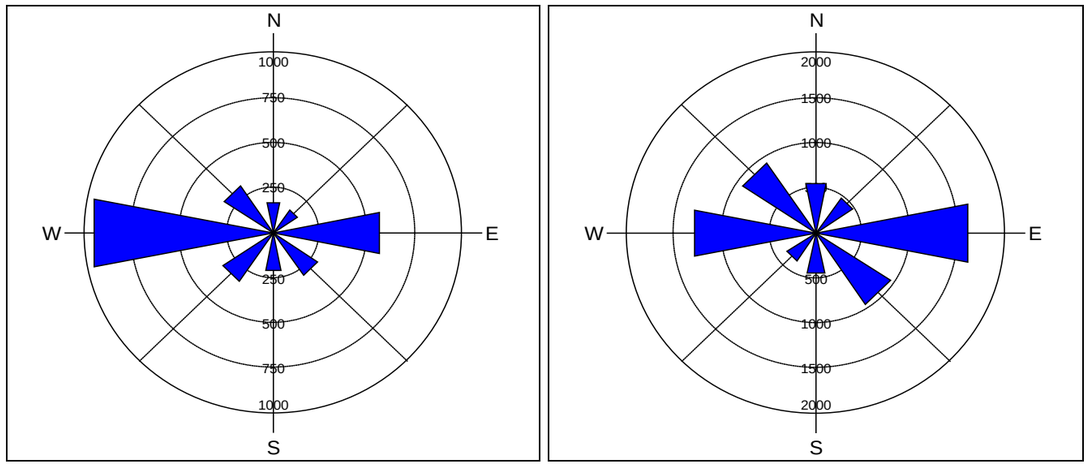
Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	586	23.3
Holding fish	84	3.3
Pursuit diving	1,248	49.5
Pursuit plunging	21	0.8
Shallow plunging	1	0.0
Surface pecking	6	0.2
Surface seizing	5	0.2
Feeding –unspecified	568	22.6
Total	**2,519**	

3.7.417 Flight direction was recorded for 2,988 guillemots on baseline surveys in the breeding season, and a further 6,653 guillemots during the rest of the year. In the breeding season, just under a third of all birds recorded were flying west, in the general direction of the breeding colony at Flamborough Head and Bempton Cliffs. A further fifth of birds were flying east. During the rest of the year, the situation was less clear. (Figure 3.95). In addition, 22 guillemots were recorded flying in August, when birds are moulting and flightless for a period. A further 36 birds were recorded as circling (not shown).

3.7.418 The majority of guillemots recorded on baseline surveys were unaged, with 3,127 adults, 17 immature birds and 3,647 juvenile birds recorded.

3.7.419 In the breeding season, just under a third of all birds recorded were flying west (32.3%), in the direction of the breeding colony at Flamborough Head and Bempton Cliffs. A further 19.0% of birds were flying east. In the non-breeding season, a similar pattern was recorded, with just over half of all birds flying east (24.5%) or west (19.6%), with 14.2% flying south east, and 13.9% flying northwest (Figure 3.95).

3.7.420 The density distribution maps for guillemot cover the periods April to June, July to October and November to March for Years 1 and 2 (Appendix B). Guillemot were evenly distributed throughout Hornsea Survey Area, with no difference in density between Subzone 1 and the 4 km buffer and the Hornsea Zone that cannot be explained by differential survey effort.



April to July (n=2,988 birds) September to March (n=6,653 birds)

Numbers shown on figures are number of birds recorded.

Figure 3.95 Flight direction of guillemot in the Hornsea Survey Area in Years 1 and 2.

Razorbill (*Alca torda*)

Status overview

3.7.421 Razorbill is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009). It is one of the commonest seabirds in Britain, breeding in large colonies with other seabirds on suitable coastal cliffs. Seabird 2000 recorded 164,557

individuals at breeding colonies around Britain (Mitchell *et al.*, 2004). The closest large colony to the Hornsea Zone is at Flamborough Head and Bempton Cliffs, which held an estimated 10,570 pairs in 2008-11.

3.7.422 Langston (2010) assessed razorbill as being at moderate risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms, while collision risk was rated as low risk. Overall, razorbill was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.423 Razorbill is listed as a qualifying interest species in the breeding season for 10 SPAs on the UK east coast. Only one, Flamborough Head and Bempton Cliffs SPA, falls within mean maximum foraging range of the Hornsea Zone (Figure 3.96).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.424 The highest densities of razorbills are found in the north western North Sea with much lower densities found overwintering in the southern North Sea (Stone *et al.,* 1995). With a flyway population of some 482,000 birds in the southern North Sea, between 1.3 and 2.0% of the biogeographic population are estimated to move through this area (Steinen *et al.,* 2007).

3.7.425 From April to August Razorbills are generally confined to coastal areas from Flamborough Head northwards along the east coast during the incubating and chick rearing season. From August to September densities of more than five birds birds/km^2 can be found in the Flamborough area as young birds disperse from the colony with their parents. Lower densities of up to one bird/km^2 were found further out near the Hornsea Zone (Stone *et al.,* 1995). Between October and March there are low to moderate densities in the southern North Sea with low densities of the east coast of up to one bird/km^2 (Stone *et al.,* 1995).

3.7.426 Data from the 2004 to 2008 reports, Aerial Surveys of Waterbirds in the UK, show razorbill numbers in the Greater Wash survey blocks GW2, GW9 and GW10 were very low, with a peak mean of two birds during the breeding season (May). A higher number of birds recorded as 'Auk spp.' were recorded, however, with a peak means of 693 in March and 722 in May respectively.

3.7.427 Razorbill was the third most frequently recorded seabird in the Hornsea Survey Area in Year 1, with a total of 15,437 birds recorded (Table 3.1). Just over half (51.6%) were recorded in the Hornsea Zone and 10 km buffer. Highest numbers were recorded between July and October (Table A.2 and Table A.4). Higher numbers of razorbills were recorded in Year 2 (18,880). The majority of birds (71.8%) were recorded in the Hornsea Zone and 10 km buffer, with highest numbers in July and August (Table A.3 and Table A.5).

3.7.428 During the main part of the Year 1 breeding season (April to June), peak estimated numbers of razorbills occurred in April, with 1,515 birds in Subzone 1 and 3,253 when including the 4 km buffer. The Subzone 1 estimate for April corresponds to approximately 1.0% of the UK breeding population (164,557 individuals) (Mitchell *et al.*, 2004), while the estimate when including the 4 km buffer represents 2.0%. In comparison, an estimated 13,947 razorbills occurred in the Hornsea Zone and 10 km buffer in April (Table 3.53). This estimate corresponds to 8.5% of the UK breeding population (Mitchell *et al.*, 2004) and 1.81-3.24% of the biogeographic breeding population of c. 430,000 – 770,000 individuals (BLI, 2012).

3.7.429 In Year 2, during the main breeding period, peak estimated numbers of razorbills were again recorded in April, with 1,415 birds in Subzone 1 and 3,038 birds estimated when including the 4 km buffer. The Subzone 1 estimate for April corresponds to approximately 0.9% of the UK breeding population (164,557 individuals) (Mitchell *et al.*, 2004). The estimate for Subzone 1 and the 4 km buffer corresponds to approximately 1.9% of the UK breeding population (Mitchell *et al.*, 2004). In comparison, an estimated 16,955 razorbills were recorded in the Hornsea Zone and 10 km buffer in June of Year 2. This estimate corresponds to 10.3% of the British breeding population (Mitchell *et al.*, 2004).

3.7.430 In the Year 1 post-breeding season (July to October), peak estimated numbers of razorbills occurred in October, with 7,099 birds in Subzone 1, and an estimated 15,241 birds when including the 4 km buffer. The Subzone 1 estimate for October corresponds to approximately 4.3% of the UK breeding population (164,557 individuals) (Mitchell *et al.*, 2004), while the estimate when including 4 km buffer corresponds to approximately 9.2%. In comparison, an estimated 33,474 razorbills were recorded in the Hornsea Zone and 10 km buffer in September (Table 3.53) which corresponds to 20.3% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.431 In the Year 2 post-breeding season, peak estimated numbers of razorbills occurred in September, with 4,256 birds estimated for Subzone 1, and 9,139 when including the 4 km buffer. The Subzone 1 estimate for September corresponds to 2.6% of the UK breeding population (164,557 individuals) (Mitchell *et al.*, 2004), while the Subzone 1 and 4 km buffer estimate corresponds to 5.5% (Mitchell *et al.*, 2004). In comparison, an estimated 52,765 razorbills were recorded in the Hornsea Zone and 10 km buffer in August; 32.1% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.432 In the Year 1 non-breeding season (November to March), peak estimated numbers of razorbills occurred in March, with 2,100 birds estimated for Subzone 1, and 4,509 birds when including the 4 km buffer. The Subzone 1 estimate for March corresponds to 1.3% of the UK breeding population (164,557 individuals) (Mitchell *et al.*, 2004). The estimate for Subzone 1 and 4 km buffer corresponds to 2.7% of the UK breeding population (Mitchell *et al.*, 2004). In comparison, an estimated 20,749 razorbills were recorded in the Hornsea Zone and 10 km buffer in December; 12.6% of the UK breeding population (Mitchell *et al.*, 2004).

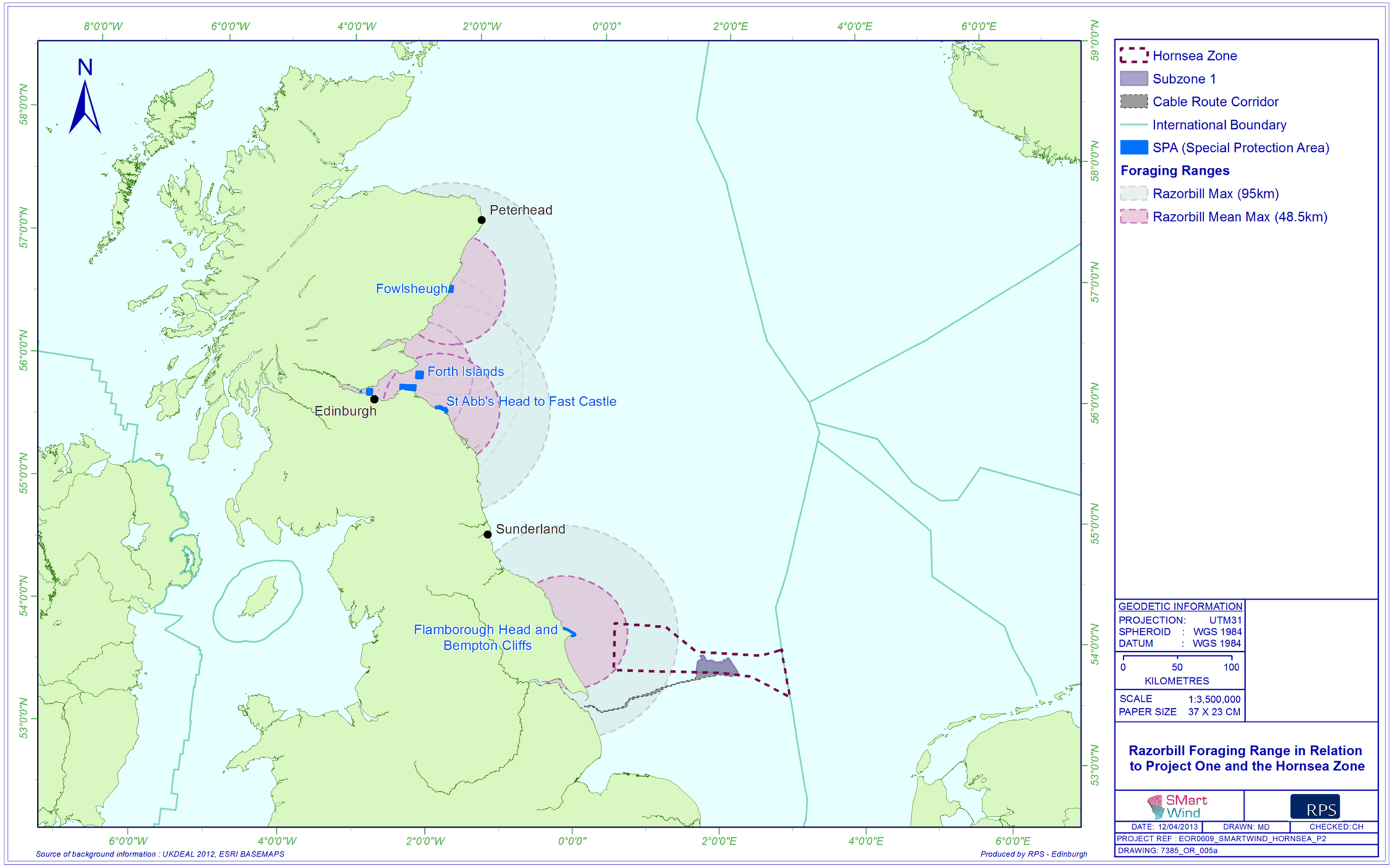


Figure 3.96 Razorbill foraging ranges from SPAs in relation to the Hornsea Survey Area.

Table 3.53 Estimated numbers of razorbills in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2.

Years	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	4161	2988	5796	348	2,100	4509	5,679
1	April	3094	1783	5368	159	1,515	3253	13,947
1	May	299	156	571	14	146	313	3,426
1	June	683	430	1085	29	332	712	4,113
1	July	3271	2278	4697	115	1,577	3386	32,310
1	August	0	0	0	0	0	0	29,891
1	September	12170	9239	16031	7	5,671	12177	33,474
1	October	15038	11654	19406	203	7,099	15241	27,009
1	November	2241	1699	2955	14	1,050	2255	6,794
1	December	4060	3067	5374	44	1,911	4104	20,749
1	January	1573	909	2722	0	733	1573	5,396
1	February	1276	741	2196	43	614	1319	7,784
2	March	1841	1268	2674	0	857	1841	8,196
2	April	3038	2284	4040	0	1,415	3038	14,021
2	May	285	157	520	0	133	285	3,501
2	June	467	301	723	58	245	525	16,955
2	July	696	425	1142	29	338	725	13,751
2	August	477	129	1768	0	222	477	52,765
2	September	9021	5637	14439	118	4,256	9139	13,281 [3]
2	October	2782	1315	5885	30	1,309	2812	2,664 [3]
2	November	1628	1070	2476	44	779	1672	2,147 [3]
2	December	346	42	2843	0	161	346	-
2	January	723	489	1068	466	554	1189	1,203 [3]
2	February	1369	923	2031	14	644	1383	1,649 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

3.7.433 In the Year 2 non-breeding season, peak estimated numbers of razorbills also occurred in March with 857 birds estimated for Subzone 1 and 984 when including the 4 km buffer. The Subzone 1 estimate for March corresponds to 0.5% of the UK breeding population (164,557 individuals), and the estimate including the 4 km buffer corresponds to 0.6% (Mitchell *et al.*, 2004). In comparison, an estimated 8,196 razorbills were recorded in the Hornsea Zone and 10 km buffer in March, which corresponds to 5.0% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.434 Coverage in the Hornsea Zone and 10 km buffer between November and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

Densities

3.7.435 In Stone *et al.* (1995), three North Sea areas overlap with the Hornsea Survey Area. The mean density of razorbill for these areas combined is fairly low (0.7 birds/km^2 and below) for the majority of the year, but increases from October to December to at least 1.0 bird/km^2 up to a peak of 2.07 birds/km^2 in November. Densities are particularly high at this time in Area 6 (south and east North Sea).

3.7.436 Razorbill densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.54, along with the data from Subzone 1 and 4 km buffer for comparison.

3.7.437 In Year 1, mean monthly razorbill density showed a similar pattern between Subzone 1 and 4 km buffer and the Hornsea Zone and 10 km buffer from March to July and between November and February. However, in August mean density in Subzone 1 and 4 km buffer dropped to zero birds/km^2, while mean density in the Hornsea Zone and 10 km buffer remained similar to July. It is not known why there were no razorbills recorded in Subzone 1 and 4 km buffer in August, however, mean density in Subzone 1 and 4 km buffer then increased sharply in September to a peak of 17.4 birds/km^2 in October. In contrast, mean density in the Hornsea Zone and 10 km buffer at this time peaked at 6.5 birds/km^2 in September (Figure 3.100).

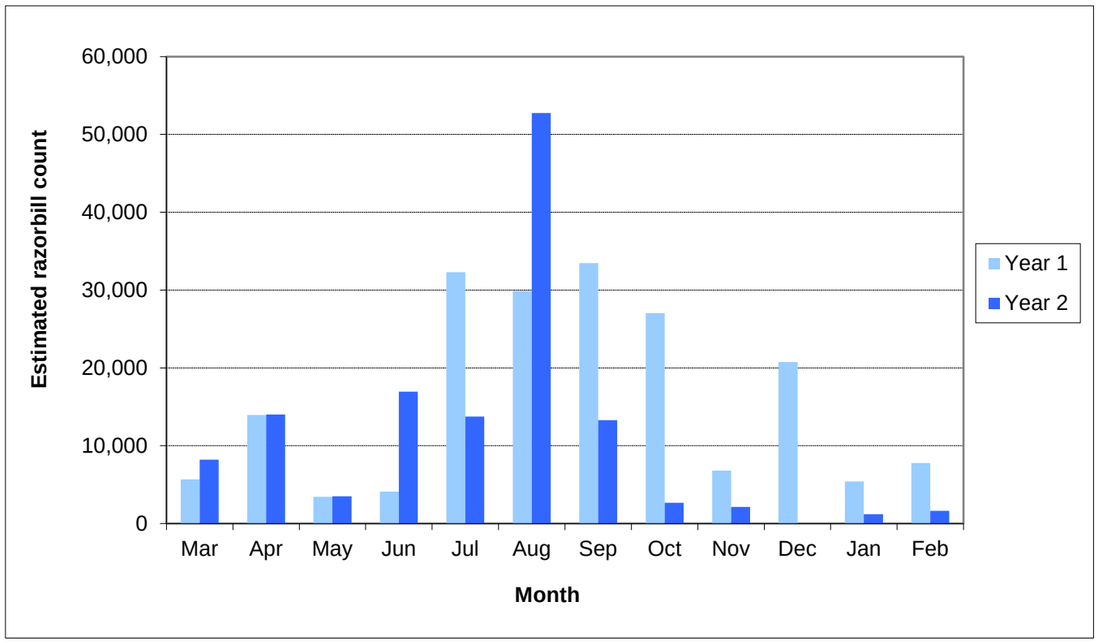


Figure 3.97 Temporal variation in distance-adjusted counts of razorbill in the Hornsea Zone plus 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

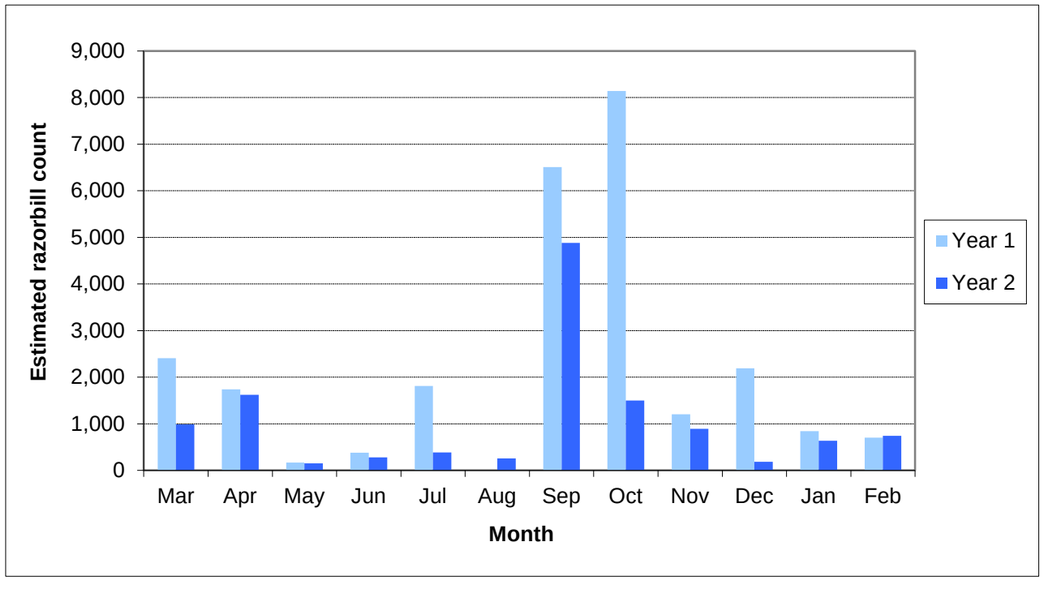


Figure 3.98 Temporal variation in distance-adjusted counts of razorbill in Subzone 1 plus 4 km buffer.

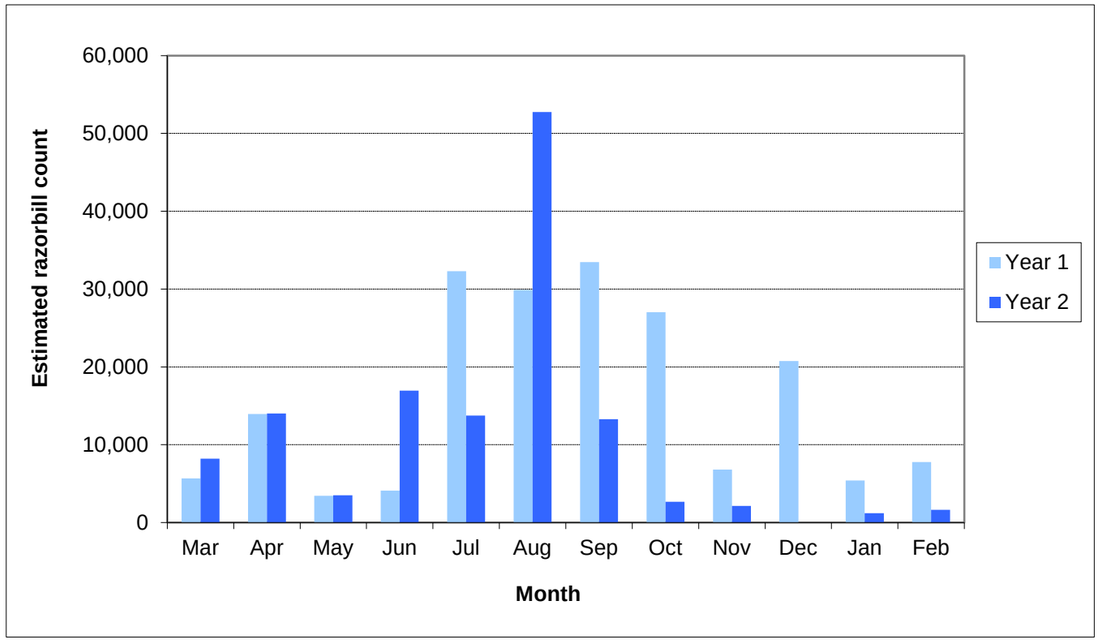


Figure 3.99 Temporal variation in distance-adjusted counts of razorbill in Subzone 1.

Table 3.54 North Sea razorbill densities from Stone *et al.* (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0.18	0.12	0.96	0.42	1.58
February	0.29	0.07	1.62	0.66	1.55
March	0.22	0.07	0.27	0.19	3.63
April	0.04	0.7	0.03	0.26	3.60
May	0.12	0.03	0.01	0.05	0.34
June	0.46	0.01	0	0.16	0.71
July	0.98	0.08	0	0.35	2.35
August	2.07	0.04	0	0.70	0.27
September	1.19	0.38	0.01	0.53	12.19
October	2.7	0.17	0.32	1.06	10.32
November	0.6	0.19	5.43	2.07	2.24
December	0.17	0.05	3.19	1.14	2.54

3.7.438 In Year 2, mean density in Subzone 1 and 4 km buffer and the Hornsea Zone and 10 km buffer was similar between March and May, however, mean density in the Hornsea Zone and 10 km buffer increased from June and peaked in August at 10.2 birds/km^2. Mean densities between September and February of Year 2 were not available for the Hornsea Zone and 10 km buffer. Mean density in Subzone 1 and 4 km buffer remained low until September, when it peaked at 10.4 birds/km^2 before decreasing again in October (Figure 3.100).

3.7.439 A comparison of the temporal distribution of razorbill density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.101.

3.7.440 ESAS mean density data for razorbill showed a similar pattern to the baseline survey data throughout the year, although peak mean densities were lower, with a peak of 1.6 birds/km^2 in July in the surrounding ¼ ICES rectangles, and 2.3 birds/km^2 in August in Regional Seas 1 and 2.

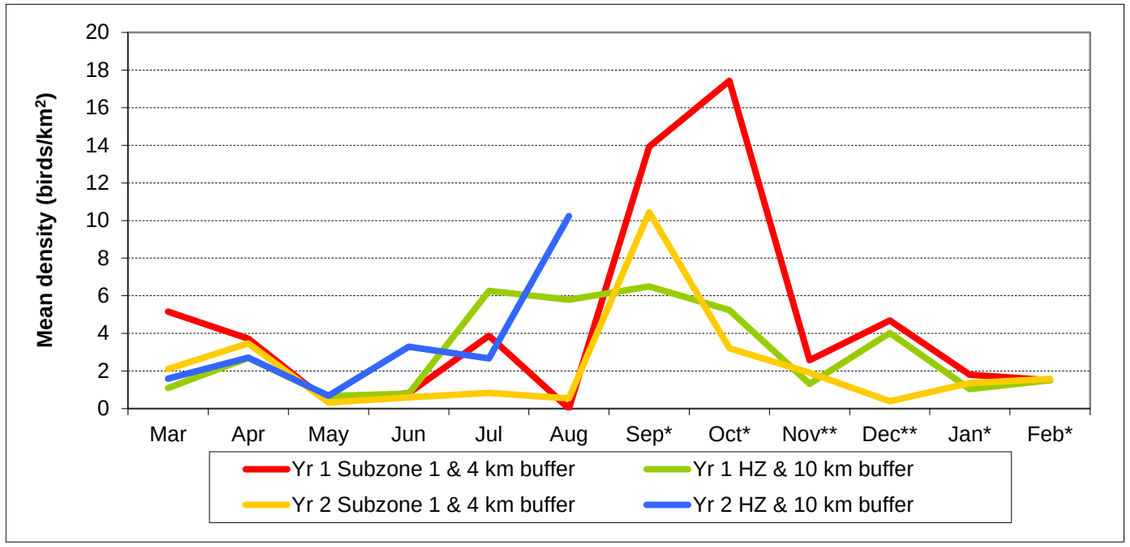


Figure 3.100 Temporal variation in mean estimated densities of razorbill in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

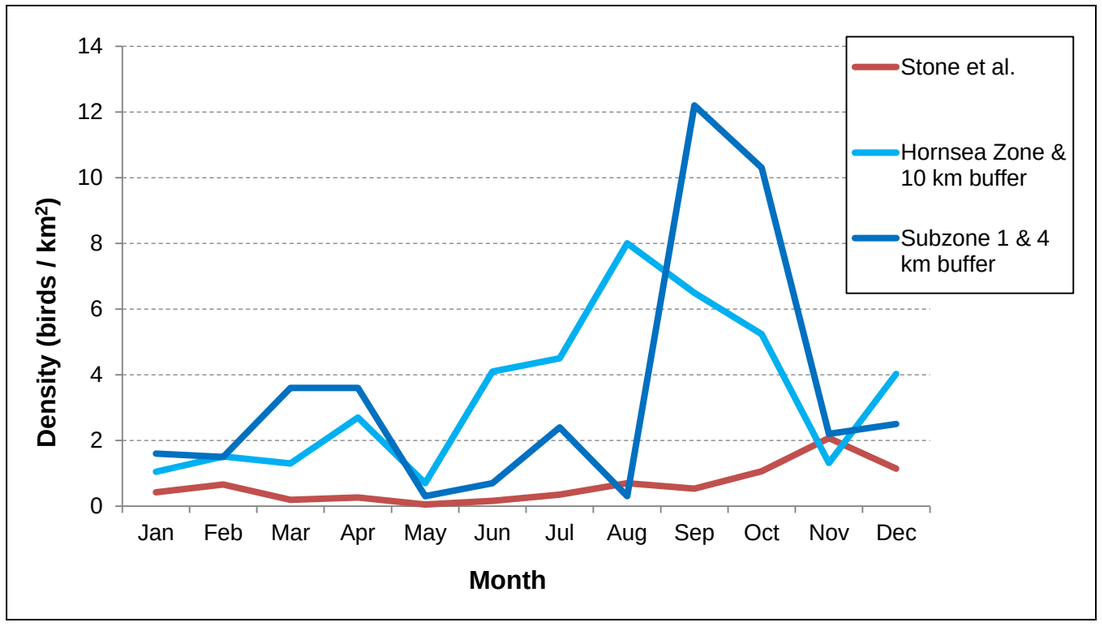


Figure 3.101 A comparison of temporal variation in densities of razorbill in the Hornsea Survey Area and wider figures from Stone *et al*. (1995).

Behaviour and distribution

3.7.441 A total of 4,913 razorbills were recorded in flight, with all birds recorded flying below 22.5 m in height (Table 3.2).

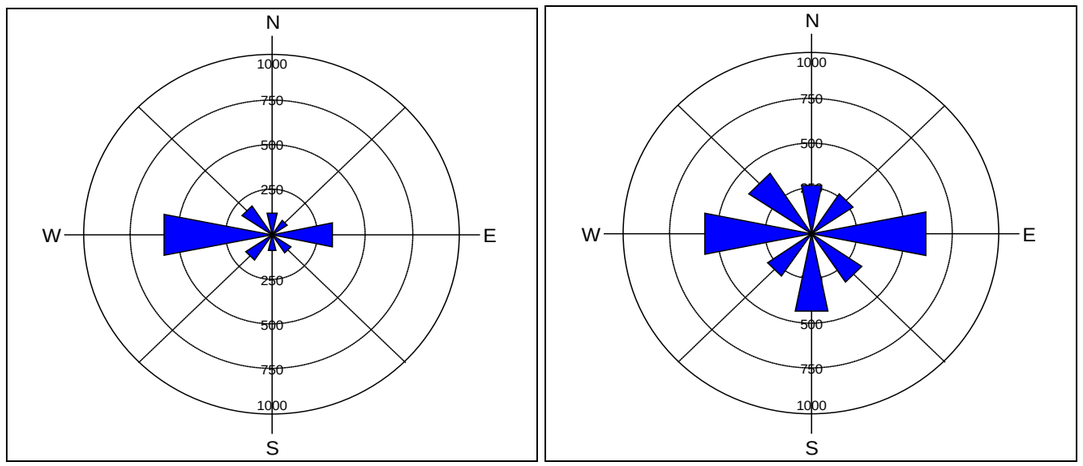
3.7.442 Foraging behaviour was recorded for 1,682 razorbills in the Hornsea Survey Area on baseline surveys, with five types of foraging behaviour recorded. An additional 383 birds were recorded feeding, but no further information was specified. The most commonly recorded foraging behaviours were pursuit diving (69.1%) and actively searching (9.2%) (Table 3.55).

3.7.443 Flight direction was recorded for 1,703 razorbills on baseline surveys in the breeding season (April to July), with direction recorded for 3,161 razorbills in the non-breeding season (September to March) (Figure 3.102). In addition, five razorbills were recorded flying in August, when birds are moulting and flightless for a period. A further 22 birds were recorded as circling (not shown).

3.7.444 In the breeding season, over a third (34.4%) of all birds recorded were flying west, in the general direction of the breeding colony at Flamborough Head and Bempton Cliffs, approximately 125 km from the closest point of Subzone 1. A further 19.3% of birds were flying east. In the non-breeding season, just under one fifth of all birds recorded were flying east (19.5%), with 18.3% flying west, and 13.7% flying south.

Table 3.55 Razorbill foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	191	9.2
Holding fish	49	2.4
Pursuit diving	1,427	69.1
Pursuit plunging	13	0.6
Shallow plunging	2	0.0
Feeding – method unspecified	383	18.5
Total	**2,065**	



April to July (n=1,703 birds) September to March (n=3,161 birds)

Numbers shown on figures are number of birds recorded

Figure 3.102 Flight direction of razorbills in the Hornsea Survey Area in Years 1 and 2.

3.7.445 The majority of razorbills were unaged on baseline surveys, however, age was recorded for 551 adults, 39 immature birds and 574 juvenile birds.

3.7.446 The density distribution maps for razorbill cover the periods April to June, July to October and November to March for Years 1 and 2 in Subzone 1 and the 4 km buffer and for the Hornsea Zone (see Appendix B). Razorbill was distributed throughout the survey area, with higher densities occurring in the western half of the Hornsea Zone. This pattern was more pronounced during the summer, when greater numbers of birds were recorded.

Little Auk (*Alle alle*)

Status overview

3.7.447 Little auks breed in the high Arctic in large numbers, and occur in UK waters in late autumn and winter months. Large "wrecks" of birds can occur following winter gales, with birds sometimes found inland on lakes or reservoirs. Little auks feed on *Calanus finmarchius*, a planktonic copepod, which is also a major food for sandeels and other fish (Forrester *et al.*, 2007).

3.7.448 Langston (2010) assessed little auk as being at moderate risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms, while collision risk was rated as low risk. Overall, little auk was assessed as being at possibly moderate risk from offshore wind developments (Table 3.3). There are no UK SPAs designated for little auks (JNCC, 2012).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.449 In Year 1, 466 little auks were recorded on surveys in the Hornsea Survey Area between October and January, with the majority of birds (71.2%) occurring in the Hornsea Zone and 10 km buffer (Table A.2 and Table A.4). Numbers in Year 2 were lower, with 145 birds recorded on surveys between October and April, with peak numbers recorded in November (Table A.3 and Table A.5).

3.7.450 Survey coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete (Table 2.1).

3.7.451 In Year 1, peak estimated numbers of little auks were recorded in November, with 424 birds in Subzone 1 and 911 birds when including the 4 km buffer, using data from 2 km transect surveys. In comparison, 14,509 little auks were estimated in the Hornsea Zone and 10 km buffer in November, using data from 6 km transect surveys (Table 3.56). This estimate corresponds to approximately 0.06% of the European breeding population (> 11,000,000 pairs) (Birdlife International, 2004).

3.7.452 In Year 2, peak estimated numbers of little auks were much lower, with 43 birds in Subzone 1 and 92 birds when including the 4 km buffer in November, using data from 2 km transect surveys. In comparison, an estimated 485 birds were recorded in the combined Subzone survey area for Projects 1 and 2 in November, using data from 2 km transect surveys. Coverage in the Hornsea Zone and 10 km buffer between September and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2. Estimates for this area are included to place the corresponding estimates for Subzone 1 in context.

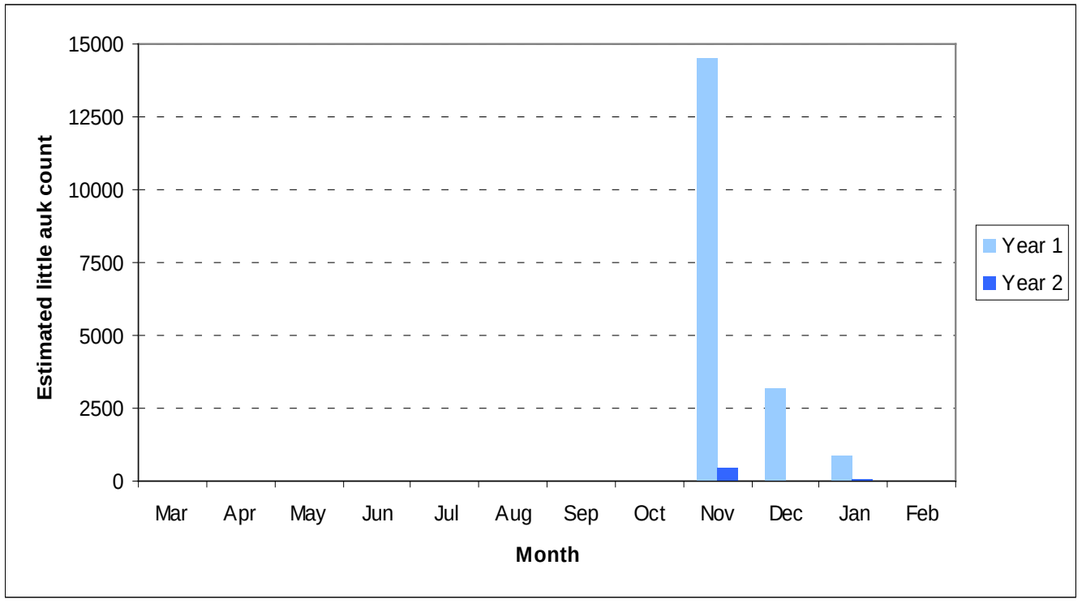


Figure 3.103 Temporal variation in distance-adjusted counts of little auk in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

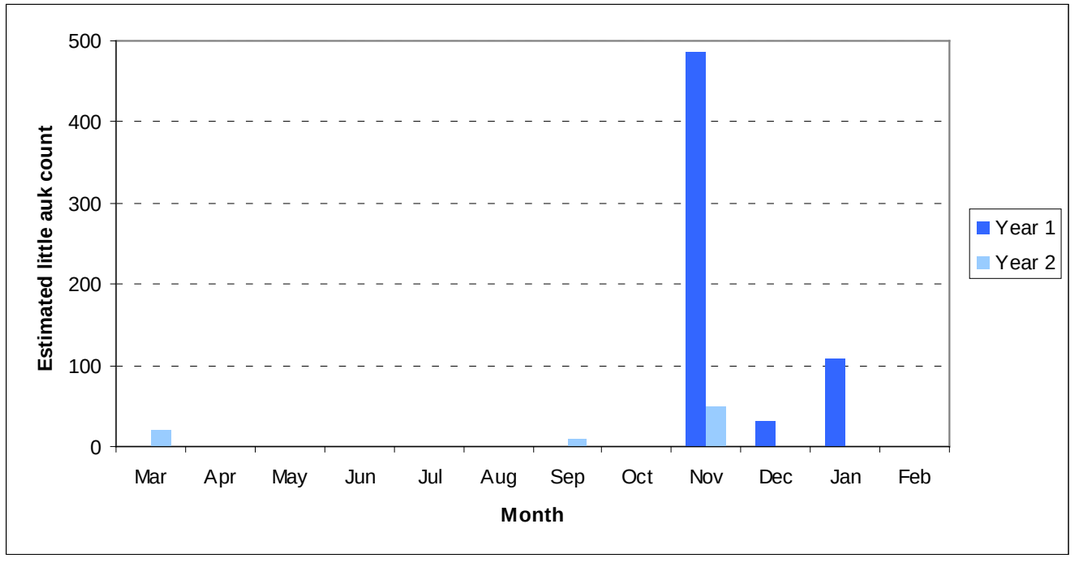


Figure 3.104 Temporal variation in distance-adjusted counts of little auk in Subzone 1 plus 4 km buffer.

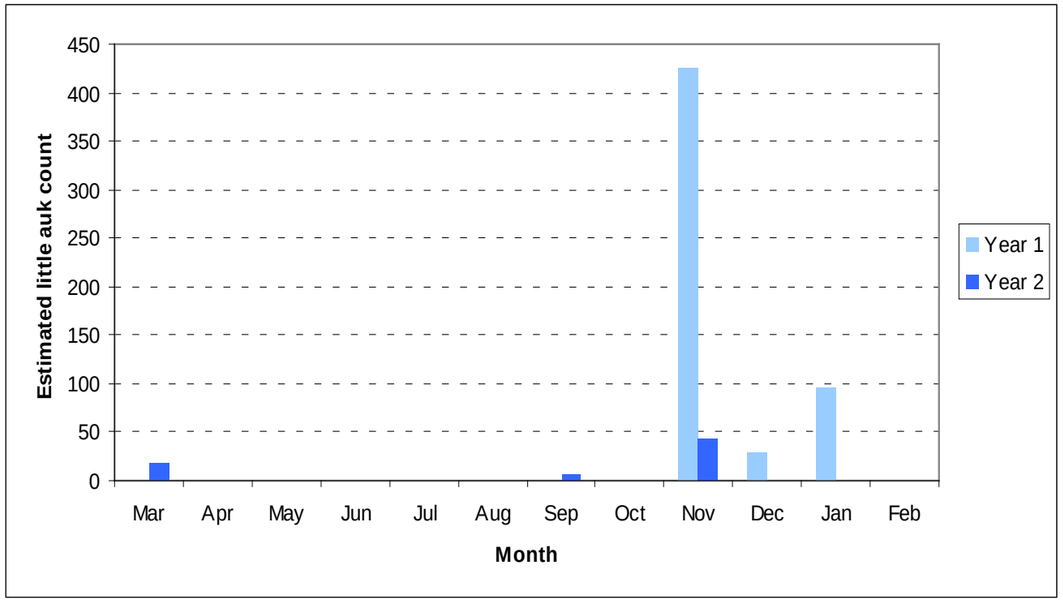


Figure 3.105 Temporal variation in distance-adjusted counts of little auk in Subzone 1.

Densities

3.7.453 In Year 1, mean monthly little auk density was highest in November, with a peak of 2.8 birds/km^2 in the Hornsea Zone and 10 km buffer, compared to 1.0 birds/km^2 in Subzone 1 and 4 km buffer. Mean densities were lower for the remaining winter months.

3.7.454 In Year 2, mean monthly little auk density was much lower, with a peak of 0.1 birds/km^2 in Subzone 1 and the 4 km buffer. Mean density in the Hornsea Zone and 10 km buffer was zero birds/km^2 between September and March, with no data available for the winter period (Figure 3.106).

3.7.455 ESAS mean density data for little auks showed a similar pattern to the baseline survey data throughout the year, although peak mean densities were lower, with a peak of 0.4 birds/km^2 in December in the surrounding ¼ ICES rectangles, and 0.3 birds/km^2 in November in Regional Seas 1 and 2.

Table 3.56 Estimated numbers of little auks in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	0	0	0	0	0	0	0
1	April	0	0	0	0	0	0	0
1	May	0	0	0	0	0	0	0
1	June	0	0	0	0	0	0	0
1	July	0	0	0	0	0	0	0
1	August	0	0	0	0	0	0	0
1	September	0	0	0	0	0	0	0
1	October	0	0	0	0	0	0	0
1	November	882	437	1778	29	424	911	14,509
1	December	45	12	166	15	28	60	3,183
1	January	204	69	602	0	95	204	873
1	February	0	0	0	0	0	0	0
2	March	40	11	142	0	19	40	0
2	April	0	0	0	0	0	0	0
2	May	0	0	0	0	0	0	0
2	June	0	0	0	0	0	0	0
2	July	0	0	0	0	0	0	0
2	August	0	0	0	0	0	0	0
2	September	0	0	0	15	7	15	0 [3]
2	October	0	0	0	0	0	0	0 [3]
2	November	92	25	335	0	43	92	485 [3]
2	December	0	0	0	0	0	0	-
2	January	0	0	0	0	0	0	45 [3]
2	February	0	0	0	0	0	0	0 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

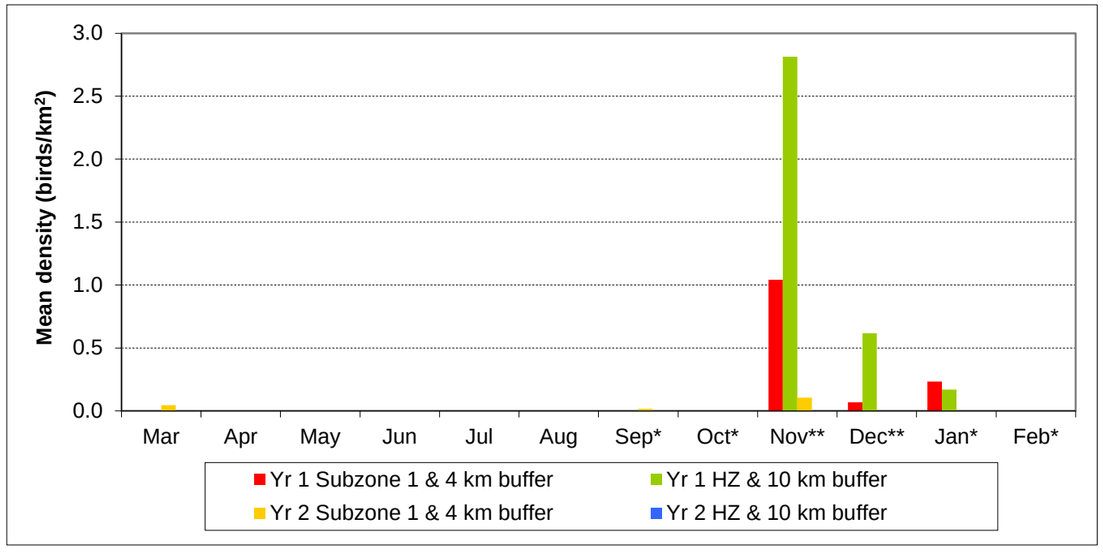


Figure 3.106 Temporal variation in mean estimated densities of little auk in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Behaviour and distribution

3.7.456 A total of 256 little auks were recorded in flight on baseline survey, all below 22.5 m in height (Table 3.2). Foraging behaviour was recorded for 40 little auks in the Hornsea Survey Area, with pursuit diving the most commonly recorded (Table 3.57).

Table 3.57 Little auk foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	2	5.0
Pursuit diving	36	90.0
Shallow seizing	2	5.0
Total	**40**	

3.7.457 The density distribution maps for little auk cover the period November to January for Years 1 and 2 (Appendix B). Little auk was observed throughout the Hornsea Survey Area, with higher densities in the western half.

Puffin (*Fratercula arctica*)

Status overview

3.7.458 Puffin is currently amber-listed on the UK Birds of Conservation Concern list (Eaton *et al.*, 2009).

3.7.459 Puffins are one of the commonest seabird species in Britain, breeding in coastal colonies. Seabird 2000 recorded 579,500 pairs at breeding colonies around Britain (Mitchell *et al.*, 2004). Lesser sandeel is the commonest prey item for puffins, but they also eat sprat, herring and a wide range of young gadoid fish (Harris, 1984).

3.7.460 Langston (2010) assessed puffin as being at moderate risk of displacement, barrier effects, habitat loss or changes in prey distribution resulting from offshore wind farms, while collision risk was rated as low risk. Overall, puffin was assessed as being at moderate risk from offshore wind developments (Table 3.3).

3.7.461 Puffin is listed as a qualifying interest species in the breeding season for 11 SPAs on the UK east coast, between Hermaness and Foreness Point (Table 3.58) These SPAs held 36.1% of the UK breeding population, and 18.0% of the biogeographic population at the time of designation (JNCC, 2012). The distance between Subzone 1 and the nearest SPA (Flamborough Head and Bempton Cliffs SPA) is within the maximum foraging range (200 km) reported to date for puffin, but outside the mean maximum foraging range (105.4 km) (Thaxter *et al.*, 2012) (Figure 3.109).

Hornsea Survey Area

Seasonal distribution and abundance

3.7.462 During the breeding season puffin are aggregated around their colonies along the east coast and high densities are found in the Flamborough Head area. During post-breeding, however, the birds disperse towards the north western North Sea before spreading out more widely throughout the winter months (Stone *et al.*, 1995).

3.7.463 Between April and July the Flamborough Head area has densities of up to five birds/km^2 due to the high numbers of birds foraging in the area local to the breeding colony. This continues into the post-breeding season of August to September as the puffins are leaving the colony.

3.7.464 Data from the 2004 to *2008* reports, Aerial Surveys of Waterbirds in the UK, show that no puffins were recorded during aerial surveys of the Greater Wash survey blocks GW2, GW9 and GW10. Birds recorded as 'Auk spp.' were recorded, however, with a peak means of 693 in March and 722 in May respectively. Numbers were lower throughout the rest of the year, but this was still one of the most frequently recorded species groups during aerial surveys.

3.7.465 A total of 2,495 puffins were recorded on surveys in the Hornsea Survey Area in Year 1, with just over half of all birds (52.4%) occurring in the Hornsea Zone and 10 km buffer (Table 3.1). Birds were recorded in all months, with peak numbers occurring in June in Subzone 1 and 4 km buffer (273 birds) and in October in the Hornsea Zone and 10 km buffer (379 birds) (Table A.2 and Table A.4).

3.7.466 Higher numbers were recorded in Year 2, with 4,733 birds recorded. The majority of puffins (76.3%) were recorded in the Hornsea Zone and 10 km buffer in Year 2. Birds were recorded in all months, with peak numbers occurring in August in Subzone 1 and 4 km buffer (345 birds) and in August in the Hornsea Zone and 10 km buffer (1,963 birds) (Table A.3 and Table A.5).

3.7.467 During the Year 1 breeding season (April to July), peak estimated numbers of puffins were recorded in June, with 1,324 birds in Subzone 1 and 2,842 birds when including the 4 km buffer (Table 3.59). This corresponds to 0.1-0.2% of the UK breeding population (579,500 pairs) (Mitchell *et al.*, 2004). In comparison, an estimated 3,765 puffins were recorded in the Hornsea Zone and 10 km buffer in April. This estimate corresponds to 0.3% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.468 During the Year 2 breeding season (April to July), peak estimated numbers of puffins were recorded in April, with 356 birds in Subzone 1 and 765 birds when including the 4 km buffer (Table 3.59). In comparison, an estimated 2,209 puffins were recorded in the Hornsea Zone and 10 km buffer in April. This estimate corresponds to 0.2% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.469 In the Year 1 non-breeding period (August to March), the peak estimated number of puffins in Subzone 1 was 795 birds, with 1,707 birds when including the 4 km buffer, in October. The peak estimated number of puffins in the Hornsea Zone and 10 km buffer over this period was 12,253 birds in October. This figure corresponds to 1.1% of the UK breeding population (Mitchell *et al.*, 2004).

3.7.470 In the Year 2 non-breeding period (November to March), the peak estimated number of puffins in Subzone 1 was 1,180 birds, with 2,533 birds when including the 4 km buffer, in November. The peak estimated number of puffins in the Hornsea Zone and 10 km buffer over the same period was 1,653 birds in March.

3.7.471 The data are presented in Table 3.58, Figure 3.109 and Figure 3.110. Coverage in the Hornsea Zone and 10 km buffer between November and February of Year 2 was incomplete, and was restricted to the combined Subzone survey area for Projects 1 and 2 (Table 2.1).

Table 3.58 SPAs for puffin on the UK east coast in the breeding season.

SPA site	Distance to Subzone 1 (km)	Site total (pairs) at time of citation [1]	% of biogeo graphic population at time of citation [1]	% of national population at time of citation [1]	Recent count (pairs) [2]	Year
Coquet Island	257.8	11,400	1.3	2.5	15,812	2009
East Caithness Cliffs	613.7	1,750	0.2	0.4	274	1999
Fair Isle	698.1	8,700	0.9	1.9	7,278	2009
Farne Islands	280.7	34,710	3.9	7.7	36,835	2008
Firth of Forth Islands	365.9	21,000	2.3	4.7	62,167	2009
Flamborough Head and Bempton Cliffs	*123.4*	*3,473*	*0.4*	*0.8*	*490*	*2008-11*
Foula	717.3	48,000	5.3	10.7	22,500	2000
Hermaness, Saxa Vord and Valla Field	771.8	25,400	2.8	5.7	2,855	1999
Hoy	616.9	3,500	0.4	0.8	3,500	-
North Caithness Cliffs	613.7	1,750	0.2	0.4	781	2000
Noss	702.6	2,348	0.3	0.5	1,927	2006
Total	**-**	**162,031**	**18.0**	**36.1**	**154,419**	**-**

[1] JNCC (2011) – SPA online species accounts.

[2] SMP (2012) – Seabird Monitoring Programme Online Database.

Sites in italics lie within the maximum foraging range of 200 km in Thaxter *et al.* (2012).

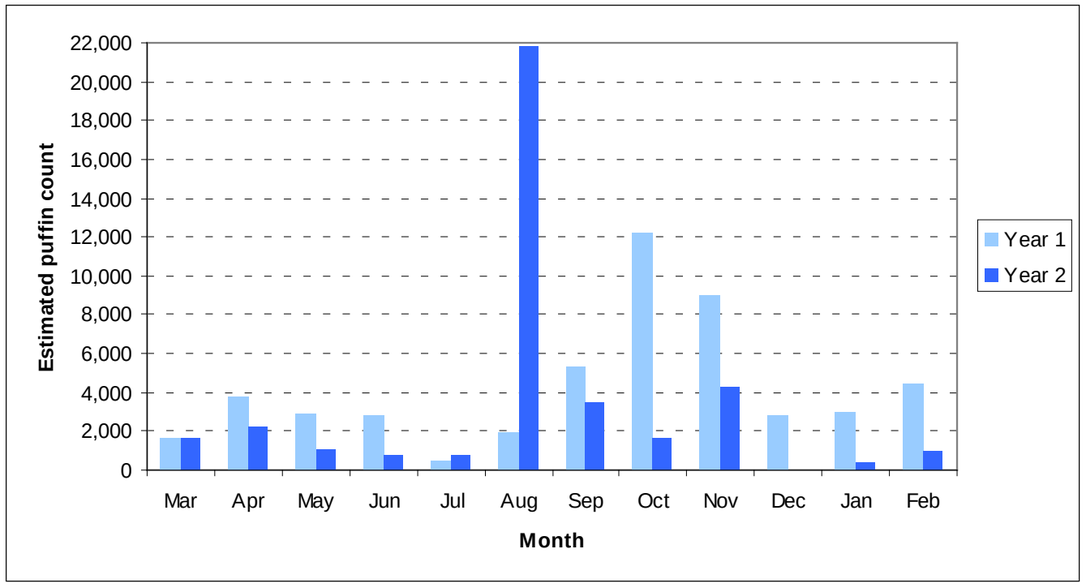


Figure 3.107 Temporal variation in distance-adjusted counts of puffin in the Hornsea Zone and 10 km buffer. (Sep, Oct, Jan, Feb: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).

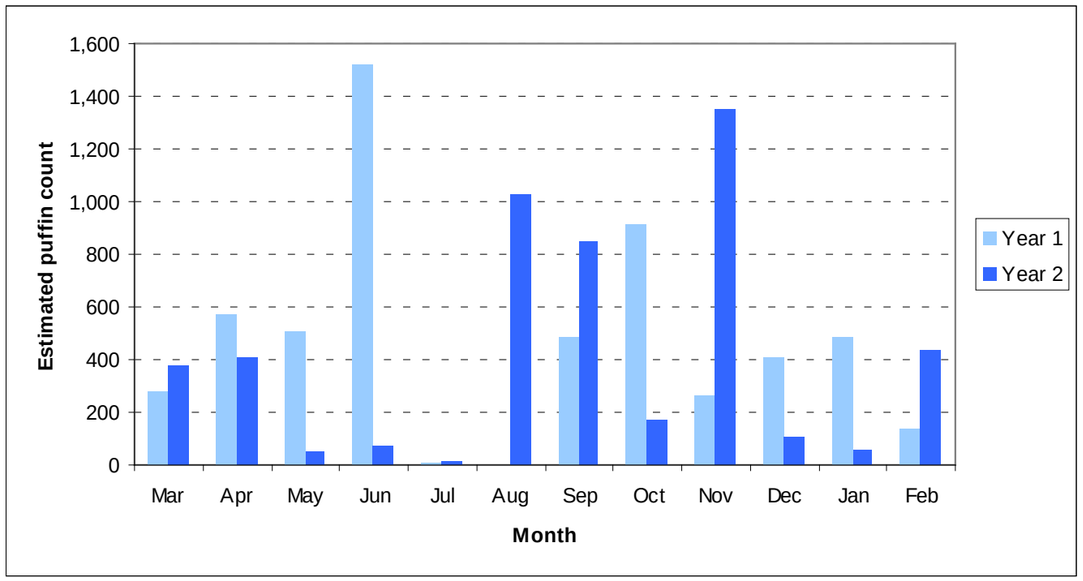


Figure 3.108 Temporal variation in distance-adjusted counts of puffin in Subzone 1 and 4 km buffer.

Densities

3.7.472 Puffin densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.60. Between October and January densities around Hornsea were recorded as very low by Stone *et al.* as the birds dispersed further north and more widely into the North Sea. The peak mean estimate for the three areas overlapping with the Hornsea Survey Area was 0.66 birds/km^2, which is relatively low compared to other species.

3.7.473 Mean monthly puffin density in Subzone 1 and 4 km buffer was slightly higher between March and May of Year 1, compared to the Hornsea Zone and 10 km buffer. Mean density in Subzone 1 was highest in June, with a peak of 3.2 birds/km^2, compared to 0.6 birds/km^2 in the Hornsea Zone and 10 km buffer (

3.7.474 Figure 3.111). Mean density then decreased in both areas in July and August, before increasing again in September, and peaking again in October, with 2.0 birds/km^2 in Subzone 1 and 4 km buffer compared to 2.4 birds/km^2 in the Hornsea Zone and 10 km buffer. Mean density was lower again between November and February of Year 1.

3.7.475 In Year 2, mean monthly puffin density in Subzone 1 and 4 km buffer was slightly higher in March and April, compared to the Hornsea Zone and 10 km buffer, and was low in both areas between May and July. Mean density then increased in August, with a peak of 2.2 birds/km^2 in Subzone 1 compared to 4.2 birds/km^2 in the Hornsea Zone and 10 km buffer (

3.7.476 Figure 3.111). Mean density then decreased in Subzone 1 and 4 km buffer in September, and October, before peaking again in November at 2.9 birds/km^2. Mean density was lower again between December and February of Year 1. Mean density in the Hornsea Zone and 10 km buffer was zero birds/km^2 between September and March, with no data available for this period.

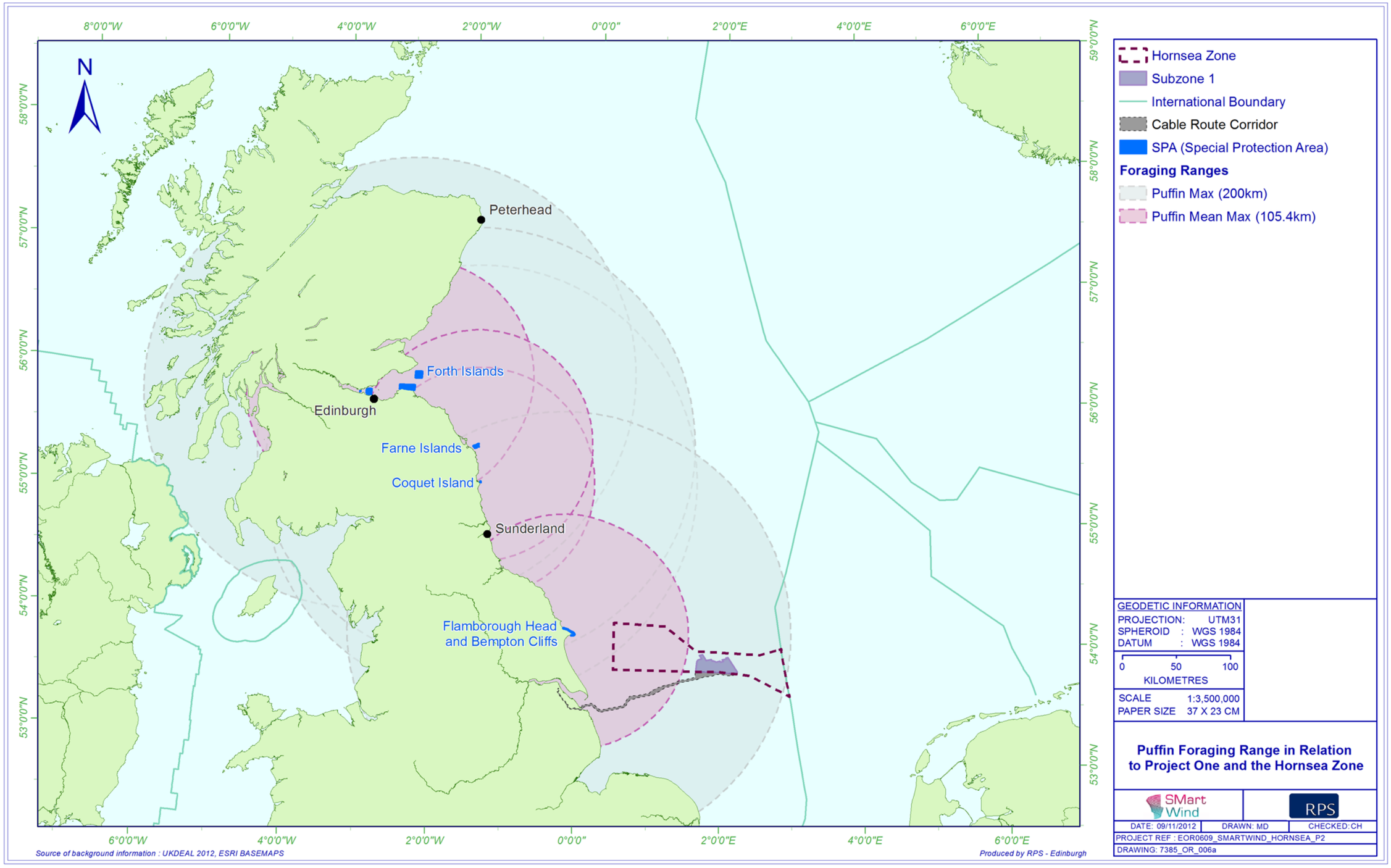


Figure 3.109 Puffin foraging ranges from SPAs in relation to the Hornsea Survey Area.

Table 3.59 Estimated numbers of puffins in Subzone 1, Subzone 1 and 4 km buffer, and Hornsea Zone in Years 1 and 2.

Year	Month	Est. number on water Subzone 1 + 4 km buffer[1]	Lower 95% C.L.	Upper 95% C.L.	Est. number flying Subzone 1 + 4 km buffer[1]	Est. total Subzone 1 [1]	Est. total Subzone 1 and 4 km buffer [1]	Est. total in HZ and 10 km buffer [2]
1	March	494	293	833	29	244	523	1,647
1	April	1068	634	1801	0	497	1068	3,765
1	May	949	608	1481	0	442	949	2,907
1	June	2842	2123	3804	0	1,324	2842	2,855
1	July	13	2	72	0	6	13	437
1	August	0	0	0	0	0	0	1,978
1	September	909	636	1300	0	423	909	5,350
1	October	1707	1093	2665	0	795	1707	12,253
1	November	497	223	1109	0	231	497	8,967
1	December	765	510	1150	0	356	765	2,766
1	January	906	459	1787	0	422	906	2,967
1	February	254	126	514	0	118	254	4,462
2	March	704	496	998	0	328	704	1,653
2	April	750	447	1257	15	356	765	2,209
2	May	100	43	233	0	47	100	1,062
2	June	136	59	310	0	63	136	742
2	July	26	7	96	0	12	26	800
2	August	1932	1251	2983	0	900	1932	21,771
2	September	1581	1182	2115	15	743	1596	3,446 [3]
2	October	301	169	538	15	147	316	1,655 [3]
2	November	2533	2092	3066	0	1,180	2533	4,287 [3]
2	December	195	53	728	0	91	195	-
2	January	101	36	281	0	47	101	365 [3]
2	February	820	522	1288	0	382	820	934 [3]

[1] Data from 2 km transect spacing.

[2] Data from 6 km transect spacing.

[3] No coverage in Hornsea Zone. Estimate based on 2 km transect spacing across combined Project One and Project Two subzone.

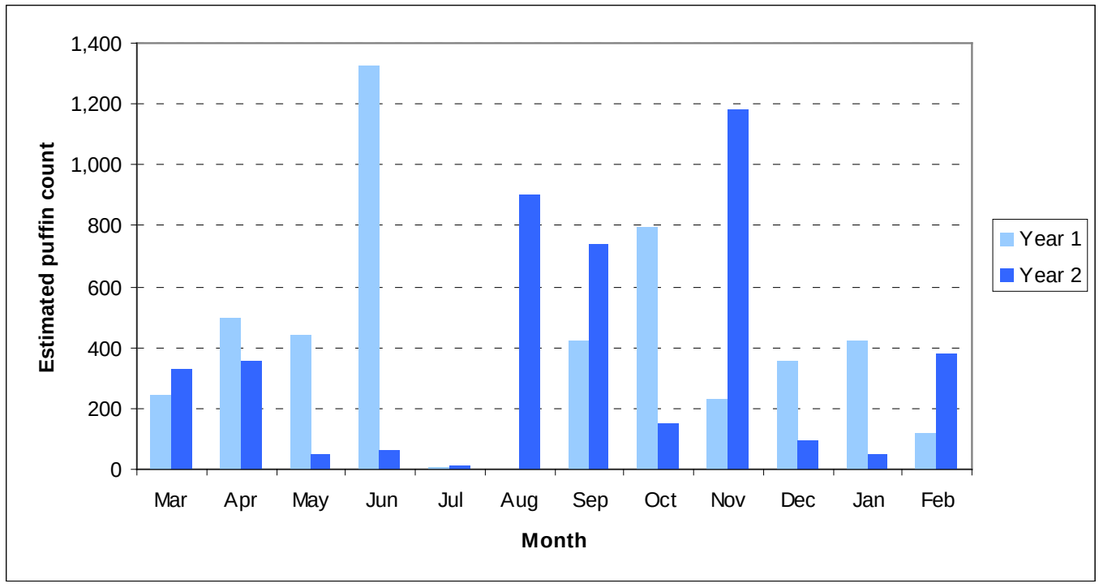


Figure 3.110 Temporal variation in distance-adjusted counts of puffin in Subzone 1.

Table 3.60 North Sea puffin densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)	Subzone 1 and 4 km buffer
January	0.05	0.13	0.01	0.06	0.58
February	0.47	0.14	0.02	0.21	0.61
March	0.38	0.13	0.01	0.17	0.70
April	0.33	0.19	0.01	0.18	1.05
May	0.19	0.16	0	0.12	0.60
June	1.95	0.02	0	0.66	1.70
July	0.61	0.11	0	0.24	0.02
August	1.12	0.05	0	0.39	1.10
September	0.79	0.20	0	0.33	1.43
October	0.10	0.04	0	0.05	1.16
November	0.26	0.09	0	0.12	1.73
December	0.08	0.14	0.02	0.08	0.55

3.7.477 A comparison of the temporal distribution of puffin density in the Hornsea Zone and 10 km buffer, Subzone 1 and 4 km buffer, and the mean density from North Sea Areas 4, 5 and 6 (Stone *et al.*, 1995), is presented in Figure 3.112. Density estimates are almost always consistently higher in the Hornsea Survey Area compared with the overlapping North Sea areas. A significantly higher density of birds occurs in the Hornsea Zone and 10 km buffer in the latter half of the year compared with the former. The pattern in Subzone 1 and 10 km buffer is less clear. This evidence suggests that the Hornsea Survey Area is significantly more important for puffins than the surrounding marine areas, particularly during post-breeding.

3.7.478 ESAS mean density data for puffins showed a similar pattern to the baseline survey data throughout the year, although peak mean densities were lower, with a peak of 0.7 birds/km^2 in June and August in the surrounding ¼ ICES rectangles, and 2.1 birds/km^2 in August in Regional Seas 1 and 2.

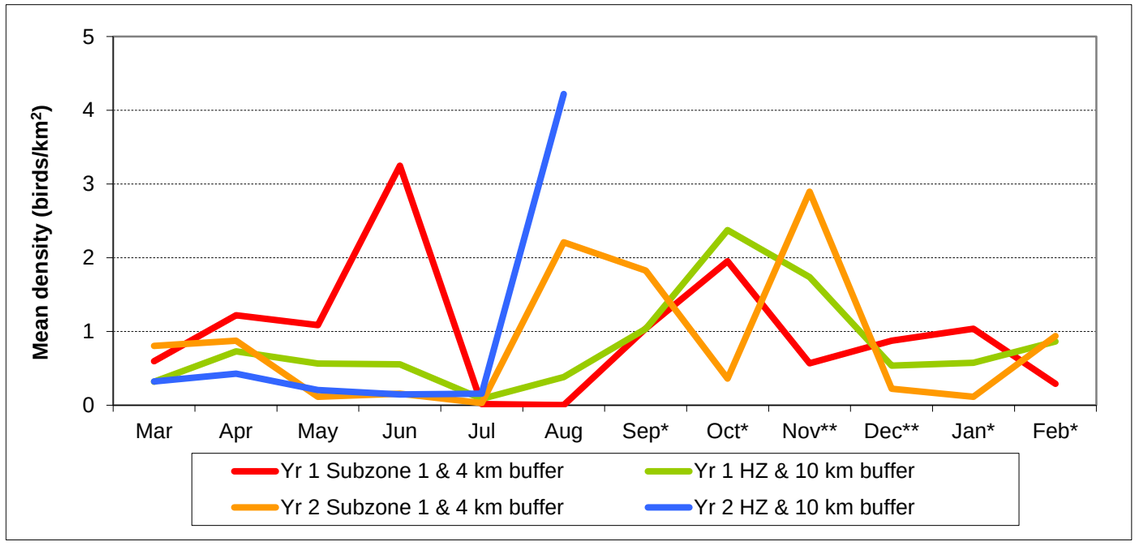


Figure 3.111 Temporal variation in mean estimated density of puffin in the Hornsea Survey Area. (Sep*, Oct*, Jan*, Feb*: surveys were not conducted in the Hornsea Zone during Year 2; Nov, Dec**: surveys incomplete for Hornsea Zone in Years 1 and 2, and Subzone 1 and 4 km buffer in Year 2 respectively).**

Behaviour and distribution

3.7.479 A total of 419 puffins were recorded in flight on baseline surveys, with all birds recorded flying below 22.5 m in height (Table 3.2).

3.7.480 The majority of puffins were unaged on baseline surveys, however, 1,248 adults, 473 immature birds and 447 juvenile birds were recorded.

3.7.481 Flight direction was recorded for 220 puffins on baseline surveys in the breeding season and 197 puffins in the non-breeding season. A further 24 birds were recorded as circling (not shown) (Figure 3.113).

3.7.482 In the breeding season, just under a third (29.5%) of all birds recorded were flying west, in the general direction of the breeding colony at Flamborough Head and Bempton Cliffs, approximately 125 km from the closest point of Subzone 1. A further 20.9% of birds were flying east. In the non-breeding season, over a quarter of all birds recorded were flying east (26.9%), with 20.3% flying west, and 12.7% flying north, although sample sizes were small for this species.

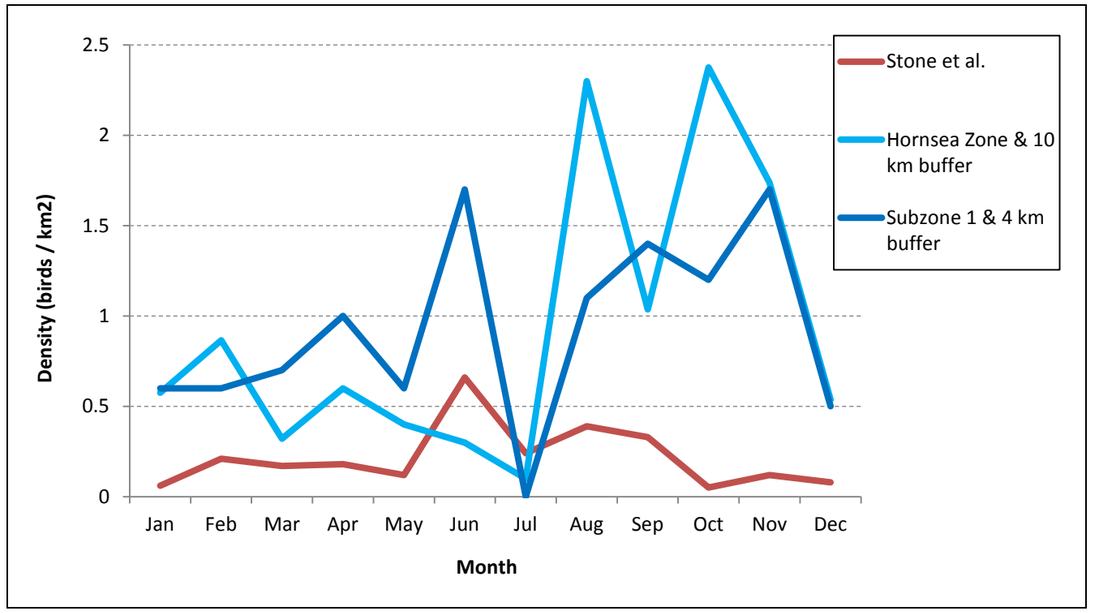
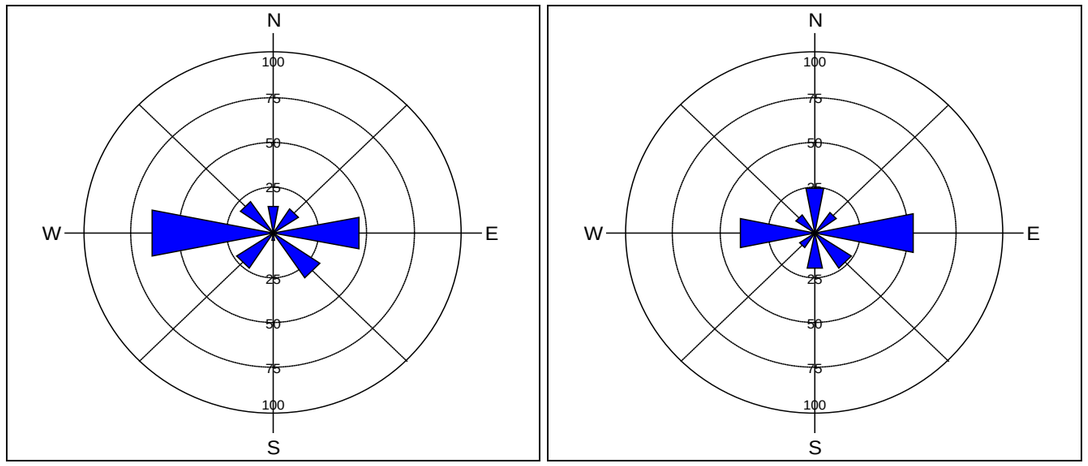


Figure 3.112 A comparison of temporal variation in density of puffin in the Hornsea Survey Area and wider figures from Stone *et al*., 1995.

3.7.483 Foraging behaviour was recorded for 351 puffins in the Hornsea Survey Area on baseline surveys, with five types of foraging behaviour recorded, and no behaviour recorded for a further six foraging birds (Table 3.61). The majority of all foraging birds were recorded pursuit diving (78.3%).

3.7.484 The density distribution maps for puffin cover the periods April to July, August to October and November to March for Years 1 and 2 in Subzone 1 and 4 km buffer and for the Hornsea Zone (Appendix B). Puffin was observed throughout Subzone 1 and the 4 km buffer, showing even distributions in the winter, spring, and late autumn, and favouring the western half of Subzone 1 during the summer.



April to July (n=220 birds) September to March (n=197 birds)

Numbers shown on figures are number of birds recorded.

Figure 3.113 Flight direction of puffins in the Hornsea Survey Area in Years 1 and 2.

Table 3.61 Puffin foraging behaviour in the Hornsea Survey Area in Years 1 and 2.

Feeding activity recorded	Number of foraging birds	% of total foraging birds
Actively searching	49	14.0
Holding fish	9	2.6
Pursuit diving	275	78.3
Pursuit plunging	9	2.6
Surface seizing	3	0.9
Feeding – method unspecified	6	1.8
Total	351 birds	

Unidentified 'Guillemot/Razorbill's

3.7.485 Like gulls, auks can be difficult to identify at sea (Stone *et al.*, 1995). Often auks can be categorised as 'guillemot/razorbill' where they cannot be identified to species level.

3.7.486 In Year 1 a total of 20,301 'guillemot/razorbill's were recorded, 11,969 in Subzone 1 and 4 km buffer, and 8,332 in the Hornsea zone and 10 km buffer. In Year 2 a greater overall number were recorded, with only 7,366 in Subzone 1 and 4 km buffer, and 20,308 in the Hornsea Zone and 10 km buffer, giving a total of 27,674.

3.7.487 In Year 1 in Subzone 1 and 4 km buffer, the peak count during the breeding season was 116 birds in April. In the non-breeding season this was much higher at 8,634 birds in September. In Year 2 the breeding season peak count was similar at 182 birds in April, and the non-breeding peak count was in August with 3,235 recorded.

3.7.488 In Year 1 the Hornsea Zone and 10 km buffer, the peak breeding season count was in April, with 253 birds recorded. The peak non-breeding season count was in September with 3176 recorded. In Year 2 the breeding season peak count was in June, with 881 birds recorded, and the non-breeding peak was in August, with 14,147 recorded.

3.7.489 'Unidentified guillemot/razorbill' densities from three North Sea areas from Stone *et al.* (1995) which overlap with the Hornsea Survey Area are presented in Table 3.62.

3.7.490 Density figures are fairly low for the mean of the three areas, with the peak being 0.55 birds/km^2 in August The highest density overall is seen in Area 4 ('western North Sea') with a peak of 1.63 birds/km^2 in August.

3.7.491 A total of 3,185 'guillemot/razorbill's were recorded in flight, but none of these birds were recorded as flying above heights above 22.5 m.

Table 3.62 North Sea 'unidentified guillemot/razorbill' densities from Stone *et al*. (1995).

Month	Area 4 – western North Sea (km^2)	Area 5 – central and north North Sea (km^2)	Area 6 – south and east North Sea (km^2)	Mean (km^2)
January	0.12	0.05	0.22	0.13
February	0.25	0.09	0.13	0.16
March	0.11	0.01	0.06	0.06
April	0.06	0	0.01	0.02
May	0.08	0.01	0	0.03
June	0.36	0	0	0.12
July	0.26	0	0	0.09
August	1.63	0.03	0	0.55
September	0.15	0.01	0	0.05
October	0.45	0.20	0.08	0.24
November	0.67	0.13	0.51	0.44
December	0.09	0.15	0.16	0.13

4 SUMMARY

4.7.1 Based on the information in Section 3.4 on species' sensitivity to recognised offshore wind farm impacts, and the results laid out in each species account in Section 3.7, a group of key species has been taken forward for Impact Assessment in Volume 2, Chapter 5: Ornithology. These are:

- Fulmar;
- Gannet;
- Arctic skua;
- Great skua;
- Little gull;
- Lesser black-backed gull;
- Herring gull;
- Great black-backed gull;
- Kittiwake;
- Common tern;
- Arctic tern;
- Guillemot;
- Razorbill; and
- Puffin.

4.7.2 This list of species was agreed during Phase 4 consultation with JNCC and Natural England (13 March 2013), and the rationale behind this selection is presented below. Essentially, the species that have been identified as being sensitive to the likely impacts associated with offshore wind farms (either due to conservation status of the species, or inherent behaviour of individuals), and found in numbers that reach significance at least at a regional scale, have been taken forward for assessment.

4.7.3 Table 4.1 provided an initial coarse filter for inclusion of species to be taken forward for impact assessment. The selection criteria were informed by the Institute of Ecology and Environmental Management's (IEEM) (2010) guidance and categorisation for inclusion within the Birds of Conservation Concern (Eaton *et al.,* 2009). This included at least one of the following:

- A qualifying species of a SPA within foraging range during the breeding season or where non-trivial connectivity may exist during migration or winter with more distant SPAs;

- A species appearing on Annex 1 of the Birds Directive and/or on Schedule 1 to the Wildlife and Countryside Act 1981;
- The UK supports an internationally-important population of the species;
- There has been a significant long-term decline in breeding population and/or range within the UK;
- The majority of the UK breeding population is localised in ten or fewer sites;
- The species (migratory) is at particular risk of collisions with turbines; and/or
- There is a population within Subzone 1 and 4 km buffer deemed sufficiently large as to be of international or national or regional importance.

4.7.4 Estimates are for the Subzone 1 and 4 km buffer, and are therefore likely to be higher than for the Project One footprint alone. For species with too few records to allow robust calculations of population estimates using Distance sampling, raw count totals have been extrapolated to create population estimates using correction factors recommended in Stone *et al.* (1995).

4.7.5 A decision on whether a particular species should be taken forward to the impact assessment stage in Volume 2, Chapter 5: Ornithology was then made, based on a combination of the above criteria.

4.7.6 National threshold figures refer to breeding or non-breeding 1% thresholds for national importance, with the relevant figure depending on the month of the peak estimate. Under the Ramsar Convention on Wetlands of International Importance, a site is considered internationally important if it regularly supports 1% of a population of a species. Similar criteria have been used for identification of SPAs in the UK, where a site may be considered nationally important if it holds 1% or more of UK numbers of a species (Collier *et al.*, 2005). Although some 1% thresholds are low, a value of 50 individuals is normally used as a minimum threshold in the British Trust for Ornithology's (BTO) Wetland Bird Survey (WeBS) reports (Holt *et al.,* 2012), and is considered relevant here.

4.7.7 Winter thresholds are taken from values given in the most recent WeBS report (Holt *et al.,* 2012). For species where no national winter thresholds were specified, national importance was determined using 1% British population thresholds of winter population estimates in BTO BirdFacts [http://www.bto.org/about-birds/birdfacts]. Where no winter estimate is known, and species can be found in Britain during this period, the breeding figure from BTO BirdFacts is used as a surrogate. Where these figures are originally given in pairs, the 1% threshold was calculated by doubling the figure to estimate the number of individuals, then dividing that figure by 100.

4.7.8 Regional breeding population estimates are taken from seabird colony counts in the JNCC Seabird Monitoring Programme database and Natural England data, for all breeding pairs occurring within the mean maximum, or maximum foraging range as applicable (from Thaxter *et al*., 2012 except where indicated) of each species from the Subzone 1 and 4 km buffer. Where species did not breed within the area regional breeding population estimates were not applicable. Assessment of importance is therefore based on their wintering or passage populations only.

4.7.9 During the non-breeding period, birds from colonies further afield may be present although it is difficult to determine how many individuals from each of the colonies will be impacted. Following advice from JNCC/Natural England (NE) (Meeting 3 October 2012), the distance the colony is from Project One is not taken into consideration. For the purposes of this assessment, and in agreement with JNCC/NE, the regional populations and colonies assessed during the non-breeding period is the whole of UK east coast population from Hermaness (in Shetland) to Sandwich Bay (in Kent).

4.7.10 During the post-breeding period the region considered will be considerably smaller as birds present during this period are likely to be from more local colonies. The assessment of impacts during the post-breeding period is only undertaken on auks and gannet as these species are concentrated in areas near to their breeding colonies immediately after leaving the nesting cliffs. Other species disperse more widely immediately following breeding and therefore do not have a distinct post-breeding period. For these species (e.g. gulls), the periods assessed are breeding and non-breeding only. For the purposes of this assessment the regional population and the colonies of the auk species assessed during the post-breeding period is based on breeding populations between Humber Flats and the Farne Islands, from the Seabird Monitoring Programme database and Natural England data.

4.7.11 Since birds may come from a wide variety of locations outside of the breeding season, species' flyway populations have also been considered where required. Estimates are taken from Stienen *et al.* (2007), BirdLife International (2004) or BTO BirdFacts, depending on the most recent value.

Table 4.1 A summary of the conservation importance and peak populations of all species recorded in Subzone 1 and the 4 km buffer in relation to national and regional thresholds.

Species	SPA connectivity	Conservation Status	% of flights >22.5 m	Foraging range		Breeding season			Winter/Passage			Taken forward for impact assessment?
				Mean maximum (km)	Maximum (km)	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	
Red-throated diver	-	Annex 1; Schedule 1; Amber; SPEC	0%	9[1]	9[1]	75 § (May)	26*	N/A	28 § (Oct)	170	121 **	NO – non-breeder and wintering threshold unlikely to be met at any stage, with highest numbers during passage. Low collision risk.
Black-throated diver	-	Annex 1; Schedule 1; Amber; BR; WR; SPEC	11.1%	Unknown	Unknown	43 § (April)	4*	N/A	7 § (Oct)	6*	Unknown	NO – non-breeder and wintering threshold (50 birds) unlikely to be met at any stage, with highest numbers during passage.
Fulmar	YES	Amber; BDMp	<0.1%	400[1]	580[1]	3,171 (Jun)	9,980	248	541 (Sep)	9,980	7,217	YES – SPA species within foraging range, regional importance, breeding.
Sooty shearwater	-	Not assessed (UK)	0%	Unknown	Unknown	0	N/A	N/A	218 (Oct)	Unknown	Unknown	NO – birds present on passage only, no conservation status in UK. Low collision risk.
Manx shearwater	-	Amber; BDMr; BL; BI	0.9%	330[1]	330[1]	64 § (Sep)	5,900	N/A	7 § (Apr)	5,900	Unknown	NO – low peak estimates in comparison with UK breeding and wider migratory population. Low collision risk.
Balearic shearwater	-	Annex 1; IUCN	N/A	34[2]	200[2]	0	N/A	N/A	0	Unknown	Unknown	NO – very low peak counts. Low collision risk.
Storm petrel	-	Annex 1; Amber; BL	0%	>65[1]	>65[1]	7 § (Jul and Aug)	520	N/A	27 § (Nov)	520	45*	NO – very low peak estimates, low collision risk.

Species	SPA connectivity	Conservation Status	% of flights >22.5 m	Foraging range		Breeding season			Winter/Passage			Taken forward for impact assessment?
				Mean maximum (km)	Maximum (km)	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	
Gannet	YES	Amber; BL; BI	5.0% $	229.4[1]	590[1]	805 (Sep)	4,380	199	827 (Oct)	4,380	2,137	YES – SPA species within foraging range, regional importance, breeding.
Cormorant	-	Green	9.1%	25[1]	35[1]	0	167	N/A	7 § (Mar and Nov)	350	8*	NO – very low peak estimates.
Shag	-	Amber; BDMp; BL; BI	0%	14.5[1]	17[1]	0	270	N/A	7 § (Nov)	1,100	123	NO – very low peak estimates.
Eider	-	Amber; WDMp	0%	38.3[2]	100[2]	0	550	N/A	21 § (Jan)	550	Unknown	NO – very low peak estimates.
Common scoter	-	Schedule 1; Red; BDp; BDMr; BR; WL	1.2%	8.2[2]	200[2]	185 § (Aug)	50	N/A	199 § (Nov)	1,000	600-800**	NO – non-breeder and winter regional threshold (600-800 birds) unlikely to be regularly met. Very low collision risk.
Grey phalarope	-	Not assessed (UK)	0%	Unknown	Unknown	0	N/A	N/A	145 § (Oct)	Unknown	Unknown	NO – brief presence, no conservation status in UK. Very low collision risk.
Pomarine skua	-	Not assessed (UK)	9.5%	Unknown	Unknown	0	N/A	N/A	30 § (May)	Unknown	Unknown	NO –low peak counts, no conservation status in UK.
Long-tailed skua	-	Not assessed (UK)	0%	Unknown	Unknown	0	N/A	N/A	7 § (Oct)	Unknown	Unknown	NO – very low peak counts, no conservation status in UK.
Arctic skua	YES (migratory only)	Red; BDp	3.8% π	62.5[1]	75[1]	61 § (Aug)	42*	N/A	142 § (Sept)	42*	29*	YES - migratory species with large proportion in SPAs, possible regional/ national importance.

Species	SPA connectivity	Conservation Status	% of flights >22.5 m	Foraging range		Breeding season			Winter/Passage			Taken forward for impact assessment?
				Mean maximum (km)	Maximum (km)	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	
Great skua	YES (migratory only)	Amber; BL; BI	4.3% π	86.4[1]	219[1]	34 § (Aug)	192	N/A	144 § (Sept)	192	189	YES - migratory species with large proportion in SPAs, possible regional/ national importance.
Little gull	-	Annex 1; Schedule 1; SPEC	0.6% $	23.58[2]	50[2]	0	N/A	N/A	12,226 (Oct)	750 (flyway pop.)**	300**	YES - migratory species, up to international importance, non-breeding.
Sabine's gull	-	Not assessed (UK)	0%	Unknown	Unknown	5 § (Sep)	N/A	N/A	0	Unknown	Unknown	NO – very low peak estimates, no conservation status in UK.
Black-headed gull	-	Amber; WDMp; WI	0.3%	25.5[1]	40[1]	55 § (Aug)	2,560	N/A	704 § (Oct)	22,000	3,700**	NO – low peak estimates compared to thresholds.
Common gull	-	Amber; WI; SPEC	6.7%	50[1]	50[1]	106 § (Jul)	960	N/A	262 § (Feb)	7,000	450**	NO –low peak estimates compared to thresholds.
Lesser black-backed gull	-	Amber; BL; BI	17.8% $	141[1]	181[1]	330 (Aug)	2,200	33*	125 (Apr)	1,200	1,250**	YES – high peak estimates compared to thresholds, although August estimate likely to have large proportion of migrant birds.
Herring gull	YES (possible maximum foraging range)	Red; BDp; WDp; BDMp	31.3% $	61.1[1]	92[1]	38 (Apr)	2,620	14*	234 (Oct)	7,300	844	YES – low peak estimates but possible connectivity with SPA.
Great black-backed gull	-	Amber; WDMp	27.4% $	Unknown	40 [3]	258 (Apr)	340	N/A	477(Oct)	760	162	YES - Regional importance, non-breeding.
Kittiwake	YES	Amber; BDMp; BL	3.7% $	60[1]	120[1]	4,095 (Jun)	7,340	890	52,946 (Sep)	7,340	4,391	YES - SPA, species within foraging range, National importance.

Species	SPA connectivity	Conservation Status	% of flights >22.5 m	Foraging range		Breeding season			Winter/Passage			Taken forward for impact assessment?
				Mean maximum (km)	Maximum (km)	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	Peak population in Subzone 1 and 4 km buffer (month)	National 1% threshold	Regional 1% threshold	
Sandwich tern	-	Annex 1; Amber; BDMr; BL; SPEC	0%	49[1]	54[1]	14 § (Jul)	220	N/A	6 § (Mar)	220	185	NO – very low peak estimates, very low collision risk.
Common tern	YES (migratory only)	Annex 1; Amber; BL	12.7% π	15.2[1]	30[1]	1,339 (Sep)	200	N/A	125 (Oct)	200	130	YES - migratory species with nearby SPAs, National importance.
Arctic tern	YES (migratory only)	Amber; BDMr	2.8% π	24.2[1]	30[1]	765 § (Aug)	1,060	N/A	30 § (Oct)	1,060	872	YES - migratory species with nearby SPAs,
Guillemot	YES	Amber; BL; BI	0%	84.2[1]	135[1]	6,895 (Jun)	26,000	832	42,034 (Oct)	26,000	8,618	YES – SPA species within foraging range, national importance, non-breeding.
Razorbill	YES (possible maximum foraging range)	Amber; BL	0%	48.5[1]	95[1]	712 (Jun)	3,280	211	15,241 (Oct)	3,280	774	YES - National importance, non-breeding population.
Little auk	-	Not assessed (UK)	0%	Unknown	Unknown	0	N/A	N/A	911 (Nov)	Unknown	Unknown	NO – migrant, no conservation status in UK, low collision risk.
Puffin	YES	Amber; BL; SPEC	0%	105.4[1]	200[1]	2,842 (Apr)	11,580	10*	2,533 (Nov)	11,580	4,268	YES – SPA species within foraging range, regional importance.

§ = scaled population estimates using correction factors in Stone *et al*. (1995), taken from raw count totals of birds on the water, added to those birds in flight during snapshot.

$ = proportion of flights at risk height taken from values used in collision risk modelling, as presented Appendix C. These are based on observed flight heights from ship-based surveys carried out at Hornsea Subzone 1 between March 2010 and February 2012. Taken as proportion of birds in categories 25-150 m. For all other species, insufficient data required flight heights from the wider Hornsea Survey area to be considered (see Table 3.2).

π - Proportion of flights at risk height taken from values used in APEM migratory collision risk modelling, taken from Cook *et al*. (2012). These provided higher mortality rates than estimated using the standard Band (2012) model.

* = 50 individuals is normally used as a minimum threshold;

** = regional winter population taken from Stienen *et al.* (2007) based on value of maximal numbers migrating through the Strait of Dover. Where used, these estimates are considered to be more accurate than Seabird 2000 coastal counts as they include all birds likely to be present in southern North Sea, including those that breed inland but may migrate offshore;

Regional winter red-throated diver population estimated to be 12,175 birds in O'Brien *et al.* (2008), based on aerial surveys from Shetland to Kent;

[1] = from Thaxter *et al*. (2012);

[2] = from Langston (2010);

[3] = from Ratcliffe (2000);

Annex I = birds listed on Annex I of the EU Birds Directive;

Schedule 1 = birds listed on Schedule 1 of the Wildlife and Countryside Act 1981;

Conservation status taken from Eaton *et al*. (2009);

IUCN = Species listed by BirdLife International as being Globally Threatened using IUCN criteria;

HD = Historical Decline in UK;

BDp = Breeding Population Decline in UK of more than 50% over 25 years;

WDp = Non-breeding Population Decline in UK of more than 50%, over 25 years;

BDr = Breeding Range Decline in UK of more than 50%;

BDMp = Breeding Population Decline in UK by more than 25% but less than 50%;

WDMp Non-breeding Population Decline in UK by more than 25% but less than 50%;

BDMr = Breeding Range Decline by more than 25% but less than 50%;

BR = UK breeding population of less than 300 pairs;

BL and WL Localisation = at least 50% of the UK breeding (BL) or non-breeding (WL) population found in 10 or fewer sites;

BI and WI International Importance = at least 20% of the European breeding (BI) or non-breeding (WI) population found in the UK.

REFERENCES

Barton C., Pollock C. and Harding N. (2009) *Arklow Bank Seabird* and *Marine Mammal Monitoring Programme Year 8 Final Report:* July 2007 to June 2008. A report to Airtricity.

BERR (2007). *Aerial surveys of waterbirds in Strategic Wind Farm Areas: 2005/2006 Final Report.* Department of Business, Environment and Regulatory Reform, London.

Birdlife International (2004) *Birds in Europe: population estimates, trends and conservation status*. Cambridge, UK: Birdlife International. (Birdlife Conservation Series No. 12).

BirdLife International (2011) *Birdlife International Seabird Foraging Range* Database. http://seabird.wikispaces.com/home

BirdLife International (2012) Species factsheet: *Melanitta nigra*. Downloaded from http://www.birdlife.org on 08/11/2012.

BirdLife International (2012) *Species factsheet: Puffinus mauretanicus*. Downloaded from http://www.birdlife.org on 31/07/2012.

BirdLife International (2012) Species factsheet: *Uria aalge*. Downloaded from http://www.birdlife.org on 08/11/2012.

BirdLife International (2011). IUCN Red List for birds. Downloaded from http://www.birdlife.org on 14/06/2011.

Calbrade N., Holt C., Austin G., Mellan H., Hearn R., Stroud D., Wotton S. and Musgrove A. (2010). *Waterbirds in the UK* 2008/09: The Wetland Bird Survey. BTO, WWT, RSPB and JNCC. Available online at: http://www.bto.org/webs/news/AR08_09/index.htm.

Camphuysen C.J., Fox T., Leopold M.F. and Petersen I.K. (2004) *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK*. A report for COWRIE.

Carter I.C., Williams J.M., Webb A. and Tasker M.L. (1993) *Seabird concentrations in the North Sea: an atlas of vulnerability to surface pollutants*. Joint Nature Conservation Committee, Peterborough.

DECC (2009). *Aerial Surveys of Waterbirds in the UK: 2007/08, Final Report*. Department of Energy and Climate Change, London.

DTI (2006). *Aerial Surveys of Waterbirds in Strategic Windfarm Areas: 2004/05, Final Report*. Department of Trade and Industry, London.

Eaton M.A., Brown A.F., Noble D.G., Musgrove A.J., Hearn R., Aebischer N.J., Gibbons D.W., Evans A. and Gregory R.D. (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*. British Birds.*

Forrester R.W., Andrews I.J., McInerny C.J., Murray R.D., McGowan R.Y., Zonfrillo B., Betts M.W., Jardine D.C. and Grundy D.S. (eds) (2007) *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Geelhoed, S. Scheidat, M. Aarts, G., van Bemmelen, R., Janinhoff, N., Verdaat, H. and Witte, R. (2011). Shortlist Masterplan Wind Aerial surveys of harbour porpoises on the Dutch Continental Shelf. IMARES Wageningen UR, Institute for Marine Resources & Ecosystem Studies.

Harris M.P. (1984) *The Puffin*. T and A.D. Poyser, Calton.

Holling M. and Rare Breeding Birds Panel (2010). *Rare breeding birds in the United Kingdom* in 2007. *British Birds*, Vol 103. p. 2-52. Available online at: http://www.rbbp.org.uk/downloads/rbbp-report-2007.pdf.

Holt C., Austin G., Calbrade N., Mellan H., Mitchell C., Stroud D., Wotton S. and Musgrove A. (2011). *Waterbirds in the UK 2009/10*: The Wetland Bird Survey. BTO, WWT, RSPB and JNCC. Available online at: http://www.bto.org/volunteer-surveys/webs/publications/wituk-200910.

Holt C., Austin G., Calbrade N., Mellan H., Hearn R., Stround D., Wotton S., and Musgrove A. (2012) *Waterbirds in the UK 2010/2011*: The Wetland Bird Survey. British Trust for Ornithology.

IPC (2010) Scoping Opinion for Hornsea Project One.

PINS (2012). Scoping Opinion, Proposed Hornsea Project One. Second Scoping Opinion, May 2012. The Planning Inspectorate.

IEEM (2010) G*uidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal*. Institute of Ecology and Environmental Management, Winchester.

JNCC (2011). *Online species accounts for SPA species*. Available online at: http://www.jncc.gov.uk/page-1419.

Jones L. A., Coyle M. D., Evans D., Gilliland P.M., and Murray A. R., (2004) *Southern North Sea Marine Natural Area Profile: A contribution to regional planning and management of the seas around England*. English Nature, Peterborough.

Kober K., Webb A., Win I., Lewis M., O'Brien S., Wilson L.J., Reid J.B. 2010. *An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs*. JNCC Report, No. 431.

Lack P. (Ed). (1986) *The atlas of wintering birds in Britain and Ireland.* T and A.D. Poyser, Calton.

Langston R.H.W. (2010). *Offshore wind farms and birds*: Round 3 zones, extensions to Round 1 and 2 sites and Scottish Territorial Waters. RSPB Research Report No. 39.

Mitchell P.I., Newton S.F., Ratcliffe N. and Dunn T.E. (2004) *Seabird populations of Britain and Ireland*. T and AD Poyser, London.

Murray S. (2011) *An aerial survey of the Bass Rock gannetry in 2009*. Scottish Birds 31.3. p. 220-225/

Musgrove, A.J., Austin, G.E., Hearn, R.D, Holt, C.A., Stroud, D.A. and Wotton, S.R. (2011). Overwinter population estimates of British waterbirds. *British Birds*, 104, p 364-397.

O'Brien S.H., Wilson L.J., Webb A. and Cranswick P.A. (2008). *Revised estimate of numbers of wintering Red-throated Divers Gavia stellata in Great Britain*. Bird Study 55, 152-160.

Pennington M., Osborn K., Harvey P., Riddington R., Okill D., Ellis P. and Heubeck M. (2004) *Birds of Shetland*. Christopher Helm.

Petersen I.K. (2005) *Bird numbers and distribution in the Horns Rev offshore wind farm area*. Annual status report 2004. NERI Report commissioned by Elsam Engineering A/S.

Philips R.A., Petersen M.K., Lilliehendhal K., Solmundsson J., Hamer K.C., Camphuysen C.J. and Zonfrillo, B. (2009). *Diet of the northern fulmar Fulmarus glacialis: Reliance on commercial fisheries*? Marine Biology: Vol 135, 1. p 159 – 170.

RSPB (2009) *Birds of Conservation Concern 3*. Available online at: http://www.rspb.org.uk/Images/BoCC_tcm9-217852.pdf

RSPB (2011) Online A-Z of UK birds. Available online at: http://www.rspb.org.uk/wildlife/birdguide/name/a/

SMart Wind, (2010) Hornsea Project One Environmental Impact Assessment Scoping Report. November 2010.

SMart Wind, (2011) Hornsea Year 1 Technical Survey Report – Birds. Report from EMU to SMart Wind, ref 11/j/1/03/1762-3/1159.

SMart Wind (2012). Hornsea Offshore Wind Farm Project One Preliminary Environmental Information Report Volume 2 – Offshore.

SMP (Seabird Monitoring Programme) (2012). Online Database. Available at: http://www.jncc.gov.uk/smp/

Snow D.W. and Perrins, C.M. (Eds). (1998). *The Birds of the Western Palearctic.* Volume 1. Concise Edition. Oxford University Press.

Stienen E.W.M., Van Waeyenberge J., Kuijken E. and Seys J. (2007) Trapped within the corridor of the Southern North Sea: the potential impact of offshore wind farms on seabirds. In: Birds and Wind Farms - Risk assessment and Mitigation (eds. de Lucas M., Janss G.F.E. and Ferrer M.), p71-80. Quercus, Madrid, Spain.

Stone C.J., Webb A., Barton C., Ratcliffe N., Redd T.C., Tasker M.L., Camphuysen C.J. and Pienkowski M.W. (1995) *An atlas of seabird distribution in north-west European waters. Joint Nature Conservation* Committee and Nederlands Institute voor Onderzoek der Zee, Peterborough.

Thaxter C.B., Lascelles B., Sugar K., Cook A.S.C.P., Roos S., Bolton M., Langston R.H.W., and Burton N.H.K. (2012) *Seabird foraging ranges as a tool for identifying candidate marine protected areas.*

Thomas C. (2011) *Yorkshire Bird Report 2009*. Yorkshire Naturalists Union.

Webb A. and Durinck J. (1992). *Counting birds from ships. In: Manual for aeroplane and ship surveys of waterfowl and seabirds,* eds. J. Komdeur, J. Bertelsen and G. Cracknell, 24-37. Slimbridge, I.W.R.B. Special Publication No.19.

Wernham C.V., Toms M.P., Marchant J.H., Clark J.A., Sirwardena G.M. and Baillie S.R. (Eds). (2002) *The Migration Atlas: movement of the birds of Britain and Ireland*. T and AD Poyser.

APPENDIX A – SURVEY DATA AND DISPLACEMENT MATRICES

Monthly survey effort in relation to Sea State

Table A.1 Sea State during surveys in the Hornsea Survey Area in Years 1 and 2.

Month	Year 1			Year 2		
	Sea State	km travelled	%	Sea State	km travelled	%
March	1	12.14	0.9	1	227.2	11.3
	2	245.12	18.0	2	634.0	31.6
	3	682.09	50.1	3	833.9	41.5
	4	419.0	30.8	4	311.9	15.5
	5	2.11	0.2	5	0	0
April	0	11.63	0.9	0	179.0	8.8
	1	301.73	22.2	1	388.7	19.1
	2	472.89	34.8	2	557.1	27.4
	3	286.87	21.1	3	688.8	33.9
	4	287.47	21.1	4	217.8	10.7
May	1	139.12	10.2	1	17.3	0.9
	2	408.43	29.9	2	309.7	15.3
	3	532.75	39.0	3	1,064.2	52.4
	4	284.93	20.9	4	639.2	31.5
June	0	151.82	11.1	0	9.8	0.4
	1	641.85	46.9	1	170.0	6.9
	2	217.61	15.9	2	626.2	25.6
	3	225.29	16.5	3	1,098.4	44.9
	4	132.01	9.6	4	544.0	22.2
July	0	19.93	1.5	0	38.6	1.5
	1	313.5	22.8	1	466.5	18.4
	2	462.53	33.7	2	409.3	16.2
	3	404.36	29.4	3	815.1	32.2
	4	174.13	12.7	4	803.0	31.7
August	0	3.74	0.3	0	116.4	4.5
	1	65.94	4.8	1	263.4	10.2
	2	231.7	16.7	2	715.7	27.7
	3	571.9	41.3	3	1,295.1	50.2
	4	510.05	36.9	4	188.6	7.3
September	1	429.32	23.5	1	94.1	13.5
	2	665.59	36.4	2	248.7	35.7
	3	430.5	23.5	3	304.0	43.6
	4	302.79	16.6	4	49.7	7.1
October	1	152.72	11.1	1	14.3	1.3
	2	414.91	30.3	2	306.6	27.5
	3	537.73	39.2	3	482.5	43.3
	4	265.03	19.3	4	310.2	27.9
November	1	93.12	8.4	1	0	0
	2	382.91	34.7	2	79.6	5.6
	3	410.24	37.2	3	440.7	31.2
	4	217.58	19.7	4	893.0	63.2
December	0	6.35	0.5	1	0	0
	1	71.56	5.9	2	0	0
	2	429.72	35.7	2	38.4	20.0
	3	394.46	32.7	3	68.7	35.8
	4	282.74	23.5	4	84.8	44.2
	5	19.68	1.6	5	0	0
January	1	37.67	3.7	1	48.4	5.0
	2	380.25	37.2	2	246.9	25.6
	3	350.95	34.3	3	293.6	30.4
	4	253.18	24.8	4	376.6	39.0
	5	0	0	5	0.2	0.02
February	1	0	0	1	12.0	1.1
	2	80.95	13.4	2	189.7	17.6
	3	312.1	51.7	3	363.9	33.7
	4	210.41	34.9	4	504.6	46.8
	5	0	0	5	8.0	0.7

Monthly species totals

Table A.2 Numbers of seabirds recorded on surveys in Subzone 1 area (and 4 km buffer) in Year 1 (raw numbers, all Sea States).

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Red-throated diver	1	2	2	0	0	0	0	0	1	0	0	0	6
Black-throated diver	0	2	0	0	0	0	0	0	0	1	0	0	3
Unidentified divers	1	0	0	0	0	0	0	0	1	2	0	0	4
Great crested grebe	0	0	0	0	0	0	0	0	0	1	0	0	1
Black-necked grebe	0	0	0	0	0	0	0	0	0	1	0	0	1
Fulmar	212	62	426	263	96	188	230	31	86	136	85	95	1,910
Sooty shearwater	0	0	0	0	0	0	81	46	2	0	0	0	129
Manx shearwater	0	1	0	3	4	4	15	0	0	0	0	0	27
Storm petrel	0	0	0	0	0	0	1	0	3	1	0	0	5
Gannet	261	96	30	83	44	273	494	511	348	51	175	243	2,609
Cormorant	1	0	0	0	0	0	0	0	0	0	0	0	1
Common scoter	0	12	0	0	0	11	26	0	31	0	0	0	80
Grey phalarope	0	0	0	0	0	0	1	1	0	0	0	0	2
Pomarine skua	0	2	2	0	0	2	2	0	3	0	0	0	11
Arctic skua	0	0	0	1	1	5	34	6	2	0	0	0	49
Long-tailed skua	0	0	0	0	0	0	0	2	0	0	0	0	2
Great skua	1	1	0	0	0	9	10	4	2	1	1	0	29
Unidentified skuas	0	0	0	0	0	0	1	0	0	0	0	0	1
Little gull	0	6	0	0	0	0	73	2,929	388	0	0	0	3,396
Sabine's gull	0	0	0	0	0	0	1	0	0	0	0	0	1
Black-headed gull	0	0	0	1	5	0	5	2	0	0	0	0	13
Common gull	15	5	2	2	2	3	18	14	10	9	5	10	95
Unidentified small gulls	0	0	0	6	0	0	0	0	100	0	0	0	106
Lesser black-backed gull	7	31	28	60	200	135	9	9	0	22	0	8	509
Herring gull	20	10	2	5	3	1	4	8	27	64	50	21	215
Great black-backed gull	75	11	6	5	15	29	87	86	74	141	163	132	824
Large gull species	5	0	2	6	44	5	510	0	3	494	290	13	1,372
Kittiwake	629	226	164	1,274	715	2,856	3,281	605	1,482	280	186	455	12,153

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Sandwich tern	0	0	0	0	0	0	1	0	0	0	0	0	1
Common tern	0	0	3	23	0	34	637	53	0	0	0	0	750
Arctic tern	0	0	2	0	0	89	1	4	0	0	0	0	96
Common/Arctic tern	0	0	16	0	0	4	1,047	0	0	0	0	0	1,067
Guillemot	412	578	442	666	1,732	2,494	5,886	4,689	2,360	1,745	737	536	22,277
Razorbill	587	381	49	116	451	8	2,625	1,841	348	651	195	227	7,479
Little auk	0	0	0	0	0	0	0	0	95	16	14	0	125
Puffin	51	104	89	273	2	7	181	186	112	79	77	27	1,188
Guillemot/razorbill	108	116	25	85	112	15	8,634	1,549	680	382	149	114	11,969
Unidentified auks	10	7	9	178	26	0	0	0	20	13	12	5	280
Total numbers	**2,396**	**1,653**	**1,299**	**3,050**	**3,452**	**6,172**	**23,895**	**12,576**	**6,178**	**4,090**	**2,139**	**1,886**	**68,786**

Table A.3 Numbers of seabirds recorded on surveys in Subzone 1 area (and 4 km buffer) in Year 2 (raw numbers, all Sea States).

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Red-throated diver	0	0	7	2	0	0	0	4	0	0	0	0	13
Black-throated diver	0	5	0	0	0	0	0	1	0	0	0	0	6
Unidentified divers	0	3	1	0	0	0	0	0	0	0	0	0	4
Fulmar	91	98	298	1,358	354	97	139	122	10	21	133	85	2,806
Sooty shearwater	0	0	0	0	0	1	2	1	0	0	0	0	4
Manx shearwater	0	0	1	5	4	6	1	0	0	0	0	0	17
Balearic shearwater	0	0	0	0	2	0	0	0	0	0	0	0	2
Storm petrel	0	0	0	0	0	1	0	0	4	0	0	0	5
Gannet	180	95	61	87	265	229	218	564	354	2	74	46	2,175
Cormorant	0	1	0	0	0	0	0	0	1	0	0	0	2
Shag	0	0	0	0	0	0	0	0	1	0	0	0	1
Eider	2	0	0	0	0	0	0	0	0	0	3	0	5
Common scoter	0	7	0	0	119	27	2	2	29	0	0	0	186
Red-breasted merganser	0	0	0	0	0	0	0	0	2	0	0	0	2
Grey phalarope	0	0	0	0	0	0	3	13	0	0	0	0	16
Pomarine skua	0	0	2	0	1	0	0	0	0	0	0	0	3
Arctic skua	0	0	1	2	4	8	15	1	0	0	0	0	31

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Great skua	1	1	0	1	4	5	16	9	5	1	1	0	44
Unidentified skuas	0	0	0	0	0	1	0	0	0	0	0	0	1
Little gull	0	0	0	0	4	4	37	64	29	0	0	8	146
Black-headed gull	4	0	2	0	2	2	33	95	8	0	0	2	148
Common gull	7	39	2	0	0	5	10	20	25	0	8	26	142
Unidentified small gulls	0	0	1	0	0	25	0	0	0	0	0	0	26
Lesser black-backed gull	13	99	110	97	21	51	19	8	1	0	16	0	435
Herring gull	22	25	16	0	0	0	0	2	24	3	7	23	122
Great black-backed gull	134	153	72	56	24	80	165	83	119	21	127	81	1,115
Large gull species	81	42	32	37	0	4	248	11	7	0	7	2	471
Kittiwake	488	623	352	1,252	2,002	1,229	3,254	448	229	40	192	162	10,271
Sandwich tern	1	2	0	0	2	0	0	0	0	0	0	0	5
Common tern	0	0	31	0	5	254	2	0	0	0	0	0	292
Arctic tern	0	0	94	0	3	21	2	2	0	0	0	0	122
Common/Arctic tern	0	0	162	0	3	2,070	1	0	0	0	0	0	2,236
Black tern	0	0	1	0	0	0	0	0	0	0	0	0	1
Guillemot	747	988	709	1,053	2,043	1,639	2,277	1,052	294	94	265	450	11,611
Razorbill	415	512	63	162	108	1,574	1,152	587	279	27	240	207	5,326
Little auk	2	0	0	0	0	0	0	0	16	1	0	0	19
Puffin	80	100	23	15	10	345	187	33	226	3	10	88	1,120
Guillemot/razorbill	122	182	69	108	48	3,235	2,902	434	101	20	125	20	7,366
Unidentified auks	3	7	0	0	1	7	67	11	7	2	3	3	111
Total numbers	**2,393**	**2,982**	**2,110**	**4,235**	**5,029**	**10,920**	**10,752**	**3,567**	**1,771**	**235**	**1,204**	**1,203**	**46,408**

Table A.4 Numbers of seabirds recorded on surveys in the Hornsea Zone (and 10 km buffer) in Year 1 (raw numbers, all Sea States).

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Red-throated diver	4	4	1	0	0	0	0	1	1	4	0	0	15
Black-throated diver	1	0	0	0	0	0	0	0	0	0	0	0	1
Unidentified divers	3	2	0	0	0	0	0	0	0	0	0	0	5
Red-necked grebe	0	0	0	0	0	0	0	0	1	0	0	0	1
Fulmar	229	197	1,036	574	268	562	720	285	168	268	353	38	4,698

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Sooty shearwater	0	0	0	0	1	2	17	44	1	0	0	0	65
Manx shearwater	0	0	0	10	21	25	8	4	0	0	0	0	68
Balearic shearwater	0	0	0	0	0	1	0	0	0	0	0	0	1
Storm petrel	0	0	0	0	0	0	0	1	5	1	0	0	7
Leach's petrel	0	0	0	0	0	0	0	1	1	0	0	0	2
Unidentified petrels	0	0	0	0	0	0	0	1	0	0	0	0	1
Gannet	696	359	85	107	226	654	387	959	426	133	155	217	4,404
Cormorant	0	0	0	1	0	0	0	0	0	0	0	0	1
Shag	0	0	0	0	0	0	0	0	0	0	0	2	2
Eider	0	2	0	0	0	0	0	0	0	0	0	0	2
Common scoter	0	5	5	6	0	23	0	7	3	0	0	0	49
Grey phalarope	0	0	0	0	0	0	2	2	0	1	1	0	6
Pomarine skua	0	1	7	0	1	2	6	2	0	2	1	0	22
Arctic skua	0	0	2	0	0	1	19	5	1	0	0	0	28
Great skua	2	1	0	0	0	4	11	6	3	0	0	0	27
Unidentified skuas	0	0	0	1	0	0	1	1	0	0	0	0	3
Sabine's gull	0	0	0	0	0	0	0	1	0	0	0	0	1
Little gull	0	1	0	0	13	2	3	1,376	11	1	0	0	1,407
Black-headed gull	2	0	0	0	57	16	2	4	1	1	0	0	83
Common gull	27	19	2	0	14	8	14	29	16	47	18	13	207
Unidentified small gulls	1	0	0	0	0	0	0	0	0	0	0	0	1
Lesser black-backed gull	23	81	41	276	186	157	16	3	0	5	0	2	790
Herring gull	46	17	5	11	26	0	1	5	22	156	73	13	375
Great black-backed gull	248	85	35	115	24	144	236	430	171	298	429	108	2,323
Unidentified large gulls	308	6	69	367	51	345	28	907	256	64	414	3	2,818
Unidentified gulls	17	0	0	0	0	0	50	0	0	0	0	0	67
Kittiwake	874	941	122	1,395	5,478	3,664	674	1,452	809	496	453	307	16,665
Common tern	0	3	4	13	0	48	576	10	0	0	0	0	654
Arctic tern	0	0	4	0	0	134	3	0	0	0	0	0	141
Common/Arctic tern	0	0	9	6	0	28	517	0	0	0	0	0	560
Little tern	0	0	3	0	0	0	0	0	0	0	0	0	3

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Guillemot	419	1,116	746	904	3,460	5,252	4,544	3,430	1,434	1,618	914	289	24,126
Razorbill	326	628	121	200	1,634	1,530	1,087	1,243	203	624	216	146	7,958
Little auk	0	0	0	0	0	0	0	1	272	46	22	0	341
Puffin	46	132	83	115	15	61	151	379	156	69	65	35	1,307
Guillemot/razorbill	173	253	58	84	943	1,170	3,176	1,684	261	241	269	20	8,332
Unidentified auks	42	67	16	20	330	0	20	4	11	28	7	4	549
Total numbers	**3,487**	**3,920**	**2,455**	**4,205**	**12,748**	**13,833**	**12,269**	**12,277**	**4,233**	**4,103**	**3,390**	**1,197**	**78,116**

Table A.5 Numbers of seabirds recorded on surveys in the Hornsea Zone (and 10 km buffer) in Year 2 (raw numbers, all Sea States).

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Red-throated diver	3	19	7	0	0	0	0	0	0	0	0	0	29
Black-throated diver	2	0	0	0	0	0	0	0	1	0	0	0	3
Unidentified divers	0	2	0	0	0	0	0	0	0	0	0	0	2
Great crested grebe	0	0	0	0	0	0	0	1	0	0	0	0	1
Slavonian grebe	0	0	0	0	0	0	0	0	0	0	0	2	2
Fulmar	580	321	1,033	1,557	826	600	24	230	24	9	109	181	5,494
Sooty shearwater	0	0	0	1	0	4	0	2	0	0	0	0	7
Manx shearwater	0	1	1	27	25	18	0	0	0	0	0	0	72
Balearic shearwater	0	0	0	0	2	0	0	0	0	0	0	0	2
Cory's/great shearwater	0	0	0	0	0	0	0	1	0	0	0	0	1
Storm petrel	0	0	0	0	2	2	2	2	4	0	0	0	12
Leach's petrel	1	0	0	0	0	0	0	0	2	0	0	0	3
Gannet	795	359	114	1,201	1,475	1,111	143	1,876	1,775	2	86	365	9,302
Cormorant	2	4	0	0	0	1	0	0	0	0	0	0	7
Shag	2	0	0	0	0	0	0	0	0	0	0	0	2
Eider	1	0	0	0	0	0	0	0	1	0	0	0	2
Common scoter	61	3	11	0	15	4	0	0	5	0	0	5	104
Unidentified scoter	0	0	0	0	4	0	0	0	0	0	0	0	4
Goldeneye	0	0	0	0	0	0	0	0	1	0	0	0	1
Grey phalarope	0	0	0	0	0	0	6	7	0	0	0	0	13

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Unidentified phalarope	0	0	0	0	0	1	0	0	0	0	0	0	1
Pomarine skua	0	1	8	0	2	2	0	1	0	0	0	0	14
Arctic skua	0	1	8	2	12	24	6	2	1	0	0	0	56
Long-tailed skua	0	0	0	1	0	0	0	0	0	0	0	0	1
Great skua	1	8	2	5	13	15	8	22	16	0	1	0	91
Unidentified skuas	0	0	0	0	1	4	0	0	1	0	0	0	6
Little gull	0	0	0	2	4	6	12	57	7	0	0	0	88
Black-headed gull	11	1	6	5	67	21	47	15	10	0	1	0	184
Common gull	70	153	13	6	21	9	5	22	19	0	26	78	422
Unidentified small gulls	0	30	0	0	0	40	0	0	0	0	0	0	70
Lesser black-backed gull	67	310	270	127	63	47	2	1	3	0	13	4	907
Herring gull	128	104	86	35	1	1	1	6	26	1	18	33	440
Yellow-legged gull	0	0	0	0	0	0	0	1	0	0	0	0	1
Great black-backed gull	388	508	88	156	103	74	32	297	606	7	132	176	2,567
Unidentified large gulls	123	475	26	76	298	622	100	261	14	0	18	23	2,036
Unidentified gulls	0	0	0	60	0	290	0	0	0	0	0	0	350
Kittiwake	1,612	2,456	1,306	7,452	8,338	8,860	409	248	416	16	143	369	31,625
Sandwich tern	0	0	0	0	0	1	0	0	0	0	0	0	1
Common tern	0	2	10	8	19	2,109	0	0	0	0	0	0	2,148
Arctic tern	0	2	23	0	256	134	1	0	0	0	0	0	416
Common/Arctic tern	0	10	36	1	207	3,440	0	0	0	0	0	1	3,695
Guillemot	4,554	2,688	1,197	4,661	9,095	9,303	802	1,260	705	20	421	1,315	36,021
Razorbill	1,362	1,058	211	1,669	3,040	4,602	432	527	230	7	102	314	13,554
Little auk	0	1	0	0	0	0	0	1	120	1	3	0	126
Puffin	113	117	35	192	300	1,962	125	208	445	2	34	79	3,612
Guillemot/razorbill	713	713	140	881	2,205	14,147	639	355	195	0	123	197	20,308
Unidentified auks	29	22	7	2	7	312	2	13	25	0	4	9	432
Total numbers	**10,618**	**9,369**	**4,638**	**18,127**	**26,401**	**47,566**	**2,798**	**5,416**	**4,652**	**65**	**1,234**	**3,151**	**134,235**

Table A.6 Numbers of non-seabird species recorded in the Hornsea Survey Area in Year 1.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Grey heron	0	0	0	0	0	0	1	0	0	0	0	0	1
Pink-footed goose	0	0	0	0	0	0	0	0	0	0	22	0	22
Greylag goose	0	0	0	0	0	0	0	0	0	0	0	10	10
Teal	0	17	0	0	0	4	16	0	0	0	0	0	37
Mallard	0	0	0	0	0	0	4	0	0	0	0	0	4
Pochard	0	0	0	0	0	0	0	0	0	3	0	0	3
Tufted duck	0	0	0	0	0	0	0	2	0	0	0	0	2
Unidentified duck	0	2	0	2	0	0	0	2	0	0	0	0	6
Hobby	0	0	0	0	0	1	0	0	0	0	0	0	1
Oystercatcher	0	0	0	0	0	11	0	0	0	0	0	0	11
Ringed plover	0	0	0	0	0	3	1	0	0	0	0	0	4
Golden plover	0	0	0	0	0	7	8	2	123	0	2	0	142
Grey plover	0	0	0	0	0	1	0	0	0	0	0	0	1
Knot	0	0	0	0	0	1	0	0	0	0	0	0	1
Dunlin	0	0	0	0	3	1	0	0	0	5	0	0	9
Snipe	0	0	0	0	0	0	0	0	0	1	0	0	1
Woodcock	1	0	0	0	0	0	0	0	0	0	0	0	1
Bar-tailed godwit	0	0	0	0	11	0	14	0	0	0	0	0	25
Whimbrel	0	0	15	0	1	25	0	0	0	0	0	0	41
Curlew	0	0	0	0	3	1	0	0	0	0	0	0	4
Green Sandpiper	0	0	0	0	0	2	0	0	0	0	0	0	2
Turnstone	0	0	0	0	0	1	0	0	0	0	0	0	1
Unidentified waders	0	0	0	0	0	29	0	2	0	0	0	0	31
Feral pigeon	0	0	0	0	2	3	1	0	0	0	0	0	6
Woodpigeon	0	0	1	0	0	0	0	0	0	0	0	1	2
Short-eared owl	0	0	0	0	0	0	1	0	1	0	0	0	2
Swift	0	0	0	0	5	0	1	0	0	0	0	0	6
Skylark	0	0	2	0	0	0	0	3	3	0	0	2	10
Swallow	0	0	1	0	1	0	0	0	0	0	0	0	2
House martin	0	0	0	0	0	0	1	0	0	0	0	0	1
Meadow pipit	3	13	0	0	0	0	20	3	2	0	0	0	41
Yellow wagtail	0	0	0	0	0	0	3	0	0	0	0	0	3

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Pied/white wagtail	4	3	0	1	0	0	0	1	0	0	0	0	9
Wren	0	0	0	0	0	0	0	2	0	0	0	0	2
Robin	0	0	0	0	0	0	0	1	0	0	0	0	1
Redstart	0	1	0	0	0	0	1	1	0	0	0	0	3
Whinchat	0	0	0	0	0	0	1	0	0	0	0	0	1
Wheatear	0	1	1	0	0	0	2	0	0	0	0	0	4
Blackbird	4	0	0	0	0	0	0	6	6	1	0	0	17
Fieldfare	1	0	0	0	0	0	0	0	2	2	0	0	5
Song thrush	0	0	0	0	0	0	1	3	0	0	0	0	4
Redwing	1	0	0	0	0	0	0	7	3	0	0	0	11
Unidentified thrush	0	0	0	0	0	0	0	4	0	0	0	0	4
Sedge warbler	0	0	0	1	0	0	0	0	0	0	0	0	1
Garden warbler	0	0	0	0	0	0	2	0	0	0	0	0	2
Blackcap	0	2	0	0	0	0	0	1	0	0	0	0	3
Yellow-browed warbler	0	0	0	0	0	0	0	1	0	0	0	0	1
Chiffchaff	1	0	1	0	0	0	0	1	0	0	0	0	3
Willow warbler	0	0	0	0	0	0	3	0	0	0	0	0	3
Goldcrest	0	0	0	0	0	0	0	1	0	0	0	0	1
Unidentified warbler	0	1	0	1	0	0	0	0	0	0	0	0	2
Pied flycatcher	0	0	0	0	0	0	2	0	0	0	0	0	2
Carrion crow	1	0	0	0	0	0	0	0	0	0	0	0	1
Starling	61	1	0	0	0	0	0	12	411	2	0	0	487
Chaffinch	0	1	0	0	0	0	0	0	0	0	0	0	1
Brambling	0	0	0	0	0	0	1	0	4	0	0	0	5
Goldfinch	0	0	0	0	0	0	0	1	0	0	0	0	1
Mealy redpoll	0	0	0	0	0	0	0	0	1	0	0	0	1
Snow bunting	0	0	0	0	0	0	0	0	6	0	0	0	6
Unidentified finch	0	0	0	0	0	0	0	1	0	0	0	0	1
Unidentified land bird	0	2	0	0	0	0	1	2	0	0	0	0	5
Total numbers	**77**	**44**	**21**	**5**	**26**	**90**	**85**	**61**	**562**	**14**	**24**	**3**	**1,017**

Table A.7 Numbers of non-seabird species recorded in the Hornsea Survey Area in Year 2.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Grey heron	1	0	0	0	0	0	0	0	0	0	0	0	1
‘Tundra’ Bean goose	0	0	0	0	0	0	0	0	3	0	0	0	3
Pink-footed goose	2	0	0	0	0	0	0	0	0	0	0	0	2
Greylag goose	6	0	0	0	0	0	0	0	0	0	0	0	6
‘Dark-bellied’ Brent goose	0	0	0	0	0	0	1	0	6	0	0	0	7
Unidentified goose	0	0	0	0	0	0	0	0	11	0	0	0	11
Shelduck	0	0	0	1	0	0	0	0	0	0	0	1	2
Wigeon	0	0	0	0	6	0	0	7	6	0	0	0	19
Gadwall	1	0	0	0	0	0	0	0	0	0	0	0	1
Teal	0	0	0	0	0	0	0	0	1	0	0	0	1
Mallard	0	1	0	0	0	0	0	0	5	0	0	0	6
Shoveler	0	0	0	0	0	4	0	0	0	0	0	0	4
Pochard	0	0	0	1	0	0	0	0	1	0	0	0	2
Tufted duck	0	0	2	0	0	3	0	0	0	0	0	0	5
Goosander	0	0	0	0	0	0	0	2	0	0	1	0	3
Unidentified duck	0	0	0	0	0	0	0	0	22	0	2	0	24
Hobby	0	0	0	1	0	0	0	0	0	0	0	0	1
Oystercatcher	1	0	0	0	0	11	0	0	0	0	0	0	12
Avocet	0	0	2	0	0	0	0	0	0	0	0	0	2
Ringed plover	0	0	1	0	2	0	0	0	3	0	0	0	6
Golden plover	3	0	1	0	0	3	0	0	0	0	0	0	7
Grey plover	0	0	2	0	0	0	0	0	0	0	0	1	3
Lapwing	0	0	0	0	20	0	7	0	70	0	51	0	148
Knot	0	0	13	0	2	1	4	0	0	0	0	2	22
Purple sandpiper	0	0	0	0	0	0	0	1	0	0	0	0	1
Little stint	0	0	2	0	0	0	0	0	0	0	0	0	2
Dunlin	1	0	0	1	0	8	16	4	0	0	0	2	22
Snipe	0	0	0	0	0	0	0	1	0	0	0	0	1
Bar-tailed godwit	0	0	3	0	0	0	1	0	0	0	0	0	4
Whimbrel	0	6	2	0	0	0	0	0	0	0	0	0	8
Curlew	0	0	0	8	3	2	1	0	0	0	0	0	14
Redshank	0	0	0	0	7	0	0	0	0	0	0	0	7

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Greenshank	1	0	0	0	0	0	0	0	0	0	0	0	1
Common sandpiper	0	0	1	0	1	0	0	0	0	0	0	0	2
Turnstone	0	0	3	0	0	0	0	0	0	0	0	0	3
Unidentified waders	0	0	0	1	0	1	0	13	0	0	0	0	15
Feral pigeon	0	1	1	4	5	3	0	0	0	0	0	0	14
Woodpigeon	0	0	3	0	0	0	0	0	0	0	0	0	3
Collared dove	0	0	1	1	0	0	0	0	0	0	0	0	2
Short-eared owl	0	0	0	0	0	0	0	6	2	0	0	0	8
Swift	0	0	6	4	10	0	0	0	0	0	0	0	20
Skylark	2	0	0	0	0	0	0	9	3	0	0	1	15
Sand martin	0	0	1	0	0	0	0	0	0	0	0	0	1
Swallow	0	2	38	7	0	0	0	1	0	0	0	0	48
House martin	0	0	1	0	0	0	0	0	0	0	0	0	1
Tree pipit	0	0	1	0	0	0	0	0	0	0	0	0	1
Meadow pipit	10	11	1	0	0	9	2	14	1	0	0	0	48
Rock pipit	0	0	0	0	0	1	0	0	0	0	0	0	1
Unidentified pipit	0	4	0	0	0	0	0	1	0	0	0	0	5
Pied/white wagtail	3	4	0	0	0	0	0	0	0	0	0	0	7
Wren	0	0	0	0	0	0	0	0	4	0	0	0	4
Robin	0	1	0	0	0	0	0	1	5	0	0	0	6
Redstart	0	0	0	0	0	0	1	0	0	0	0	0	1
Black redstart	0	0	0	0	0	0	0	0	1	0	0	0	1
Wheatear	0	2	0	0	0	3	0	0	0	0	0	0	5
Blackbird	1	0	0	0	0	0	0	11	9	0	0	1	22
Fieldfare	0	0	0	0	0	0	0	5	32	0	0	0	37
Song thrush	0	0	0	0	0	0	16	3	8	0	0	1	28
Redwing	1	0	0	0	0	0	0	57	216	0	0	0	274
Unidentified thrush	0	0	0	0	0	0	0	4	14	0	0	0	18
Sedge warbler	0	0	1	0	0	0	0	0	0	0	0	0	1
Blackcap	0	0	0	0	0	0	0	1	0	0	0	0	1
Whitethroat	0	0	0	0	0	0	0	1	0	0	0	0	1
Chiffchaff	1	2	2	0	0	0	2	0	0	0	0	0	7

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Willow warbler	0	2	0	0	0	0	0	0	0	0	0	0	2
Goldcrest	0	0	0	0	0	0	0	2	0	0	0	0	2
Unidentified warbler	0	2	1	1	0	1	2	2	0	0	0	0	9
Spotted flycatcher	0	0	0	0	1	0	0	0	0	0	0	0	1
Jackdaw	0	1	0	0	0	0	0	0	0	0	0	0	1
Carrion crow	0	0	0	0	0	0	0	0	1	0	0	0	1
Starling	23	1	0	0	2	0	0	187	117	0	0	0	330
Brambling	0	0	0	0	0	0	0	5	0	0	0	0	5
Goldfinch	0	1	0	0	0	0	0	0	0	0	0	0	1
Greenfinch	0	4	0	0	0	0	0	0	0	0	0	0	4
Linnet	1	2	0	0	0	0	0	0	0	0	0	3	3
Unidentified land bird	0	3	0	0	0	1	0	9	2	0	0	0	15
Total numbers	**58**	**50**	**89**	**30**	**59**	**51**	**53**	**347**	**543**	**0**	**54**	**12**	**1,341**

Monthly breakdown on flight height data in Hornsea Survey Area

Table A.8 Monthly breakdown of flight height data within the Hornsea Survey Area, of species being taken forward for Impact Assessment.

Flight height		Year 1												Year 2												TOTAL
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
Fulmar	Total recorded	332	212	818	583	221	460	427	211	201	325	305	110	374	274	695	1465	815	446	71	223	28	21	205	226	9,048
	No. at 0 to 22.5 m	332	212	818	583	221	460	427	211	201	324	305	110	374	274	695	1464	815	446	71	223	28	21	205	225	9,045
	No. at > 22.5 m	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3
	% at > 22.5 m	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0.4	<0.1
Gannet	Total recorded	816	352	87	109	163	563	542	1065	560	157	291	416	746	242	115	896	1348	983	233	1524	1287	4	150	385	13,034
	No. at 0 to 22.5 m	794	346	85	93	155	533	539	1023	511	151	282	415	723	239	109	821	1161	920	194	1415	943	4	144	377	11,977
	No. at > 22.5 m	22	6	2	16	8	30	3	42	49	6	9	1	23	3	6	75	187	63	39	109	344	0	6	8	1,057
	% at > 22.5 m	2.7	1.7	2.3	14.7	4.9	5.3	0.6	3.9	8.8	3.8	3.1	0.2	3.1	1.2	5.2	8.4	13.9	6.4	16.7	7.2	26.7	0	4.0	2.1	8.1
Arctic skua	Total recorded	0	0	2	0	1	4	39	11	3	0	0	0	0	1	8	2	11	22	19	3	1	0	0	0	127
	No. at 0 to 22.5 m	0	0	2	0	1	4	39	11	3	0	0	0	0	1	8	2	11	22	18	3	1	0	0	0	126
	No. at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	% at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
Great skua	Total recorded	1	2	0	0	0	10	18	8	5	1	1	0	2	3	2	4	10	16	17	28	20	1	2	0	151
	No. at 0 to 22.5 m	1	2	0	0	0	8	14	7	5	1	1	0	2	3	2	4	10	15	14	22	19	1	1	0	132
	No. at > 22.5 m	0	0	0	0	0	2	4	1	0	0	0	0	0	0	0	0	0	1	3	6	1	0	1	0	19
	% at > 22.5 m	0	0	0	0	0	20.0	22.2	12.5	0	0	0	0	0	0	0	0	0	6.3	17.6	21.4	5.0	0	50.0	0	12.6
Kittiwake	Total recorded	742	796	185	1219	3489	2614	1696	1070	1950	635	348	648	1151	1266	942	6561	6278	2666	1264	510	546	43	301	405	37,325
	No. at 0 to 22.5 m	718	761	180	1121	3472	2601	1688	1063	1889	588	315	645	1085	1262	929	6490	5971	2617	1225	494	481	41	267	380	36,283
	No. at > 22.5 m	24	35	5	98	17	13	8	7	61	47	33	3	66	4	13	71	307	49	39	16	65	2	34	25	1042
	% at > 22.5 m	3.2	4.4	2.7	8.0	0.5	0.5	0.5	0.7	3.1	7.4	9.5	0.5	5.7	0.3	1.4	1.1	4.9	1.8	3.1	3.1	11.9	4.7	11.3	6.2	2.8

Flight height		Year 1												Year 2												TOTAL
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
Great black-backed gull	Total recorded	275	86	39	118	24	166	277	333	197	322	385	177	353	314	103	155	104	138	141	263	515	22	190	209	4,906
	No. at 0 to 22.5 m	211	47	25	112	16	144	263	266	136	213	249	158	232	290	77	127	62	109	96	183	259	15	95	147	3,532
	No. at > 22.5 m	64	39	14	6	8	22	14	67	61	109	136	19	121	24	26	28	42	29	45	80	256	7	95	62	1374
	% at > 22.5 m	23.3	45.3	35.9	5.1	33.3	13.3	5.1	20.1	31.0	33.9	35.3	10.7	34.3	7.6	25.2	18.1	40.4	21.0	31.9	30.4	49.7	31.8	50.0	29.7	28
Little gull	Total recorded	0	3	0	0	5	2	41	3049	273	0	0	0	0	0	0	1	8	5	33	76	24	0	0	2	3,522
	No. at 0 to 22.5 m	0	3	0	0	5	2	41	3024	270	0	0	0	0	0	0	1	8	5	23	76	24	0	0	2	3,484
	No. at > 22.5 m	0	0	0	0	0	0	0	25	3	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	38
	% at > 22.5 m	0	0	0	0	0	0	0	0.8	1.1	0	0	0	0	0	0	0	0	0	30.3	0	0	0	0	0	1.1
Common tern	Total recorded	0	0	7	30	0	82	966	61	0	0	0	0	0	1	18	7	24	2212	2	0	0	0	0	0	3,410
	No. at 0 to 22.5 m	0	0	7	30	0	82	958	61	0	0	0	0	0	1	16	7	23	2174	2	0	0	0	0	0	3,361
	No. at > 22.5 m	0	0	0	0	0	0	8	0	0	0	0	0	0	0	2	0	1	38	0	0	0	0	0	0	49
	% at > 22.5 m	0	0	0	0	0	0	0.8	0	0	0	0	0	0	0	11.1	0	4.2	1.7	0	0	0	0	0	0	1.4
Arctic tern	Total recorded	0	0	6	0	0	177	4	4	0	0	0	0	0	0	86	0	221	131	3	2	0	0	0	0	634
	No. at 0 to 22.5 m	0	0	6	0	0	177	4	4	0	0	0	0	0	0	86	0	221	131	3	2	0	0	0	0	634
	No. at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Flight height		Year 1												Year 2												TOTAL
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
Guillemot	Total recorded	346	93	61	91	313	7	28	395	563	948	759	303	1024	95	111	1221	1015	17	58	281	594	12	333	1033	9,701
	No. at 0 to 22.5 m	346	93	61	91	313	6	28	395	563	948	759	303	1024	95	111	1221	1015	17	58	281	594	12	333	1032	9,699
	No. at > 22.5 m	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
	% at > 22.5 m	0	0	0	0	0	14.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	<0.1
Razorbill	Total recorded	314	175	26	59	231	1	22	491	69	161	52	205	597	145	68	828	187	4	170	531	192	0	157	228	4,913
	No. at 0 to 22.5 m	314	175	26	59	231	1	22	491	69	161	52	205	597	145	68	828	187	4	170	531	192	0	157	228	4,913
	No. at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Puffin	Total recorded	7	19	6	10	1	6	0	23	20	7	6	16	20	25	6	77	77	18	2	15	24	1	7	26	419
	No. at 0 to 22.5 m	7	19	6	10	1	6	0	23	20	7	6	16	20	25	6	77	77	18	2	15	24	1	7	26	419
	No. at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% at > 22.5 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A.9 Summary of aerial surveys from three Greater Wash survey blocks (from DTI, 2006; BERR, 2007; DECC, 2009.

Season	Period 1: early winter (Nov)			Period 2: mid-winter 1 (Dec)				Period 3: mid-winter 2 (Feb)			Period 4: late-winter (Mar)				Period 5: breeding, incubation (May)			Period 6: breeding, chick-rearing (Jul)		
Survey block	GW2	GW2	Mean	GW2	GW2	GW9	Mean	GW2	GW2	Mean	GW2	GW2	GW9	Mean	GW9	GW10	Mean	GW9	GW10	Mean
Year	2004/5	2005/6		2004/5	2005/6	2007/8		2004/5	2005/6		2004/5	2005/6	2007/8		2007/8	2007/8		2007/8	2007/8	
Fulmar	6	22	14	1	22	90	38	19	9	14	12	0	26	13	25	27	26	20	16	18
Gannet	18	3	11	2	0	8	5	3	11	7	15	21	362	133	69	17	43	630	150	390
Great skua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2
Skua spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1
Little gull	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kittiwake	85	23	54	8	9	2	6	14	28	21	17	17	305	113	1314	283	799	1466	857	1162
Small gull spp.	36	29	33	0	2	21	8	3	2	3	8	4	40	17	16	9	13	0	0	0
Great black-backed gull	11	3	7	7	15	11	11	6	11	9	0	0	2	1	0	2	1	0	0	0
Black-backed gull spp.	13	3	8	16	21	5	14	3	19	11	5	0	0	2	1	1	1	0	0	0
Large gull spp.	19	5	12	3	2	7	4	1	2	2	32	0	41	24	0	1	1	1	3	2
Gull spp.	131	16	74	49	64	2	38	29	40	35	251	8	239	166	140	45	93	20	16	18
Arctic/Common tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	1	0	1
Tern spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	9	22	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	6	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	2	0	1	1
Auk spp.	475	116	296	99	82	104	95	225	240	234	634	120	1326	693	1420	23	722	263	284	274

Table A.10 Monthly population estimates of non-Distance species for Year 1 surveys within Subzone 1 + 4 km buffer, using Stone *et al.* (1995) correction factors.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Red-throated diver	0	10	22	0	0	0	0	0	7	0	0	0
Black-throated diver	0	15	0	0	0	0	0	0	0	0	0	0
Great crested grebe	0	0	0	0	0	0	0	0	0	7	0	0
Black-necked grebe	0	0	0	0	0	0	0	0	0	7	0	0
Manx shearwater	0	7	0	15	24	32	64	0	0	0	0	0
Storm petrel	0	0	0	0	0	0	4	0	22	18	0	0
Cormorant	7	0	0	0	0	0	0	0	0	0	0	0
Common scoter	0	90	0	0	0	81	96	0	186	0	0	0
Grey phalarope	0	0	0	0	0	0	0	11	0	0	0	0
Pomarine skua	0	10	7	0	10	17	11	0	22	7	0	0
Arctic skua	0	0	7	10	7	34	141	52	15	0	0	0
Long-tailed skua	0	0	0	0	0	0	0	7	0	0	0	0
Great skua	7	0	0	0	0	34	44	24	7	7	7	0
Sabine's gull	0	0	0	0	0	0	5	0	0	0	0	0
Black-headed gull	0	0	0	0	18	0	13	15	0	0	0	0
Common gull	60	40	15	15	106	15	77	55	30	69	55	81
Sandwich tern	0	0	0	0	0	0	0	0	0	0	0	0
Arctic tern	0	0	15	0	0	765	11	30	0	0	0	0

Table A.11 Monthly population estimates of non-Distance species for Year 2 surveys within Subzone 1 + 4 km buffer, using Stone *et al.* (1995) correction factors.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Red-throated diver	0	7	75	18	0	0	0	28	0	-	0	0
Black-throated diver	0	43	0	0	0	0	0	7	0	-	0	0
Manx shearwater	0	0	7	27	38	34	9	0	0	-	0	0
Balearic shearwater	0	0	0	0	0	0	0	0	0	-	0	0
Storm petrel	0	0	0	0	7	7	0	0	27	-	0	0
Cormorant	6	0	0	0	0	0	0	0	7	-	0	0
Shag	0	0	0	0	0	0	0	0	7	-	0	0
Eider	12	0	0	0	0	0	0	0	0	-	21	0
Common scoter	0	55	0	0	55	185	14	14	199	-	0	27
Red-breasted merganser	0	0	0	0	0	0	0	0	14	-	0	0
Grey phalarope	0	0	0	0	0	0	28	145	0	-	0	0
Pomarine skua	0	7	30	0	7	0	0	7	0	-	0	0
Arctic skua	0	7	14	16	14	61	142	7	0	-	0	0
Great skua	6	0	0	0	30	29	144	85	34	-	14	0
Black-headed gull	24	0	14	0	0	55	290	704	55	-	0	14
Common gull	42	216	14	7	0	27	100	157	185	-	55	262
Sandwich tern	6	0	0	0	14	0	0	0	0	-	0	0
Arctic tern	0	0	754	0	0	123	14	14	0	-	0	0
Black tern	0	0	7	0	0	0	0	0	0	-	0	0
Unidentified skua	0	0	0	0	0	9	0	0	7	-	0	0

Displacement Matrices

Table A.12 Displacement of breeding fulmars (mean peak number = 948; low sensitivity = Subzone 1 only).

Fulmar (breeding: Mar-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	2	5	9	19	28	38	47	57	66	76	85	95
20	2	4	9	19	38	57	76	95	114	133	152	171	190
25	2	5	12	24	47	71	95	119	142	166	190	213	237
30	3	6	14	28	57	85	114	142	171	199	228	256	284
40	4	8	19	38	76	114	152	190	228	265	303	341	379
50	5	9	24	47	95	142	190	237	284	332	379	427	474
60	6	11	28	57	114	171	228	284	341	398	455	512	569
70	7	13	33	66	133	199	265	332	398	465	531	597	664
75	7	14	36	71	142	213	284	356	427	498	569	640	711
80	8	15	38	76	152	228	303	379	455	531	607	683	758
90	9	17	43	85	171	256	341	427	512	597	683	768	853
100	9	19	47	95	190	284	379	474	569	664	758	853	948

Table A.13 Displacement of non-breeding fulmars (mean peak number = 253; low sensitivity = Subzone 1 only).

Fulmar (non-breeding: Aug-Feb)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	2	5	7	9	12	14	16	19	21	24
20	0	1	2	5	9	14	19	24	28	33	38	42	47
25	1	1	3	6	12	18	24	29	35	41	47	53	59
30	1	1	4	7	14	21	28	35	42	49	56	63	71
40	1	2	5	9	19	28	38	47	56	66	75	85	94
50	1	2	6	12	24	35	47	59	71	82	94	106	118
60	1	3	7	14	28	42	56	71	85	99	113	127	141
70	2	3	8	16	33	49	66	82	99	115	132	148	165
75	2	4	9	18	35	53	71	88	106	123	141	159	176
80	2	4	9	19	38	56	75	94	113	132	150	169	188
90	2	4	11	21	42	63	85	106	127	148	169	190	212
100	2	5	12	24	47	71	94	118	141	165	188	212	235

Table A.14 Displacement of breeding fulmars (mean peak number = 1,471; Subzone 1 + 2km buffer).

Fulmar (breeding: Mar-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	3	7	15	29	44	59	74	88	103	118	132	147
20	3	6	15	29	59	88	118	147	177	206	235	265	294
25	4	7	18	37	74	110	147	184	221	257	294	331	368
30	4	9	22	44	88	132	177	221	265	309	353	397	441
40	6	12	29	59	118	177	235	294	353	412	471	530	588
50	7	15	37	74	147	221	294	368	441	515	588	662	736
60	9	18	44	88	177	265	353	441	530	618	706	794	883
70	10	21	51	103	206	309	412	515	618	721	824	927	1,030
75	11	22	55	110	221	331	441	552	662	772	883	993	1,103
80	12	24	59	118	235	353	471	588	706	824	941	1,059	1,177
90	13	26	66	132	265	397	530	662	794	927	1,059	1,192	1,324
100	15	29	74	147	294	441	588	736	883	1,030	1,177	1,324	1,471

Table A.15 Displacement of non-breeding fulmars (mean peak number = 364; Subzone 1 + 2km buffer).

Fulmar (non-breeding: Aug-Feb)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	2	4	7	11	15	18	22	25	29	33	36
20	1	1	4	7	15	22	29	36	44	51	58	66	73
25	1	2	5	9	18	27	36	46	55	64	73	82	91
30	1	2	5	11	22	33	44	55	66	76	87	98	109
40	1	3	7	15	29	44	58	73	87	102	116	131	146
50	2	4	9	18	36	55	73	91	109	127	146	164	182
60	2	4	11	22	44	66	87	109	131	153	175	197	218
70	3	5	13	25	51	76	102	127	153	178	204	229	255
75	3	5	14	27	55	82	109	137	164	191	218	246	273
80	3	6	15	29	58	87	116	146	175	204	233	262	291
90	3	7	16	33	66	98	131	164	197	229	262	295	328
100	4	7	18	36	73	109	146	182	218	255	291	328	364

Table A.16 Displacement of breeding gannets (mean peak number = 341; low sensitivity = Subzone 1 only).

Gannet (breeding: Apr-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	2	3	7	10	14	17	20	24	27	31	34
20	1	1	3	7	14	20	27	34	41	48	55	61	68
25	1	2	4	9	17	26	34	43	51	60	68	77	85
30	1	2	5	10	20	31	41	51	61	72	82	92	102
40	1	3	7	14	27	41	55	68	82	95	109	123	136
50	2	3	9	17	34	51	68	85	102	119	136	153	171
60	2	4	10	20	41	61	82	102	123	143	164	184	205
70	2	5	12	24	48	72	95	119	143	167	191	215	239
75	3	5	13	26	51	77	102	128	153	179	205	230	256
80	3	5	14	27	55	82	109	136	164	191	218	246	273
90	3	6	15	31	61	92	123	153	184	215	246	276	307
100	3	7	17	34	68	102	136	171	205	239	273	307	341

Table A.17 Displacement of non-breeding gannets (mean peak number = 338; low sensitivity = Subzone 1 only).

Gannet (non-breeding: Oct-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	2	3	7	10	14	17	20	24	27	30	34
20	1	1	3	7	14	20	27	34	41	47	54	61	68
25	1	2	4	8	17	25	34	42	51	59	68	76	85
30	1	2	5	10	20	30	41	51	61	71	81	91	101
40	1	3	7	14	27	41	54	68	81	95	108	122	135
50	2	3	8	17	34	51	68	85	101	118	135	152	169
60	2	4	10	20	41	61	81	101	122	142	162	183	203
70	2	5	12	24	47	71	95	118	142	166	189	213	237
75	3	5	13	25	51	76	101	127	152	177	203	228	254
80	3	5	14	27	54	81	108	135	162	189	216	243	270
90	3	6	15	30	61	91	122	152	183	213	243	274	304
100	3	7	17	34	68	101	135	169	203	237	270	304	338

Table A.18 Displacement of breeding gannets (mean peak number = 530; Subzone 1 + 2km buffer).

Gannet (breeding: May-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	1	3	5	11	16	21	27	32	37	42	48	53
20	1	2	5	11	21	32	42	53	64	74	85	95	106
25	1	3	7	13	27	40	53	66	80	93	106	119	133
30	2	3	8	16	32	48	64	80	95	111	127	143	159
40	2	4	11	21	42	64	85	106	127	148	170	191	212
50	3	5	13	27	53	80	106	133	159	186	212	239	265
60	3	6	16	32	64	95	127	159	191	223	254	286	318
70	4	7	19	37	74	111	148	186	223	260	297	334	371
75	4	8	20	40	80	119	159	199	239	278	318	358	398
80	4	8	21	42	85	127	170	212	254	297	339	382	424
90	5	10	24	48	95	143	191	239	286	334	382	429	477
100	5	11	27	53	106	159	212	265	318	371	424	477	530

Table A.19 Displacement of non-breeding gannets (mean peak number = 525; Subzone 1 + 2km buffer).

Gannet (non-breeding: Oct-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	1	3	5	11	16	21	26	32	37	42	47	53
20	1	2	5	11	21	32	42	53	63	74	84	95	105
25	1	3	7	13	26	39	53	66	79	92	105	118	131
30	2	3	8	16	32	47	63	79	95	110	126	142	158
40	2	4	11	21	42	63	84	105	126	147	168	189	210
50	3	5	13	26	53	79	105	131	158	184	210	236	263
60	3	6	16	32	63	95	126	158	189	221	252	284	315
70	4	7	18	37	74	110	147	184	221	257	294	331	368
75	4	8	20	39	79	118	158	197	236	276	315	354	394
80	4	8	21	42	84	126	168	210	252	294	336	378	420
90	5	9	24	47	95	142	189	236	284	331	378	425	473
100	5	11	26	53	105	158	210	263	315	368	420	473	525

Table A.20 Displacement of breeding kittiwake (mean peak number = 1,897; low sensitivity = Subzone 1 only).

Kittiwake (breeding: Mar-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	2	4	9	19	38	57	76	95	114	133	152	171	190
20	4	8	19	38	76	114	152	190	228	266	304	341	379
25	5	9	24	47	95	142	190	237	285	332	379	427	474
30	6	11	28	57	114	171	228	285	341	398	455	512	569
40	8	15	38	76	152	228	304	379	455	531	607	683	759
50	9	19	47	95	190	285	379	474	569	664	759	854	949
60	11	23	57	114	228	341	455	569	683	797	911	1,024	1,138
70	13	27	66	133	266	398	531	664	797	930	1,062	1,195	1,328
75	14	28	71	142	285	427	569	711	854	996	1,138	1,280	1,423
80	15	30	76	152	304	455	607	759	911	1,062	1,214	1,366	1,518
90	17	34	85	171	341	512	683	854	1,024	1,195	1,366	1,537	1,707
100	19	38	95	190	379	569	759	949	1,138	1,328	1,518	1,707	1,897

Table A.21 Displacement of non-breeding kittiwake (mean peak number = 20,272 within 'post-breeding' period; low sensitivity = Subzone 1 only).

Kittiwake (non-breeding: Aug-Feb)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	20	41	101	203	405	608	811	1,014	1,216	1,419	1,622	1,824	2,027
20	41	81	203	405	811	1,216	1,622	2,027	2,433	2,838	3,244	3,649	4,054
25	51	101	253	507	1,014	1,520	2,027	2,534	3,041	3,548	4,054	4,561	5,068
30	61	122	304	608	1,216	1,824	2,433	3,041	3,649	4,257	4,865	5,473	6,082
40	81	162	405	811	1,622	2,433	3,244	4,054	4,865	5,676	6,487	7,298	8,109
50	101	203	507	1,014	2,027	3,041	4,054	5,068	6,082	7,095	8,109	9,122	10,136
60	122	243	608	1,216	2,433	3,649	4,865	6,082	7,298	8,514	9,731	10,947	12,163
70	142	284	710	1,419	2,838	4,257	5,676	7,095	8,514	9,933	11,352	12,771	14,190
75	152	304	760	1,520	3,041	4,561	6,082	7,602	9,122	10,643	12,163	13,684	15,204
80	162	324	811	1,622	3,244	4,865	6,487	8,109	9,731	11,352	12,974	14,596	16,218
90	182	365	912	1,824	3,649	5,473	7,298	9,122	10,947	12,771	14,596	16,420	18,245
100	203	405	1,014	2,027	4,054	6,082	8,109	10,136	12,163	14,190	16,218	18,245	20,272

Table A.22 Displacement of breeding kittiwake (mean peak number = 2,946; Subzone 1 + 2km buffer).

Kittiwake (breeding: Mar-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	3	6	15	29	59	88	118	147	177	206	236	265	295
20	6	12	29	59	118	177	236	295	354	412	471	530	589
25	7	15	37	74	147	221	295	368	442	516	589	663	737
30	9	18	44	88	177	265	354	442	530	619	707	795	884
40	12	24	59	118	236	354	471	589	707	825	943	1,061	1,178
50	15	29	74	147	295	442	589	737	884	1,031	1,178	1,326	1,473
60	18	35	88	177	354	530	707	884	1,061	1,237	1,414	1,591	1,768
70	21	41	103	206	412	619	825	1,031	1,237	1,444	1,650	1,856	2,062
75	22	44	110	221	442	663	884	1,105	1,326	1,547	1,768	1,989	2,210
80	24	47	118	236	471	707	943	1,178	1,414	1,650	1,885	2,121	2,357
90	27	53	133	265	530	795	1,061	1,326	1,591	1,856	2,121	2,386	2,651
100	29	59	147	295	589	884	1,178	1,473	1,768	2,062	2,357	2,651	2,946

Table A.23 Displacement of non-breeding kittiwake (mean peak number = 31,481 within 'post-breeding' period; Subzone 1 + 2km buffer).

Kittiwake (non-breeding: Aug-Feb)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	31	63	157	315	630	944	1,259	1,574	1,889	2,204	2,518	2,833	3,148
20	63	126	315	630	1,259	1,889	2,518	3,148	3,778	4,407	5,037	5,667	6,296
25	79	157	394	787	1,574	2,361	3,148	3,935	4,722	5,509	6,296	7,083	7,870
30	94	189	472	944	1,889	2,833	3,778	4,722	5,667	6,611	7,555	8,500	9,444
40	126	252	630	1,259	2,518	3,778	5,037	6,296	7,555	8,815	10,074	11,333	12,592
50	157	315	787	1,574	3,148	4,722	6,296	7,870	9,444	11,018	12,592	14,166	15,741
60	189	378	944	1,889	3,778	5,667	7,555	9,444	11,333	13,222	15,111	17,000	18,889
70	220	441	1,102	2,204	4,407	6,611	8,815	11,018	13,222	15,426	17,629	19,833	22,037
75	236	472	1,181	2,361	4,722	7,083	9,444	11,805	14,166	16,528	18,889	21,250	23,611
80	252	504	1,259	2,518	5,037	7,555	10,074	12,592	15,111	17,629	20,148	22,666	25,185
90	283	567	1,417	2,833	5,667	8,500	11,333	14,166	17,000	19,833	22,666	25,500	28,333
100	315	630	1,574	3,148	6,296	9,444	12,592	15,741	18,889	22,037	25,185	28,333	31,481

Table A.24 Displacement of breeding great black-backed gull (mean peak number = 80; low sensitivity = Subzone 1 only).

Great black-backed gull (breeding: Apr-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	1	2	2	3	4	5	6	6	7	8
20	0	0	1	2	3	5	6	8	10	11	13	14	16
25	0	0	1	2	4	6	8	10	12	14	16	18	20
30	0	0	1	2	5	7	10	12	14	17	19	22	24
40	0	1	2	3	6	10	13	16	19	22	26	29	32
50	0	1	2	4	8	12	16	20	24	28	32	36	40
60	0	1	2	5	10	14	19	24	29	34	38	43	48
70	1	1	3	6	11	17	22	28	34	39	45	50	56
75	1	1	3	6	12	18	24	30	36	42	48	54	60
80	1	1	3	6	13	19	26	32	38	45	51	58	64
90	1	1	4	7	14	22	29	36	43	50	58	65	72
100	1	2	4	8	16	24	32	40	48	56	64	72	80

Table A.25 Displacement of non-breeding great black-backed gull (mean peak number = 275; low sensitivity = Subzone 1 only).

Great black-backed gull (non-breeding: Sep-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	1	3	6	8	11	14	17	19	22	25	28
20	1	1	3	6	11	17	22	28	33	39	44	50	55
25	1	1	3	7	14	21	28	34	41	48	55	62	69
30	1	2	4	8	17	25	33	41	50	58	66	74	83
40	1	2	6	11	22	33	44	55	66	77	88	99	110
50	1	3	7	14	28	41	55	69	83	96	110	124	138
60	2	3	8	17	33	50	66	83	99	116	132	149	165
70	2	4	10	19	39	58	77	96	116	135	154	173	193
75	2	4	10	21	41	62	83	103	124	144	165	186	206
80	2	4	11	22	44	66	88	110	132	154	176	198	220
90	2	5	12	25	50	74	99	124	149	173	198	223	248
100	3	6	14	28	55	83	110	138	165	193	220	248	275

Table A.26 Displacement of breeding great black-backed gull (mean peak number = 125; Subzone 1 + 2km buffer). Note does not include % of unidentified 'large gulls'.

Great black-backed gull (breeding: Apr-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	1	3	4	5	6	8	9	10	11	13
20	0	1	1	3	5	8	10	13	15	18	20	23	25
25	0	1	2	3	6	9	13	16	19	22	25	28	31
30	0	1	2	4	8	11	15	19	23	26	30	34	38
40	1	1	3	5	10	15	20	25	30	35	40	45	50
50	1	1	3	6	13	19	25	31	38	44	50	56	63
60	1	2	4	8	15	23	30	38	45	53	60	68	75
70	1	2	4	9	18	26	35	44	53	61	70	79	88
75	1	2	5	9	19	28	38	47	56	66	75	84	94
80	1	2	5	10	20	30	40	50	60	70	80	90	100
90	1	2	6	11	23	34	45	56	68	79	90	101	113
100	1	3	6	13	25	38	50	63	75	88	100	113	125

Table A.27 Displacement of non-breeding great black-backed gull (mean peak number = 424; Subzone 1 + 2km buffer).

Great black-backed gull (non-breeding: Sep-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	2	4	8	13	17	21	25	30	34	38	42
20	1	2	4	8	17	25	34	42	51	59	68	76	85
25	1	2	5	11	21	32	42	53	64	74	85	95	106
30	1	3	6	13	25	38	51	64	76	89	102	114	127
40	2	3	8	17	34	51	68	85	102	119	136	153	170
50	2	4	11	21	42	64	85	106	127	148	170	191	212
60	3	5	13	25	51	76	102	127	153	178	204	229	254
70	3	6	15	30	59	89	119	148	178	208	237	267	297
75	3	6	16	32	64	95	127	159	191	223	254	286	318
80	3	7	17	34	68	102	136	170	204	237	271	305	339
90	4	8	19	38	76	114	153	191	229	267	305	343	382
100	4	8	21	42	85	127	170	212	254	297	339	382	424

Table A.28 Displacement of breeding lesser black-backed gull (mean peak number = 124; low sensitivity = Subzone 1 only).

Lesser black-backed gull (breeding: May-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	1	2	4	5	6	7	9	10	11	12
20	0	0	1	2	5	7	10	12	15	17	20	22	25
25	0	1	2	3	6	9	12	16	19	22	25	28	31
30	0	1	2	4	7	11	15	19	22	26	30	33	37
40	0	1	2	5	10	15	20	25	30	35	40	45	50
50	1	1	3	6	12	19	25	31	37	43	50	56	62
60	1	1	4	7	15	22	30	37	45	52	60	67	74
70	1	2	4	9	17	26	35	43	52	61	69	78	87
75	1	2	5	9	19	28	37	47	56	65	74	84	93
80	1	2	5	10	20	30	40	50	60	69	79	89	99
90	1	2	6	11	22	33	45	56	67	78	89	100	112
100	1	2	6	12	25	37	50	62	74	87	99	112	124

Table A.29 Displacement of non-breeding lesser black-backed gull (mean peak number = 43; low sensitivity = Subzone 1 only).

Lesser black-backed gull (non-breeding: Sep-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	0	1	1	2	2	3	3	3	4	4
20	0	0	0	1	2	3	3	4	5	6	7	8	9
25	0	0	1	1	2	3	4	5	6	8	9	10	11
30	0	0	1	1	3	4	5	6	8	9	10	12	13
40	0	0	1	2	3	5	7	9	10	12	14	15	17
50	0	0	1	2	4	6	9	11	13	15	17	19	22
60	0	1	1	3	5	8	10	13	15	18	21	23	26
70	0	1	2	3	6	9	12	15	18	21	24	27	30
75	0	1	2	3	6	10	13	16	19	23	26	29	32
80	0	1	2	3	7	10	14	17	21	24	28	31	34
90	0	1	2	4	8	12	15	19	23	27	31	35	39
100	0	1	2	4	9	13	17	22	26	30	34	39	43

Table A.30 Displacement of breeding lesser black-backed gull (mean peak number = 193; Subzone 1 + 2km buffer).

Lesser black-backed gull (breeding: May-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	2	4	6	8	10	12	14	15	17	19
20	0	1	2	4	8	12	15	19	23	27	31	35	39
25	0	1	2	5	10	14	19	24	29	34	39	43	48
30	1	1	3	6	12	17	23	29	35	41	46	52	58
40	1	2	4	8	15	23	31	39	46	54	62	69	77
50	1	2	5	10	19	29	39	48	58	68	77	87	97
60	1	2	6	12	23	35	46	58	69	81	93	104	116
70	1	3	7	14	27	41	54	68	81	95	108	122	135
75	1	3	7	14	29	43	58	72	87	101	116	130	145
80	2	3	8	15	31	46	62	77	93	108	124	139	154
90	2	3	9	17	35	52	69	87	104	122	139	156	174
100	2	4	10	19	39	58	77	97	116	135	154	174	193

Table A.31 Displacement of non-breeding lesser black-backed gull (mean peak number = 66; Subzone 1 + 2km buffer).

Lesser black-backed gull (non-breeding: Sep-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	9	11	12	13
25	0	0	1	2	3	5	7	8	10	12	13	15	17
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	13	16	18	21	24	26
50	0	1	2	3	7	10	13	17	20	23	26	30	33
60	0	1	2	4	8	12	16	20	24	28	32	36	40
70	0	1	2	5	9	14	18	23	28	32	37	42	46
75	0	1	2	5	10	15	20	25	30	35	40	45	50
80	1	1	3	5	11	16	21	26	32	37	42	48	53
90	1	1	3	6	12	18	24	30	36	42	48	53	59
100	1	1	3	7	13	20	26	33	40	46	53	59	66

Table A.32 Displacement of breeding herring gull (mean peak number = 10; low sensitivity = Subzone 1 only).

Herring gull (breeding: Apr-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	0	0	0	0	1	1	1	1	1	1
20	0	0	0	0	0	1	1	1	1	1	2	2	2
25	0	0	0	0	1	1	1	1	2	2	2	2	3
30	0	0	0	0	1	1	1	2	2	2	2	3	3
40	0	0	0	0	1	1	2	2	2	3	3	4	4
50	0	0	0	1	1	2	2	3	3	4	4	5	5
60	0	0	0	1	1	2	2	3	4	4	5	5	6
70	0	0	0	1	1	2	3	4	4	5	6	6	7
75	0	0	0	1	2	2	3	4	5	5	6	7	8
80	0	0	0	1	2	2	3	4	5	6	6	7	8
90	0	0	0	1	2	3	4	5	5	6	7	8	9
100	0	0	1	1	2	3	4	5	6	7	8	9	10

Table A.33 Displacement of non-breeding herring gull (mean peak number = 67; low sensitivity = Subzone 1 only).

Herring gull (non-breeding: Sep-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	9	11	12	13
25	0	0	1	2	3	5	7	8	10	12	13	15	17
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	13	16	19	21	24	27
50	0	1	2	3	7	10	13	17	20	23	27	30	34
60	0	1	2	4	8	12	16	20	24	28	32	36	40
70	0	1	2	5	9	14	19	23	28	33	38	42	47
75	1	1	3	5	10	15	20	25	30	35	40	45	50
80	1	1	3	5	11	16	21	27	32	38	43	48	54
90	1	1	3	6	12	18	24	30	36	42	48	54	60
100	1	1	3	7	13	20	27	34	40	47	54	60	67

Table A.34 Displacement of breeding herring gull (mean peak number = 30; Subzone 1 + 2km buffer).

Herring gull (breeding: Apr-Aug)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	0	1	1	1	2	2	2	2	3	3
20	0	0	0	1	1	2	2	3	4	4	5	5	6
25	0	0	0	1	2	2	3	4	5	5	6	7	8
30	0	0	0	1	2	3	4	5	5	6	7	8	9
40	0	0	1	1	2	4	5	6	7	8	10	11	12
50	0	0	1	2	3	5	6	8	9	11	12	14	15
60	0	0	1	2	4	5	7	9	11	13	14	16	18
70	0	0	1	2	4	6	8	11	13	15	17	19	21
75	0	0	1	2	5	7	9	11	14	16	18	20	23
80	0	0	1	2	5	7	10	12	14	17	19	22	24
90	0	1	1	3	5	8	11	14	16	19	22	24	27
100	0	1	2	3	6	9	12	15	18	21	24	27	30

Table A.35 Displacement of non-breeding herring gull (mean peak number = 103; Subzone 1 + 2km buffer).

Herring gull (non-breeding: Sep-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	1	2	3	4	5	6	7	8	9	10
20	0	0	1	2	4	6	8	10	12	14	16	19	21
25	0	1	1	3	5	8	10	13	15	18	21	23	26
30	0	1	2	3	6	9	12	15	19	22	25	28	31
40	0	1	2	4	8	12	16	21	25	29	33	37	41
50	1	1	3	5	10	15	21	26	31	36	41	46	52
60	1	1	3	6	12	19	25	31	37	43	49	56	62
70	1	1	4	7	14	22	29	36	43	50	58	65	72
75	1	2	4	8	15	23	31	39	46	54	62	70	77
80	1	2	4	8	16	25	33	41	49	58	66	74	82
90	1	2	5	9	19	28	37	46	56	65	74	83	93
100	1	2	5	10	21	31	41	52	62	72	82	93	103

Table A.36 Displacement of breeding guillemot (mean peak number = 3,458; medium sensitivity = Subzone 1 + 1km buffer).

Guillemot (breeding: May-Jun)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	3	7	17	35	69	104	138	173	207	242	277	311	346
20	7	14	35	69	138	207	277	346	415	484	553	622	692
25	9	17	43	86	173	259	346	432	519	605	692	778	865
30	10	21	52	104	207	311	415	519	622	726	830	934	1,037
40	14	28	69	138	277	415	553	692	830	968	1,107	1,245	1,383
50	17	35	86	173	346	519	692	865	1,037	1,210	1,383	1,556	1,729
60	21	41	104	207	415	622	830	1,037	1,245	1,452	1,660	1,867	2,075
70	24	48	121	242	484	726	968	1,210	1,452	1,694	1,936	2,179	2,421
75	26	52	130	259	519	778	1,037	1,297	1,556	1,815	2,075	2,334	2,594
80	28	55	138	277	553	830	1,107	1,383	1,660	1,936	2,213	2,490	2,766
90	31	62	156	311	622	934	1,245	1,556	1,867	2,179	2,490	2,801	3,112
100	35	69	173	346	692	1,037	1,383	1,729	2,075	2,421	2,766	3,112	3,458

Table A.37 Displacement of post-breeding guillemot (mean peak number = 19,016; medium sensitivity = Subzone 1 + 1km buffer).

Guillemot (post-breeding: Jul-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	19	38	95	190	380	570	761	951	1,141	1,331	1,521	1,711	1,902
20	38	76	190	380	761	1,141	1,521	1,902	2,282	2,662	3,043	3,423	3,803
25	48	95	238	475	951	1,426	1,902	2,377	2,852	3,328	3,803	4,279	4,754
30	57	114	285	570	1,141	1,711	2,282	2,852	3,423	3,993	4,564	5,134	5,705
40	76	152	380	761	1,521	2,282	3,043	3,803	4,564	5,324	6,085	6,846	7,606
50	95	190	475	951	1,902	2,852	3,803	4,754	5,705	6,656	7,606	8,557	9,508
60	114	228	570	1,141	2,282	3,423	4,564	5,705	6,846	7,987	9,128	10,269	11,410
70	133	266	666	1,331	2,662	3,993	5,324	6,656	7,987	9,318	10,649	11,980	13,311
75	143	285	713	1,426	2,852	4,279	5,705	7,131	8,557	9,983	11,410	12,836	14,262
80	152	304	761	1,521	3,043	4,564	6,085	7,606	9,128	10,649	12,170	13,692	15,213
90	171	342	856	1,711	3,423	5,134	6,846	8,557	10,269	11,980	13,692	15,403	17,114
100	190	380	951	1,902	3,803	5,705	7,606	9,508	11,410	13,311	15,213	17,114	19,016

Table A.38 Displacement of non-breeding guillemot (mean peak number = 15,364; medium sensitivity = Subzone 1 + 1km buffer).

Guillemot (non-breeding: Oct-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	15	31	77	154	307	461	615	768	922	1,075	1,229	1,383	1,536
20	31	61	154	307	615	922	1,229	1,536	1,844	2,151	2,458	2,766	3,073
25	38	77	192	384	768	1,152	1,536	1,921	2,305	2,689	3,073	3,457	3,841
30	46	92	230	461	922	1,383	1,844	2,305	2,766	3,226	3,687	4,148	4,609
40	61	123	307	615	1,229	1,844	2,458	3,073	3,687	4,302	4,916	5,531	6,146
50	77	154	384	768	1,536	2,305	3,073	3,841	4,609	5,377	6,146	6,914	7,682
60	92	184	461	922	1,844	2,766	3,687	4,609	5,531	6,453	7,375	8,297	9,218
70	108	215	538	1,075	2,151	3,226	4,302	5,377	6,453	7,528	8,604	9,679	10,755
75	115	230	576	1,152	2,305	3,457	4,609	5,762	6,914	8,066	9,218	10,371	11,523
80	123	246	615	1,229	2,458	3,687	4,916	6,146	7,375	8,604	9,833	11,062	12,291
90	138	277	691	1,383	2,766	4,148	5,531	6,914	8,297	9,679	11,062	12,445	13,828
100	154	307	768	1,536	3,073	4,609	6,146	7,682	9,218	10,755	12,291	13,828	15,364

Table A.39 Displacement of breeding guillemot (mean peak number = 4,218; medium sensitivity = Subzone 1 + 2km buffer).

Guillemot (breeding: May-Jun)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	4	8	21	42	84	127	169	211	253	295	337	380	422
20	8	17	42	84	169	253	337	422	506	591	675	759	844
25	11	21	53	105	211	316	422	527	633	738	844	949	1,055
30	13	25	63	127	253	380	506	633	759	886	1,012	1,139	1,265
40	17	34	84	169	337	506	675	844	1,012	1,181	1,350	1,518	1,687
50	21	42	105	211	422	633	844	1,055	1,265	1,476	1,687	1,898	2,109
60	25	51	127	253	506	759	1,012	1,265	1,518	1,772	2,025	2,278	2,531
70	30	59	148	295	591	886	1,181	1,476	1,772	2,067	2,362	2,657	2,953
75	32	63	158	316	633	949	1,265	1,582	1,898	2,214	2,531	2,847	3,164
80	34	67	169	337	675	1,012	1,350	1,687	2,025	2,362	2,700	3,037	3,374
90	38	76	190	380	759	1,139	1,518	1,898	2,278	2,657	3,037	3,417	3,796
100	42	84	211	422	844	1,265	1,687	2,109	2,531	2,953	3,374	3,796	4,218

Table A.40 Displacement of post-breeding guillemot (mean peak number = 23,191; medium sensitivity = Subzone 1 + 2km buffer).

Guillemot (post-breeding: Jul-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	23	46	116	232	464	696	928	1,160	1,391	1,623	1,855	2,087	2,319
20	46	93	232	464	928	1,391	1,855	2,319	2,783	3,247	3,711	4,174	4,638
25	58	116	290	580	1,160	1,739	2,319	2,899	3,479	4,058	4,638	5,218	5,798
30	70	139	348	696	1,391	2,087	2,783	3,479	4,174	4,870	5,566	6,262	6,957
40	93	186	464	928	1,855	2,783	3,711	4,638	5,566	6,493	7,421	8,349	9,276
50	116	232	580	1,160	2,319	3,479	4,638	5,798	6,957	8,117	9,276	10,436	11,596
60	139	278	696	1,391	2,783	4,174	5,566	6,957	8,349	9,740	11,132	12,523	13,915
70	162	325	812	1,623	3,247	4,870	6,493	8,117	9,740	11,364	12,987	14,610	16,234
75	174	348	870	1,739	3,479	5,218	6,957	8,697	10,436	12,175	13,915	15,654	17,393
80	186	371	928	1,855	3,711	5,566	7,421	9,276	11,132	12,987	14,842	16,698	18,553
90	209	417	1,044	2,087	4,174	6,262	8,349	10,436	12,523	14,610	16,698	18,785	20,872
100	232	464	1,160	2,319	4,638	6,957	9,276	11,596	13,915	16,234	18,553	20,872	23,191

Table A.41 Displacement of non-breeding guillemot (mean peak number = 18,736; medium sensitivity = Subzone 1 + 2km buffer).

Guillemot (non-breeding: Oct-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	19	37	94	187	375	562	749	937	1,124	1,312	1,499	1,686	1,874
20	37	75	187	375	749	1,124	1,499	1,874	2,248	2,623	2,998	3,372	3,747
25	47	94	234	468	937	1,405	1,874	2,342	2,810	3,279	3,747	4,216	4,684
30	56	112	281	562	1,124	1,686	2,248	2,810	3,372	3,935	4,497	5,059	5,621
40	75	150	375	749	1,499	2,248	2,998	3,747	4,497	5,246	5,996	6,745	7,494
50	94	187	468	937	1,874	2,810	3,747	4,684	5,621	6,558	7,494	8,431	9,368
60	112	225	562	1,124	2,248	3,372	4,497	5,621	6,745	7,869	8,993	10,117	11,242
70	131	262	656	1,312	2,623	3,935	5,246	6,558	7,869	9,181	10,492	11,804	13,115
75	141	281	703	1,405	2,810	4,216	5,621	7,026	8,431	9,836	11,242	12,647	14,052
80	150	300	749	1,499	2,998	4,497	5,996	7,494	8,993	10,492	11,991	13,490	14,989
90	169	337	843	1,686	3,372	5,059	6,745	8,431	10,117	11,804	13,490	15,176	16,862
100	187	375	937	1,874	3,747	5,621	7,494	9,368	11,242	13,115	14,989	16,862	18,736

Table A.42 Displacement of breeding razorbill (mean peak number = 915; medium sensitivity = Subzone 1 + 1km buffer).

Razorbill (breeding: May-Jun)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	2	5	9	18	27	37	46	55	64	73	82	92
20	2	4	9	18	37	55	73	92	110	128	146	165	183
25	2	5	11	23	46	69	92	114	137	160	183	206	229
30	3	5	14	27	55	82	110	137	165	192	220	247	275
40	4	7	18	37	73	110	146	183	220	256	293	329	366
50	5	9	23	46	92	137	183	229	275	320	366	412	458
60	5	11	27	55	110	165	220	275	329	384	439	494	549
70	6	13	32	64	128	192	256	320	384	448	512	576	641
75	7	14	34	69	137	206	275	343	412	480	549	618	686
80	7	15	37	73	146	220	293	366	439	512	586	659	732
90	8	16	41	82	165	247	329	412	494	576	659	741	824
100	9	18	46	92	183	275	366	458	549	641	732	824	915

Table A.43 Displacement of post-breeding razorbill (mean peak number = 7,314; medium sensitivity = Subzone 1 + 1km buffer).

Razorbill (post-breeding: Jul-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	7	15	37	73	146	219	293	366	439	512	585	658	731
20	15	29	73	146	293	439	585	731	878	1,024	1,170	1,317	1,463
25	18	37	91	183	366	549	731	914	1,097	1,280	1,463	1,646	1,829
30	22	44	110	219	439	658	878	1,097	1,317	1,536	1,755	1,975	2,194
40	29	59	146	293	585	878	1,170	1,463	1,755	2,048	2,340	2,633	2,926
50	37	73	183	366	731	1,097	1,463	1,829	2,194	2,560	2,926	3,291	3,657
60	44	88	219	439	878	1,317	1,755	2,194	2,633	3,072	3,511	3,950	4,388
70	51	102	256	512	1,024	1,536	2,048	2,560	3,072	3,584	4,096	4,608	5,120
75	55	110	274	549	1,097	1,646	2,194	2,743	3,291	3,840	4,388	4,937	5,486
80	59	117	293	585	1,170	1,755	2,340	2,926	3,511	4,096	4,681	5,266	5,851
90	66	132	329	658	1,317	1,975	2,633	3,291	3,950	4,608	5,266	5,924	6,583
100	73	146	366	731	1,463	2,194	2,926	3,657	4,388	5,120	5,851	6,583	7,314

Table A.44 Displacement of non-breeding razorbill (mean peak number = 6,570; medium sensitivity = Subzone 1 + 1km buffer).

Razorbill (non-breeding: Oct-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	7	13	33	66	131	197	263	329	394	460	526	591	657
20	13	26	66	131	263	394	526	657	788	920	1,051	1,183	1,314
25	16	33	82	164	329	493	657	821	986	1,150	1,314	1,478	1,643
30	20	39	99	197	394	591	788	986	1,183	1,380	1,577	1,774	1,971
40	26	53	131	263	526	788	1,051	1,314	1,577	1,840	2,102	2,365	2,628
50	33	66	164	329	657	986	1,314	1,643	1,971	2,300	2,628	2,957	3,285
60	39	79	197	394	788	1,183	1,577	1,971	2,365	2,759	3,154	3,548	3,942
70	46	92	230	460	920	1,380	1,840	2,300	2,759	3,219	3,679	4,139	4,599
75	49	99	246	493	986	1,478	1,971	2,464	2,957	3,449	3,942	4,435	4,928
80	53	105	263	526	1,051	1,577	2,102	2,628	3,154	3,679	4,205	4,730	5,256
90	59	118	296	591	1,183	1,774	2,365	2,957	3,548	4,139	4,730	5,322	5,913
100	66	131	329	657	1,314	1,971	2,628	3,285	3,942	4,599	5,256	5,913	6,570

Table A.45 Displacement of breeding razorbill (mean peak number = 1,115; medium sensitivity = Subzone 1 + 2km buffer).

Razorbill (breeding: May-Jun)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	2	6	11	22	33	45	56	67	78	89	100	112
20	2	4	11	22	45	67	89	112	134	156	178	201	223
25	3	6	14	28	56	84	112	139	167	195	223	251	279
30	3	7	17	33	67	100	134	167	201	234	268	301	335
40	4	9	22	45	89	134	178	223	268	312	357	401	446
50	6	11	28	56	112	167	223	279	335	390	446	502	558
60	7	13	33	67	134	201	268	335	401	468	535	602	669
70	8	16	39	78	156	234	312	390	468	546	624	702	781
75	8	17	42	84	167	251	335	418	502	585	669	753	836
80	9	18	45	89	178	268	357	446	535	624	714	803	892
90	10	20	50	100	201	301	401	502	602	702	803	903	1,004
100	11	22	56	112	223	335	446	558	669	781	892	1,004	1,115

Table A.46 Displacement of post-breeding razorbill (mean peak number = 8,920; medium sensitivity = Subzone 1 + 2km buffer).

Razorbill (post-breeding: Jul-Sep)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	9	18	45	89	178	268	357	446	535	624	714	803	892
20	18	36	89	178	357	535	714	892	1,070	1,249	1,427	1,606	1,784
25	22	45	112	223	446	669	892	1,115	1,338	1,561	1,784	2,007	2,230
30	27	54	134	268	535	803	1,070	1,338	1,606	1,873	2,141	2,408	2,676
40	36	71	178	357	714	1,070	1,427	1,784	2,141	2,498	2,854	3,211	3,568
50	45	89	223	446	892	1,338	1,784	2,230	2,676	3,122	3,568	4,014	4,460
60	54	107	268	535	1,070	1,606	2,141	2,676	3,211	3,746	4,282	4,817	5,352
70	62	125	312	624	1,249	1,873	2,498	3,122	3,746	4,371	4,995	5,620	6,244
75	67	134	335	669	1,338	2,007	2,676	3,345	4,014	4,683	5,352	6,021	6,690
80	71	143	357	714	1,427	2,141	2,854	3,568	4,282	4,995	5,709	6,422	7,136
90	80	161	401	803	1,606	2,408	3,211	4,014	4,817	5,620	6,422	7,225	8,028
100	89	178	446	892	1,784	2,676	3,568	4,460	5,352	6,244	7,136	8,028	8,920

Table A.47 Displacement of non-breeding razorbill (mean peak number = 8,011; medium sensitivity = Subzone 1 + 2km buffer).

Razorbill (non-breeding: Oct-Apr)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	8	16	40	80	160	240	320	401	481	561	641	721	801
20	16	32	80	160	320	481	641	801	961	1,122	1,282	1,442	1,602
25	20	40	100	200	401	601	801	1,001	1,202	1,402	1,602	1,802	2,003
30	24	48	120	240	481	721	961	1,202	1,442	1,682	1,923	2,163	2,403
40	32	64	160	320	641	961	1,282	1,602	1,923	2,243	2,564	2,884	3,204
50	40	80	200	401	801	1,202	1,602	2,003	2,403	2,804	3,204	3,605	4,006
60	48	96	240	481	961	1,442	1,923	2,403	2,884	3,365	3,845	4,326	4,807
70	56	112	280	561	1,122	1,682	2,243	2,804	3,365	3,925	4,486	5,047	5,608
75	60	120	300	601	1,202	1,802	2,403	3,004	3,605	4,206	4,807	5,407	6,008
80	64	128	320	641	1,282	1,923	2,564	3,204	3,845	4,486	5,127	5,768	6,409
90	72	144	360	721	1,442	2,163	2,884	3,605	4,326	5,047	5,768	6,489	7,210
100	80	160	401	801	1,602	2,403	3,204	4,006	4,807	5,608	6,409	7,210	8,011

Table A.48 Displacement of breeding puffin (mean peak number = 1,070; medium sensitivity = Subzone 1 + 1km buffer).

Puffin (breeding: Apr-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	2	5	11	21	32	43	54	64	75	86	96	107
20	2	4	11	21	43	64	86	107	128	150	171	193	214
25	3	5	13	27	54	80	107	134	161	187	214	241	268
30	3	6	16	32	64	96	128	161	193	225	257	289	321
40	4	9	21	43	86	128	171	214	257	300	342	385	428
50	5	11	27	54	107	161	214	268	321	375	428	482	535
60	6	13	32	64	128	193	257	321	385	449	514	578	642
70	7	15	37	75	150	225	300	375	449	524	599	674	749
75	8	16	40	80	161	241	321	401	482	562	642	722	803
80	9	17	43	86	171	257	342	428	514	599	685	770	856
90	10	19	48	96	193	289	385	482	578	674	770	867	963
100	11	21	54	107	214	321	428	535	642	749	856	963	1,070

Table A.49 Displacement of non-breeding puffin (mean peak number = 1,257; medium sensitivity = Subzone 1 + 1km buffer).

Puffin (non-breeding: Aug-Marl)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	3	6	13	25	38	50	63	75	88	101	113	126
20	3	5	13	25	50	75	101	126	151	176	201	226	251
25	3	6	16	31	63	94	126	157	189	220	251	283	314
30	4	8	19	38	75	113	151	189	226	264	302	339	377
40	5	10	25	50	101	151	201	251	302	352	402	453	503
50	6	13	31	63	126	189	251	314	377	440	503	566	629
60	8	15	38	75	151	226	302	377	453	528	603	679	754
70	9	18	44	88	176	264	352	440	528	616	704	792	880
75	9	19	47	94	189	283	377	471	566	660	754	848	943
80	10	20	50	101	201	302	402	503	603	704	804	905	1,006
90	11	23	57	113	226	339	453	566	679	792	905	1,018	1,131
100	13	25	63	126	251	377	503	629	754	880	1,006	1,131	1,257

Table A.50 Displacement of breeding puffin (mean peak number = 1,305; medium sensitivity = Subzone 1 + 2km buffer).

Puffin (breeding: Apr-Jul)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	3	7	13	26	39	52	65	78	91	104	117	131
20	3	5	13	26	52	78	104	131	157	183	209	235	261
25	3	7	16	33	65	98	131	163	196	228	261	294	326
30	4	8	20	39	78	117	157	196	235	274	313	352	392
40	5	10	26	52	104	157	209	261	313	365	418	470	522
50	7	13	33	65	131	196	261	326	392	457	522	587	653
60	8	16	39	78	157	235	313	392	470	548	626	705	783
70	9	18	46	91	183	274	365	457	548	639	731	822	914
75	10	20	49	98	196	294	392	489	587	685	783	881	979
80	10	21	52	104	209	313	418	522	626	731	835	940	1,044
90	12	23	59	117	235	352	470	587	705	822	940	1,057	1,175
100	13	26	65	131	261	392	522	653	783	914	1,044	1,175	1,305

Table A.51 Displacement of non-breeding puffin (mean peak number = 1,534; medium sensitivity = Subzone 1 + 2km buffer).

Puffin (non-breeding: Aug-Mar)	Mortality (%)												
Displaced (%)	**1**	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	2	3	8	15	31	46	61	77	92	107	123	138	153
20	3	6	15	31	61	92	123	153	184	215	245	276	307
25	4	8	19	38	77	115	153	192	230	268	307	345	384
30	5	9	23	46	92	138	184	230	276	322	368	414	460
40	6	12	31	61	123	184	245	307	368	430	491	552	614
50	8	15	38	77	153	230	307	384	460	537	614	690	767
60	9	18	46	92	184	276	368	460	552	644	736	828	920
70	11	21	54	107	215	322	430	537	644	752	859	966	1,074
75	12	23	58	115	230	345	460	575	690	805	920	1,035	1,151
80	12	25	61	123	245	368	491	614	736	859	982	1,104	1,227
90	14	28	69	138	276	414	552	690	828	966	1,104	1,243	1,381
100	15	31	77	153	307	460	614	767	920	1,074	1,227	1,381	1,534

Table A.52 Mean peak population estimates for VORs within Subzone 1 + 4 km buffer.

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Fulmar	Breeding	Mar - Jul	May	897	June	3,171	2,034
	Non-breeding	Aug - Feb	Aug	465	Sep	541	503
Gannet	Breeding	Apr -Sep	Aug	660	Sep	805	733
	Non-breeding	Oct - Mar	Nov	827	Oct	624	726
Arctic skua*	Breeding	May - Aug	Aug	34	Aug	61	48
	Passage	Sep - Nov	Sep	141	Sep	142	142
Great skua*	Breeding	May - Aug	Aug	34	Jul	30	32
	Wintering	Sep - Apr	Sep	44	Sep	144	94
Little gull	Breeding	May - Jul	N/A	0	N/A	0	0
	Passage	Aug - Nov	Oct	12,226	Oct/Nov	68	6,147
	Wintering	Dec - Apr	Apr	54	Feb	74	64
Great black-backed gull	Breeding	Apr - Aug	Aug	87	Apr	258	173
	Non-breeding	Sep - Mar	Jan	474	Oct	477	476
Lesser black-backed gull	Breeding	May-Aug	Aug	330	Jun	203	267
	Non-breeding	Sep-Apr	Apr/Dec	58	Apr	125	92
Herring gull	Breeding	Apr-Aug	May	7	Apr	38	23
	Non-breeding	Sep-Mar	Dec	234	Mar	51	143
Kittiwake	Breeding	Mar-Jul	Jun	4,095	Jul	3,862	3,979
	Non-breeding	Aug-Feb	Aug	20,347	Sep	52,946	36,647
Small gulls	Breeding	Mar-Jul	Jun	4,150	Jun	4,177	4,164
	Non-breeding	Aug-Feb	Aug	23,456	Sep	55,351	39,404
Large gulls	Breeding	Apr - Aug	Aug	407	Apr	417	412
	Non-breeding	Sep - Mar	Jan	538	Sep	948	743
All gulls	Breeding	Apr - Aug	Aug	15,027	Jun	3,450	9,239
	Non-breeding	Sep - Mar	Oct	11,865	Sep	10,063	10,964
Common tern	Breeding	May - Sep	Sep	1,339	May	58	699
	Non-breeding	Oct - Apr	Oct	125	N/A	0	63
Arctic tern*	Breeding	May - Aug	Aug	765	Oct	30	398
	Non-breeding	Sep - Apr	May	754	Sep and Oct	14	384
Guillemot	Breeding	May - Jun	Jun	4,767	Jun	6,895	5,831
	Post-breeding	Jul - Sep	Sep	25,154	Sep	18,251	21,703
	Non-breeding	Oct - Apr	Oct	42,034	Oct	9,776	25,905

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Razorbill	Breeding	May - Jun	Jun	712	Jun	525	619
	Post-breeding	Jul - Sep	Sep	12,177	Sep	9,139	10,658
	Non-breeding	Oct - Apr	Oct	15,241	Apr	3,038	9,140
Puffin	Breeding	Apr - Jul	Jun	2,842	Apr	765	1,804
	Non-breeding	Aug - Mar	Oct	1,707	Nov	2,533	2,120
Large auks	Breeding	May - Jun	Jun	5,648	Jun	7,308	6,478
	Post-breeding	Jul - Sep	Sep	51,001	Sep	31,215	41,108
	Non-breeding	Oct - Apr	Oct	61,179	Oct	12,667	36,923
All auks	Breeding	May - Jun	Jun	8,134	Jun	7,283	7,709
	Post-breeding	Jul - Sep	Sep	47,594	Sep	32,058	39,826
	Non-breeding	Oct - Apr	Oct	57,810	Oct	11,654	34,732

* Population estimates obtained using correction factors in Stone *et al.* (1995).

Table A.53 Mean peak population estimates for VORs within Subzone 1 + 2km buffer.

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Fulmar	Breeding	Mar - Jul	May	649	Jun	2,293	1,471
	Non-breeding	Aug - Feb	Aug	336	Sep	391	364
Gannet	Breeding	May - Sep	Aug	477	Sep	582	530
	Non-breeding	Oct - Apr	Nov	598	Oct	451	525
Little gull	Breeding	May - Jul	N/A	0	N/A	0	0
	Passage	Aug - Nov	Oct	8,843	Oct/ Nov	49	4,446
	Wintering	Dec - Apr	Apr	39	Feb	54	47
Great black-backed gull	Breeding	Apr - Aug	Aug	63	Apr	186	125
	Non-breeding	Sep - Mar	Jan	343	Sep	413	378
Lesser black-backed gull	Breeding	May-Aug	Aug	239	Jun	147	193
	Non-breeding	Sep-Apr	Apr/ Dec	42	Apr	90	66
Herring gull	Breeding	Apr-Aug	May	5	Apr	27	16
	Non-breeding	Sep-Mar	Dec	169	Mar	37	103
Kittiwake	Breeding	Mar-Jul	Jun	2,962	Jul	2,793	2,878
	Non-breeding	Aug-Feb	Aug	14,716	Sep	38,294	26,505
Small gulls	Breeding	Mar-Jul	Jun	3,002	Jun	2,949	2,976
	Non-breeding	Aug-Feb	Aug	16,965	Sep	46,632	31,799

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Large gulls	Breeding	Apr - Aug	Aug	294	Apr	302	298
	Non-breeding	Sep - Mar	Jan	389	Sep	685	537
All gulls	Breeding	Apr - Aug	Aug	10,869	Jun	2,495	6,682
	Non-breeding	Sep - Mar	Oct	8,581	Sep	7,278	7,930
Common tern	Breeding	May - Sep	Sep	968	May	42	505
	Non-breeding	Oct - Apr	Oct	90	N/A	0	45
Guillemot	Breeding	May - Jun	Jun	3,448	Jun	4,987	4,218
	Post-breeding	Jul - Sep	Sep	18,193	Sep	13,201	15,697
	Non-breeding	Oct - Apr	Oct	30,402	Oct	7,070	18,736
Razorbill	Breeding	May - Jun	Jun	515	Jun	380	448
	Post-breeding	Jul - Sep	Sep	8,807	Sep	6,610	7,709
	Non-breeding	Oct - Apr	Oct	11,024	Apr	2,197	6,611
Puffin	Breeding	Apr - Jul	Jun	2,056	Apr	553	1,305
	Non-breeding	Aug - Mar	Oct	1,235	Nov	1,832	1,534
Large auks	Breeding	May - Jun	Jun	4,085	Jun	5,286	4,686
	Post-breeding	Jul - Sep	Sep	36,887	Sep	22,577	29,732
	Non-breeding	Oct - Apr	Oct	44,249	Oct	9,162	26,706
All auks	Breeding	May - Jun	Jun	5,883	Jun	5,268	5,576
	Post-breeding	Jul - Sep	Sep	34,423	Sep	23,186	28,805
	Non-breeding	Oct - Apr	Oct	41,812	Oct	8,429	25,121

Table A.54 Mean peak population estimates for VORs within Subzone 1 + 1km buffer.

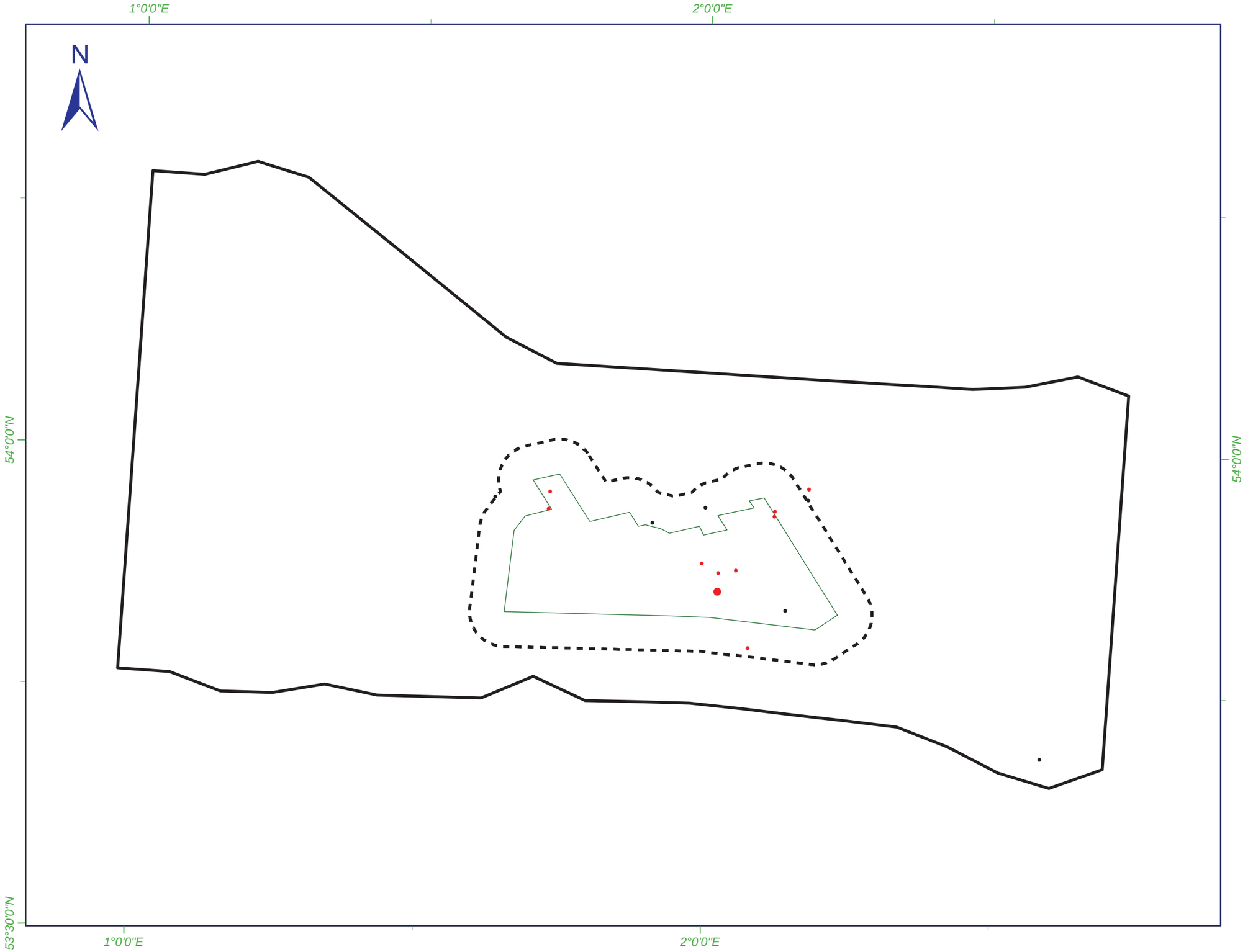
Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Fulmar	Breeding	Mar - Jul	May	532	Jun	1,881	1,207
	Non-breeding	Aug - Feb	Aug	276	Sep	391	334
Gannet	Breeding	May - Sep	Aug	392	Sep	477	435
	Non-breeding	Oct - Apr	Nov	490	Oct	370	430
Little gull	Breeding	May - Jul	N/A	0	N/A	0	0
	Passage	Aug - Nov	Oct	7,251	Oct	40	3,646
	Wintering	Dec - Apr	Apr	32	Feb	44	38
Great black-backed gull	Breeding	Apr - Aug	Aug	52	Apr	153	103
	Non-breeding	Sep - Mar	Jan	281	Sep	339	310

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Lesser black-backed gull	Breeding	May-Aug	Aug	196	Jun	120	158
	Non-breeding	Sep-Apr	Apr	34	Apr	74	54
Herring gull	Breeding	Apr-Aug	May	4	May	18	11
	Non-breeding	Sep-Mar	Dec	139	Mar	30	85
Kittiwake	Breeding	Mar-Jul	Jun	2,429	Jul	2,291	2,360
	Non-breeding	Aug-Feb	Aug	12,067	Sep	31,401	21,734
Small gulls	Breeding	Mar-Jul	Jun	2,461	Jun	2,418	2,440
	Non-breeding	Aug-Feb	Aug	13,911	Sep	38,238	26,075
Large gulls	Breeding	Apr - Aug	Aug	241	Apr	247	244
	Non-breeding	Sep - Mar	Jan	319	Sep	562	441
All gulls	Breeding	Apr - Aug	Aug	8,912	Jun	2,046	5,479
	Non-breeding	Sep - Mar	Oct	7,037	Sep	5,968	6,503
Common tern	Breeding	May - Sep	Sep	794	May	34	414
	Non-breeding	Oct - Apr	Oct	74	N/A	0	37
Guillemot	Breeding	May - Jun	Jun	2,827	Jun	4,089	3,458
	Post-breeding	Jul - Sep	Sep	14,918	Sep	10,825	12,872
	Non-breeding	Oct - Apr	Oct	24,930	Oct	5,798	15,364
Razorbill	Breeding	May - Jun	Jun	422	Jun	312	367
	Post-breeding	Jul - Sep	Sep	7,222	Sep	5,420	6,321
	Non-breeding	Oct - Apr	Oct	9,039	Apr	1,802	5,421
Puffin	Breeding	Apr - Jul	Jun	1,686	Apr	454	1,070
	Non-breeding	Aug - Mar	Oct	1,012	Nov	1,502	1,257
Large auks	Breeding	May - Jun	Jun	3,350	Jun	4,334	3,842
	Post-breeding	Jul - Sep	Sep	30,247	Sep	18,513	24,380
	Non-breeding	Oct - Apr	Oct	36,284	Oct	7,513	21,899
All auks	Breeding	May - Jun	Jun	4,824	Jun	4,319	4,572
	Post-breeding	Jul - Sep	Sep	28,227	Sep	19,031	23,629
	Non-breeding	Oct - Apr	Oct	34,286	Oct	6,912	20,599

Table A.55 Mean peak population estimates for Subzone 1 only, for flying and sitting birds (*estimated counts based on correction factors in Stone *et al*. (1995) – note all birds assumed to be on sea).

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Fulmar	Breeding	Mar - Jul	May	418	Jun	1,477	948
	Non-breeding	Aug - Feb	Aug	217	Sep	252	235
Gannet	Breeding	May - Sep	Aug	307	Sep	375	341
	Non-breeding	Oct - Apr	Nov	385	Oct	290	338
Little gull	Breeding	May - Jul	N/A	0	N/A	0	0
	Passage	Aug - Nov	Oct	5,694	Oct	32	2,863
	Wintering	Dec - Apr	Apr	25	Feb	34	30
Great black-backed gull	Breeding	Apr - Aug	Aug	40	Apr	120	80
	Non-breeding	Sep - Mar	Jan	221	Sep	266	244
Lesser black-backed gull	Breeding	May-Aug	Aug	154	Jun	94	124
	Non-breeding	Sep-Apr	Apr	27	Apr	58	43
Herring gull	Breeding	Apr-Aug	May	3	May	14	9
	Non-breeding	Sep-Mar	Dec	109	Mar	24	67
Kittiwake	Breeding	Mar-Jul	Jun	1,907	Jul	1,799	1,853
	Non-breeding	Aug-Feb	Aug	9,477	Sep	24,659	17,068
Small gulls	Breeding	Mar-Jul	Jun	1,933	Jun	1,899	1,916
	Non-breeding	Aug-Feb	Aug	10,925	Sep	30,028	20,477
Large gulls	Breeding	Apr - Aug	Aug	190	Apr	194	192
	Non-breeding	Sep - Mar	Jan	254	Sep	442	348
All gulls	Breeding	Apr - Aug	Aug	6,999	Jun	1,607	4,303
	Non-breeding	Sep - Mar	Oct	5,526	Sep	4,687	5,107
Common tern	Breeding	May - Sep	Sep	624	May	27	326
	Non-breeding	Oct - Apr	Oct	59	N/A	0	30
Guillemot	Breeding	May - Jun	Jun	2,220	Jun	3,211	2,716
	Post-breeding	Jul - Sep	Sep	11,716	Sep	8,501	10,109
	Non-breeding	Oct - Apr	Oct	19,578	Oct	4,553	12,066
Razorbill	Breeding	May - Jun	Jun	331	Jun	245	288
	Post-breeding	Jul - Sep	Sep	5,671	Sep	4,256	4,964
	Non-breeding	Oct - Apr	Oct	7,098	Apr	1,415	4,257
Puffin	Breeding	Apr - Jul	Jun	1,323	Apr	356	840
	Non-breeding	Aug - Mar	Oct	795	Nov	1,180	988

Species	Season	Months	Year 1 peak month	Year 1 peak figure	Year 2 peak month	Year 2 peak figure	Mean peak Years 1 & 2
Large auks	Breeding	May - Jun	Jun	2,631	Jun	3,404	3,018
	Post-breeding	Jul - Sep	Sep	23,753	Sep	14,538	19,146
	Non-breeding	Oct - Apr	Oct	28,494	Oct	5,899	17,197
All auks	Breeding	May - Jun	Jun	3,788	Jun	3,392	3,590
	Post-breeding	Jul - Sep	Sep	22,167	Sep	14,931	18,549
	Non-breeding	Oct - Apr	Oct	26,924	Oct	5,427	16,176



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

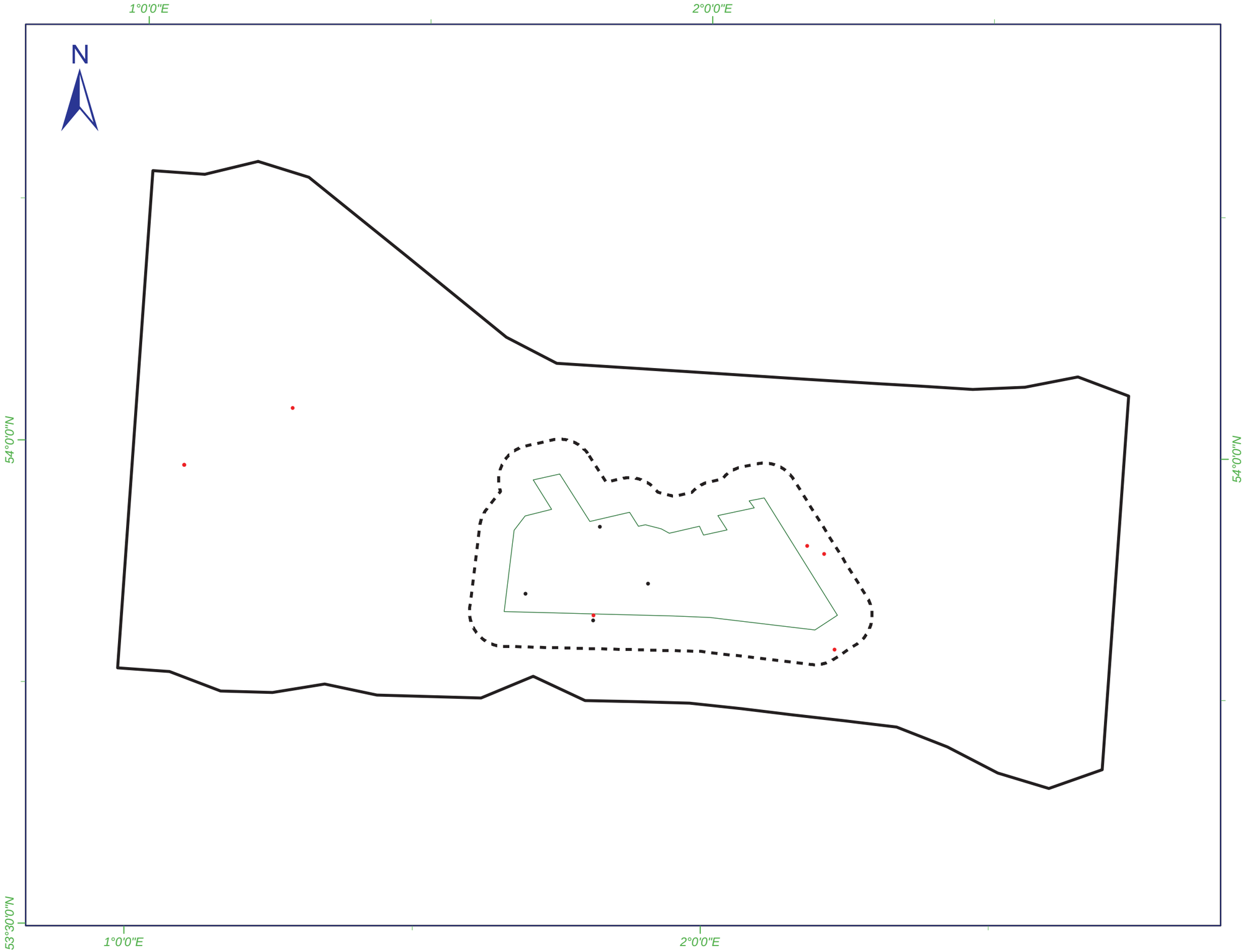
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Arctic Skua Abundance (August to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ArcticSkuaAbundanceAugToOct2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

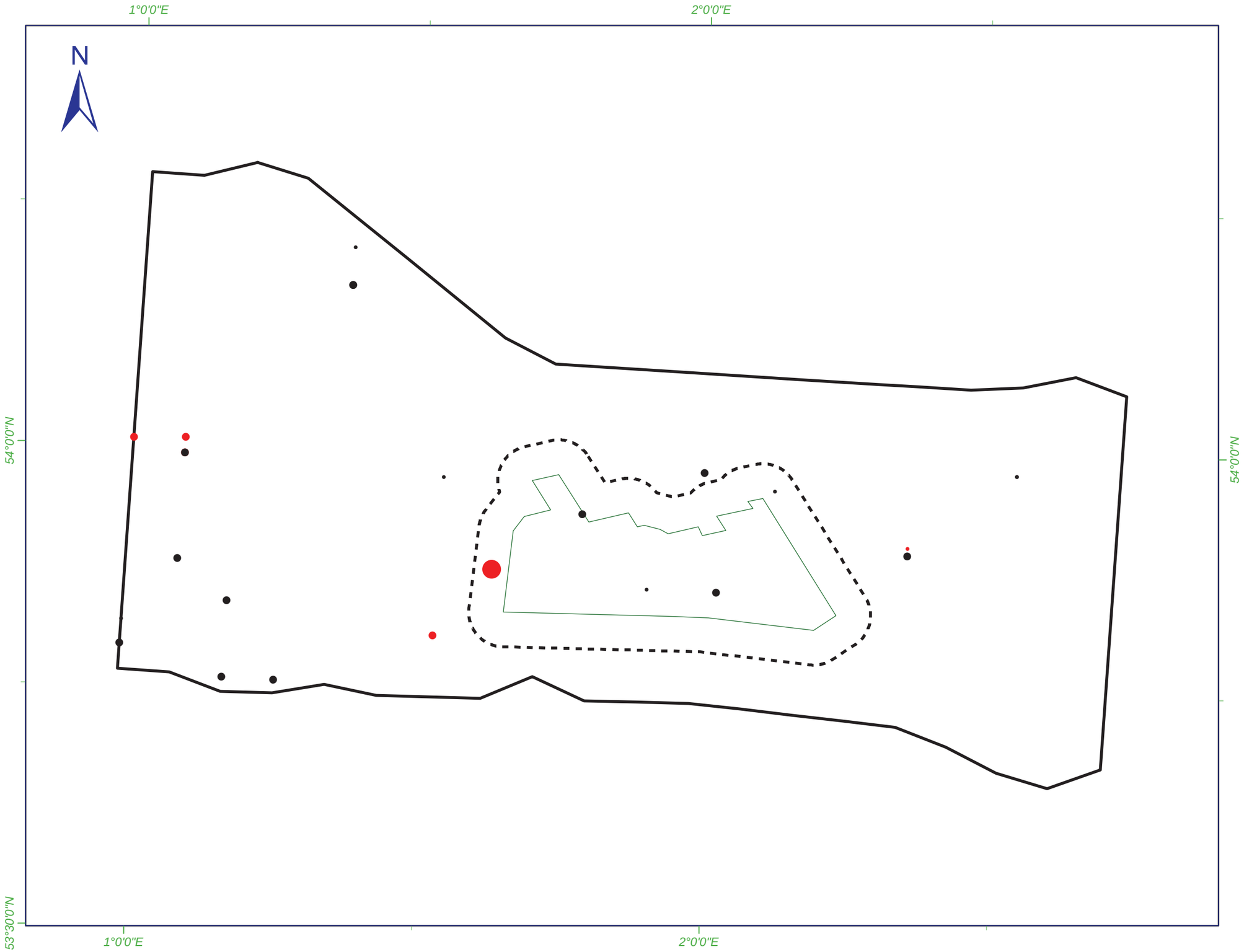
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Arctic Skua Abundance (August to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ArcticSkuaAbundanceAugToOct2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Arctic Tern Abundance (May to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ArcticTernAbundanceMayToOct2010_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

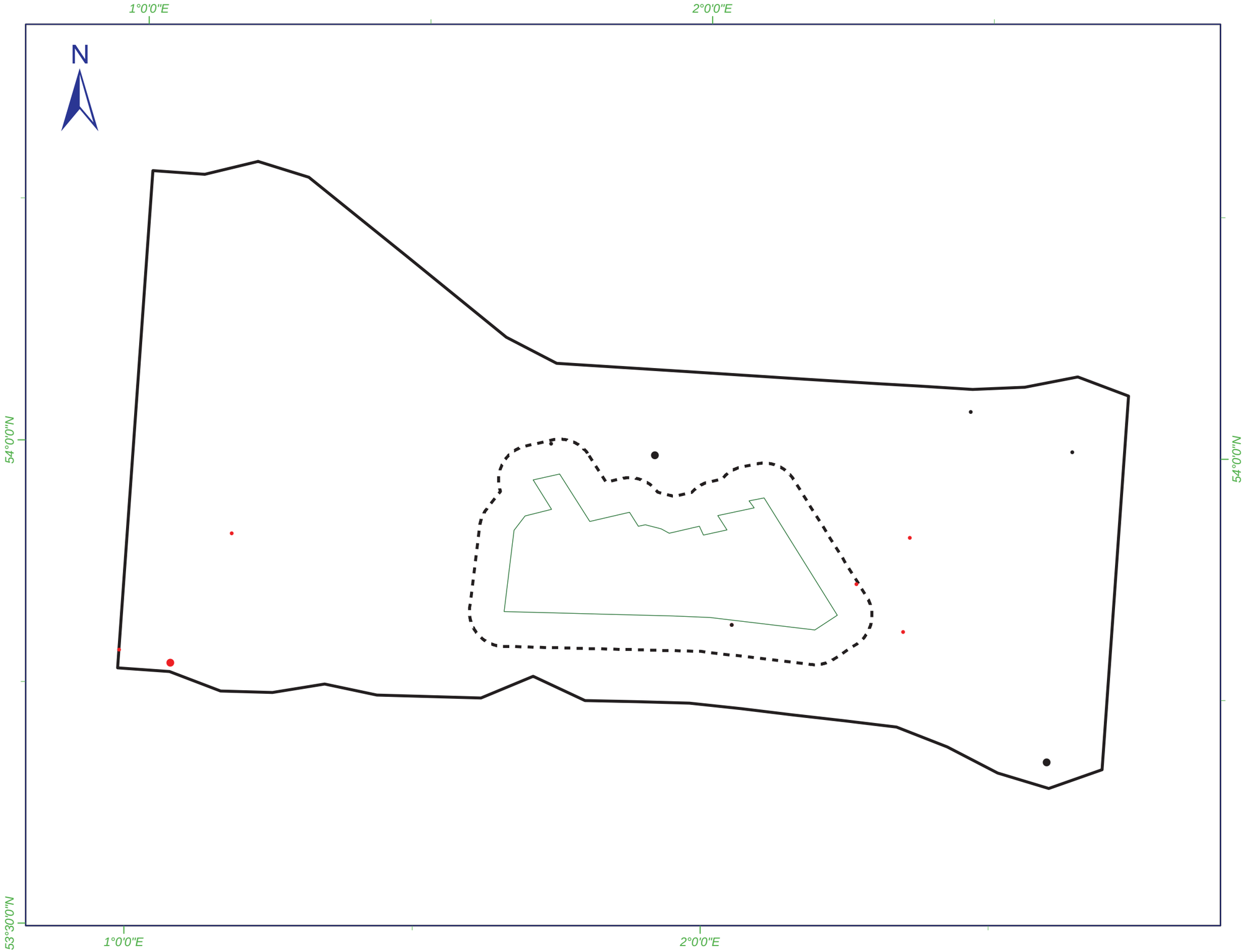
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Arctic Tern Abundance
(May to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ArcticTernAbundanceMayToOct2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Black-Headed Gull
(July to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: BlackHeadedGullAbundanceJulToOct2010_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

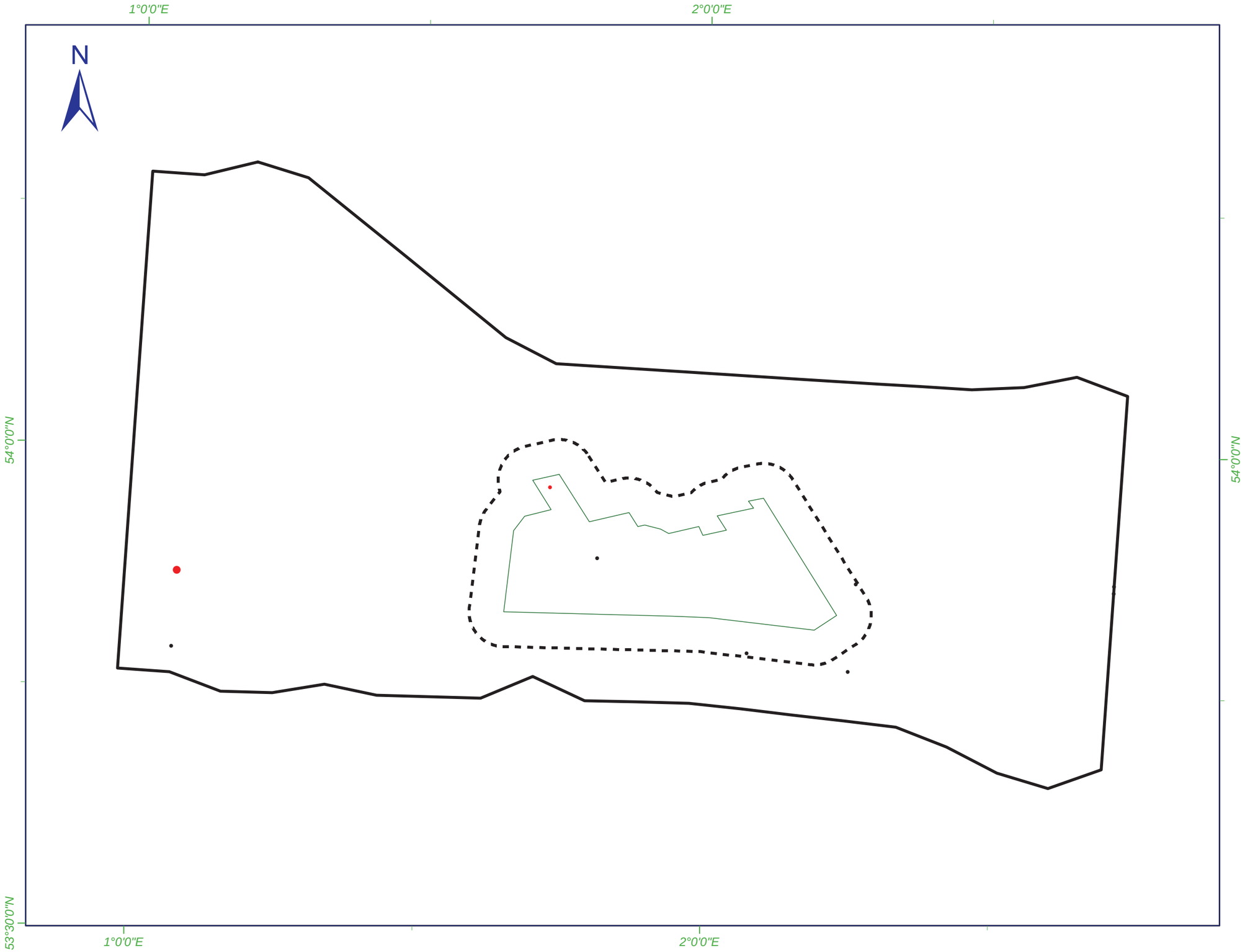
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Black-Headed Gull
(July to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: BlackHeadedGullAbundanceJulToOct2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Gull Abundance (April to August 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonGullAbundanceAprToAug2010_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION:	UTM31
SPHEROID :	WGS 1984
DATUM :	WGS 1984

0 5 10
KILOMETRES

SCALE	1:500,000
PAPER SIZE	37 X 23 CM

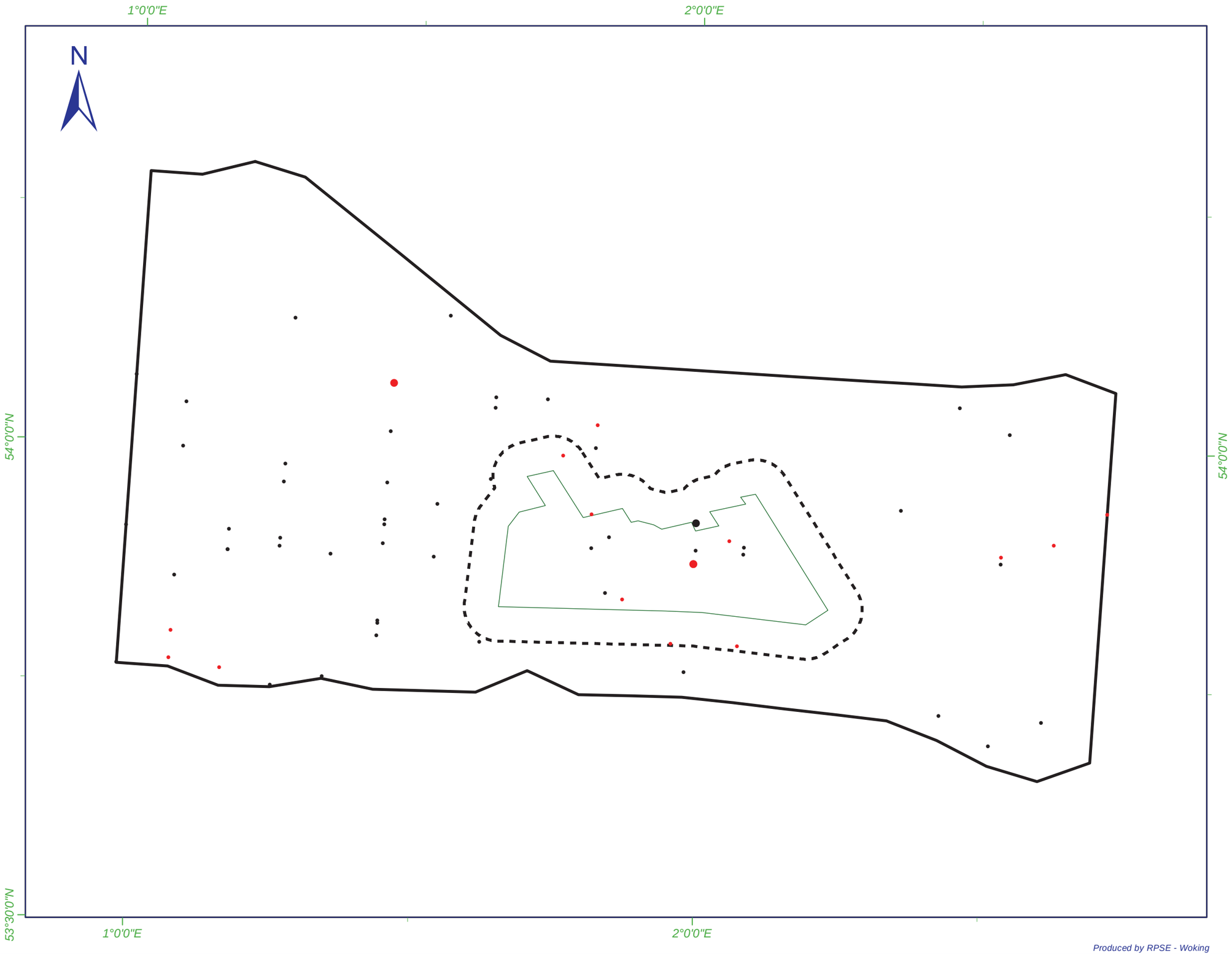
Common Gull Abundance (April to August 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: CommonGullAbundanceAprToAug2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Gull Abundance (September 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonGullAbundanceSep10ToMar11_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Gull Abundance (September 2011 to March 2012)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonGullAbundanceSep11ToMar12_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

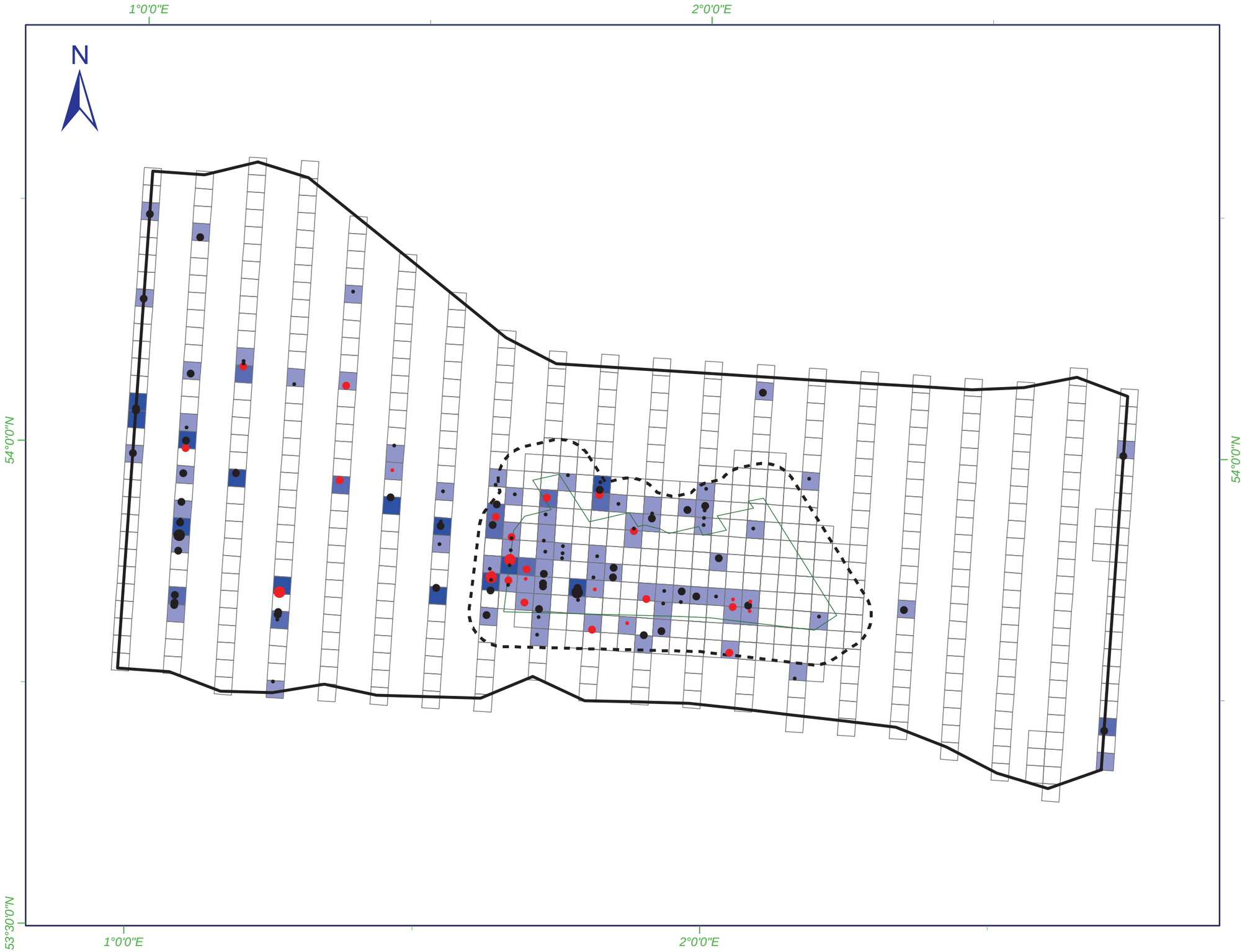
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Scoter Abundance (February to November 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonScoterAbundanceFebToNov2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

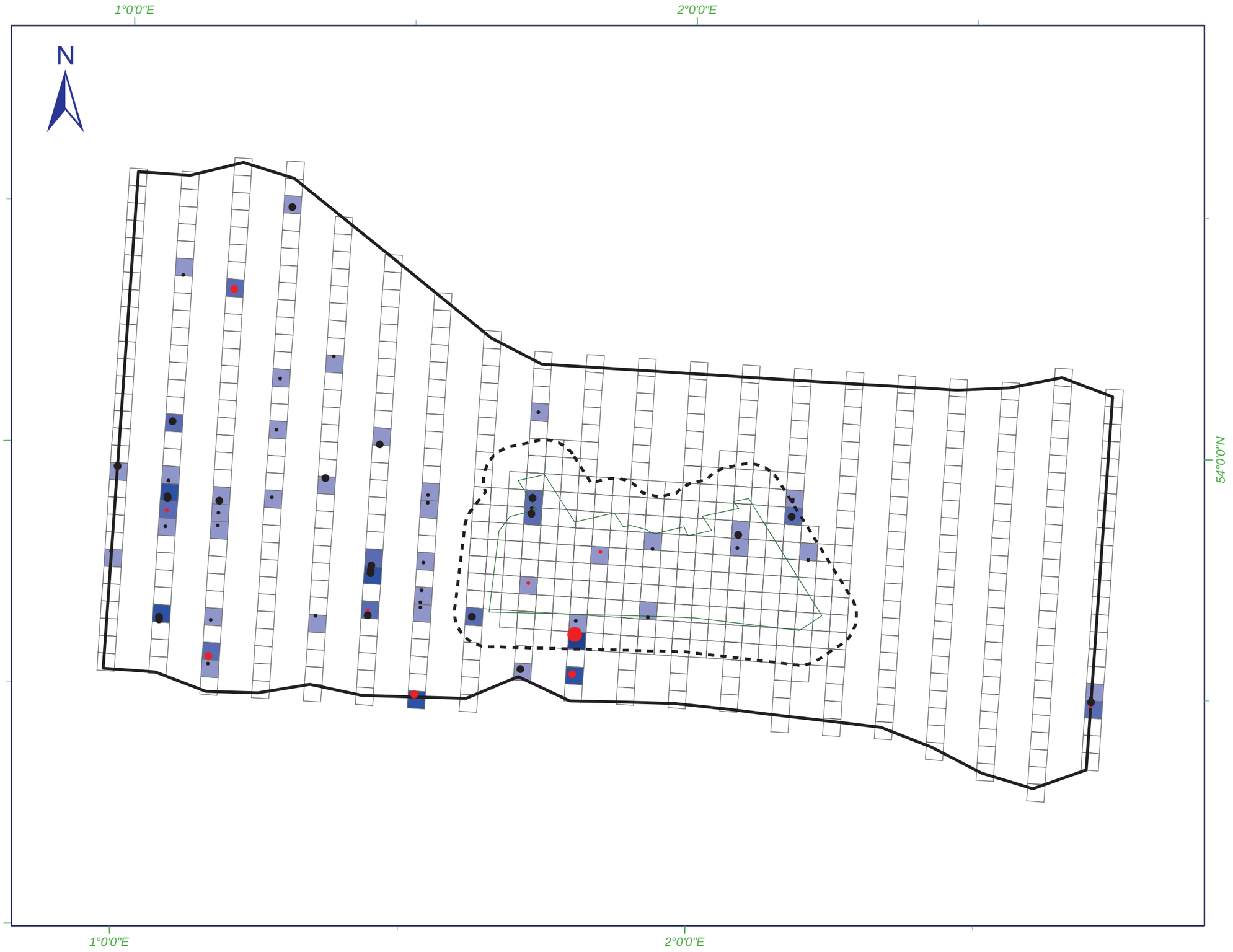
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Tern Density (August & September 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonTernDensityAug&Sep2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

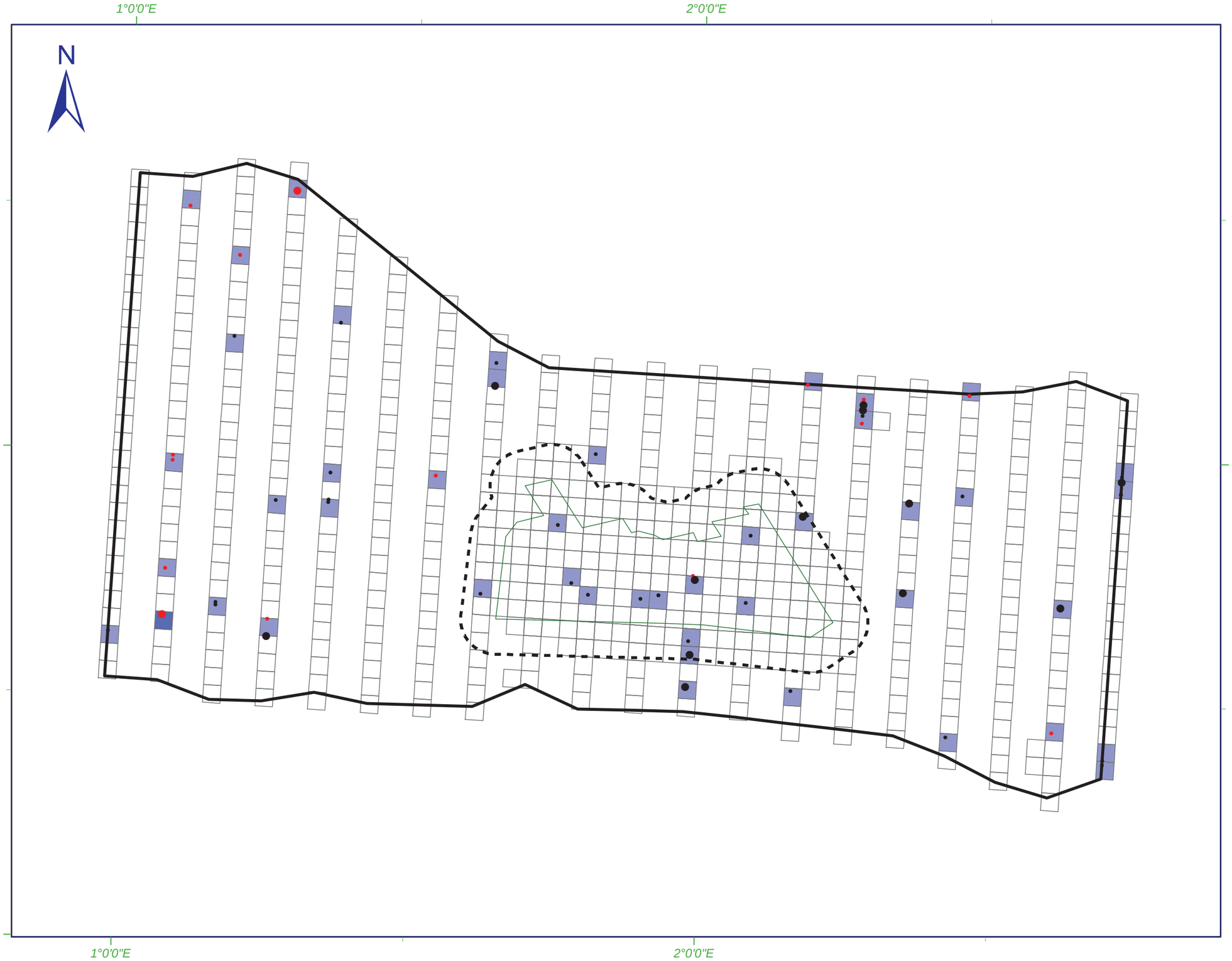
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Common Tern Density
(August & September 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: CommonTernDensityAug&Sep2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

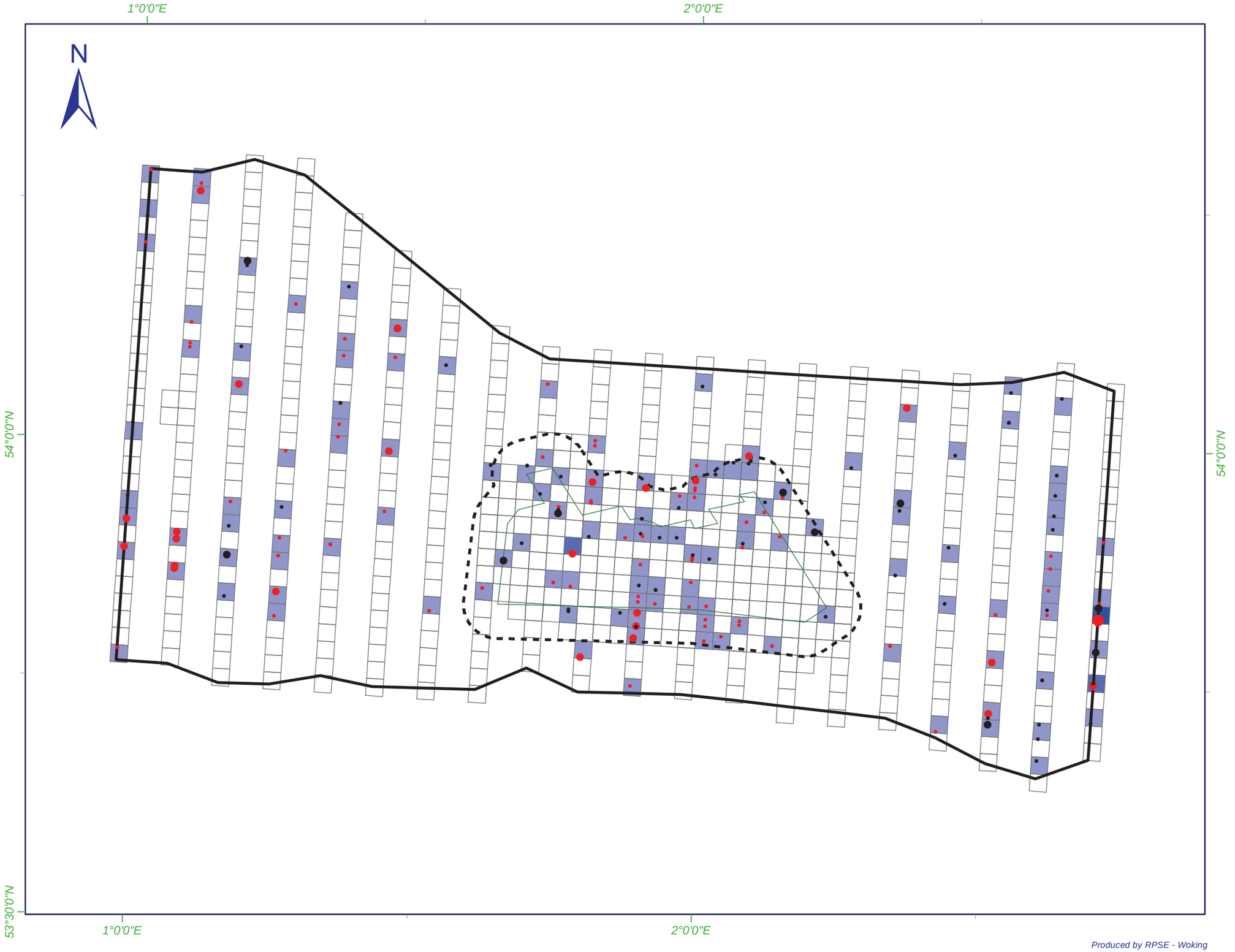
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (April to August 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GreatBBGullDensityAprilToAugust2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

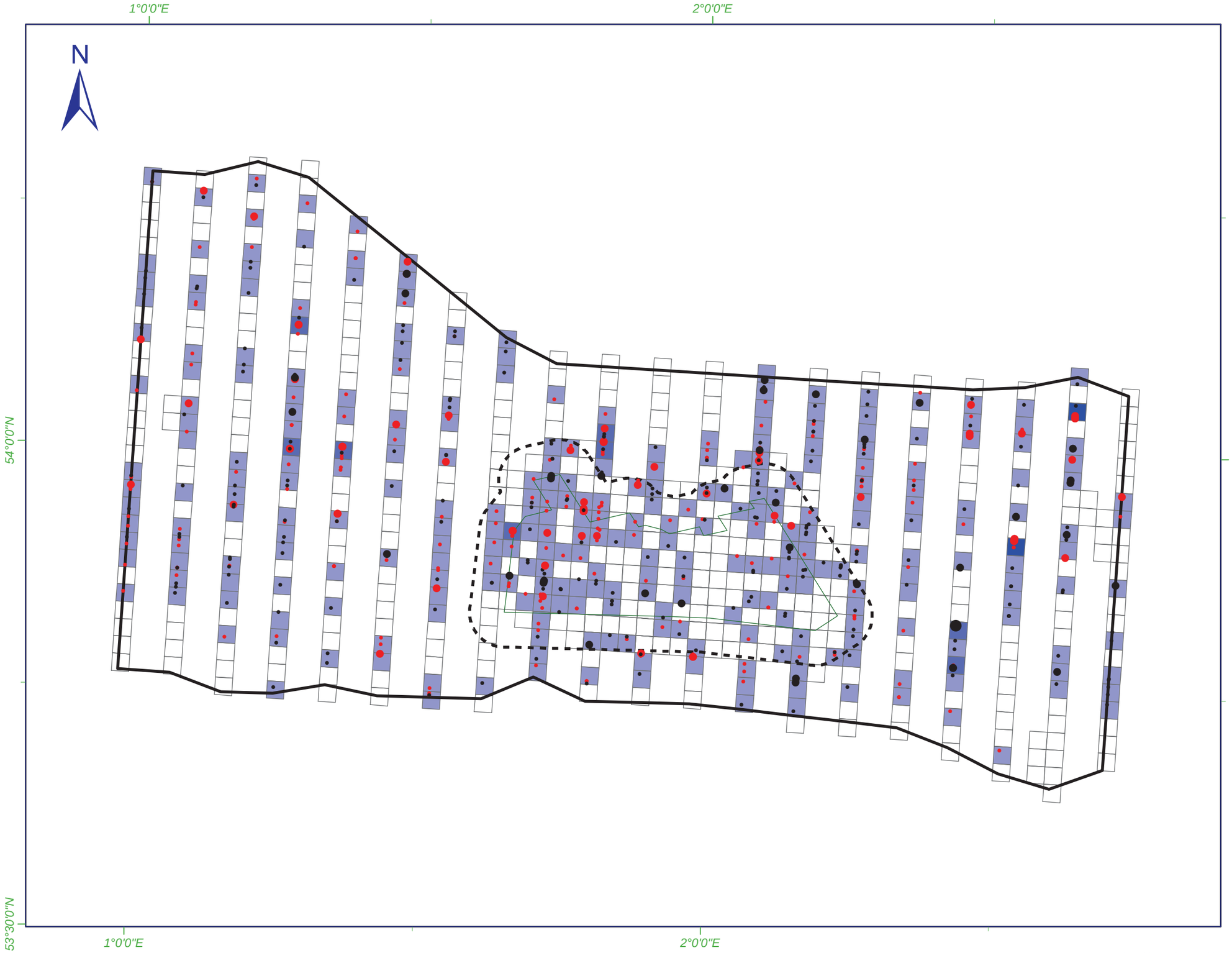
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (April to August 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GreatBBGullDensityAprilToAugust2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (September 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GreatBBGullDensitySep10toMar11_RJ_130517R1

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Great Skua Abundance
(August to November 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GreatSkuaAbundanceAugToNov2010_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

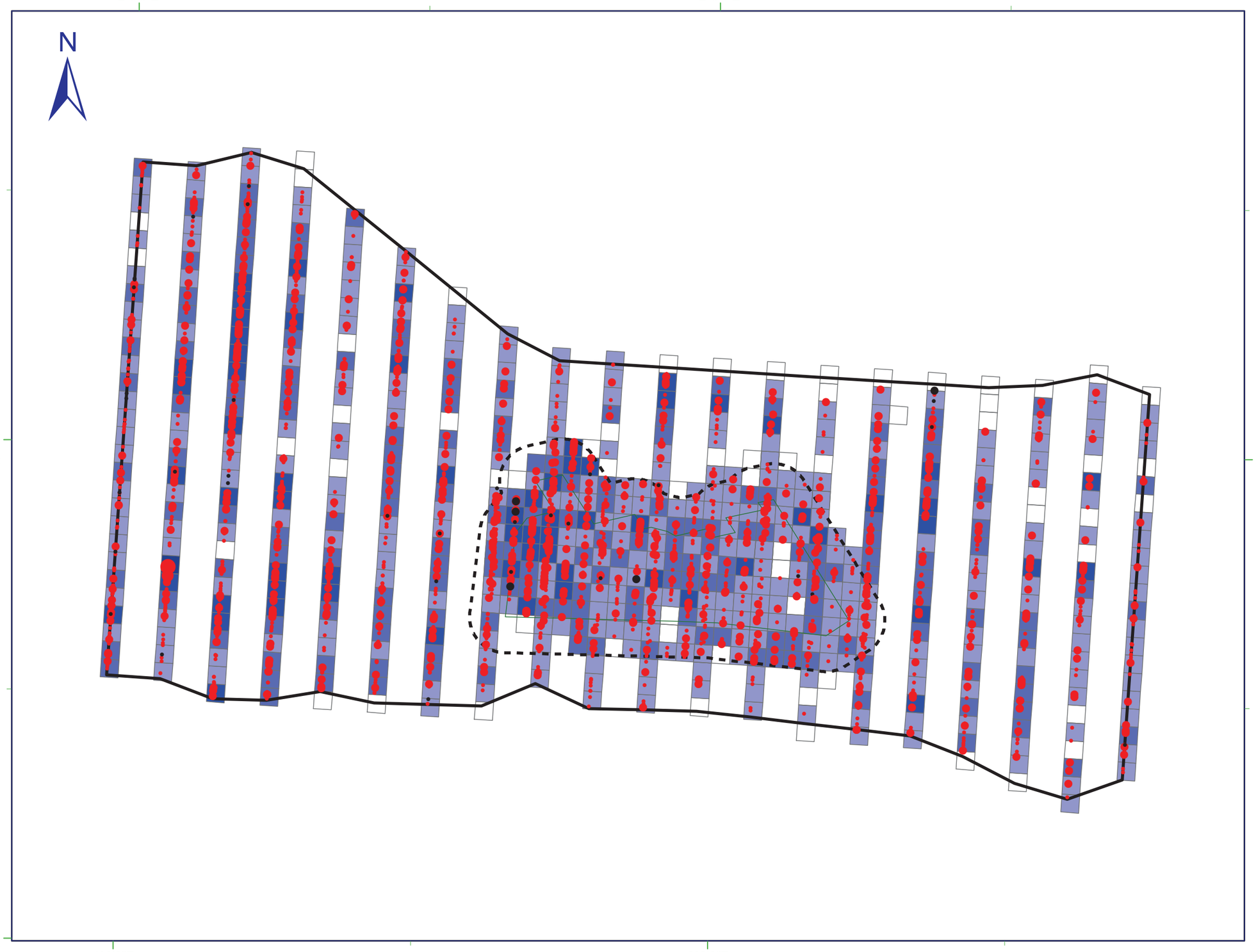
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Great Skua Abundance
(August to November 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GreatSkuaAbundanceAugToNov2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

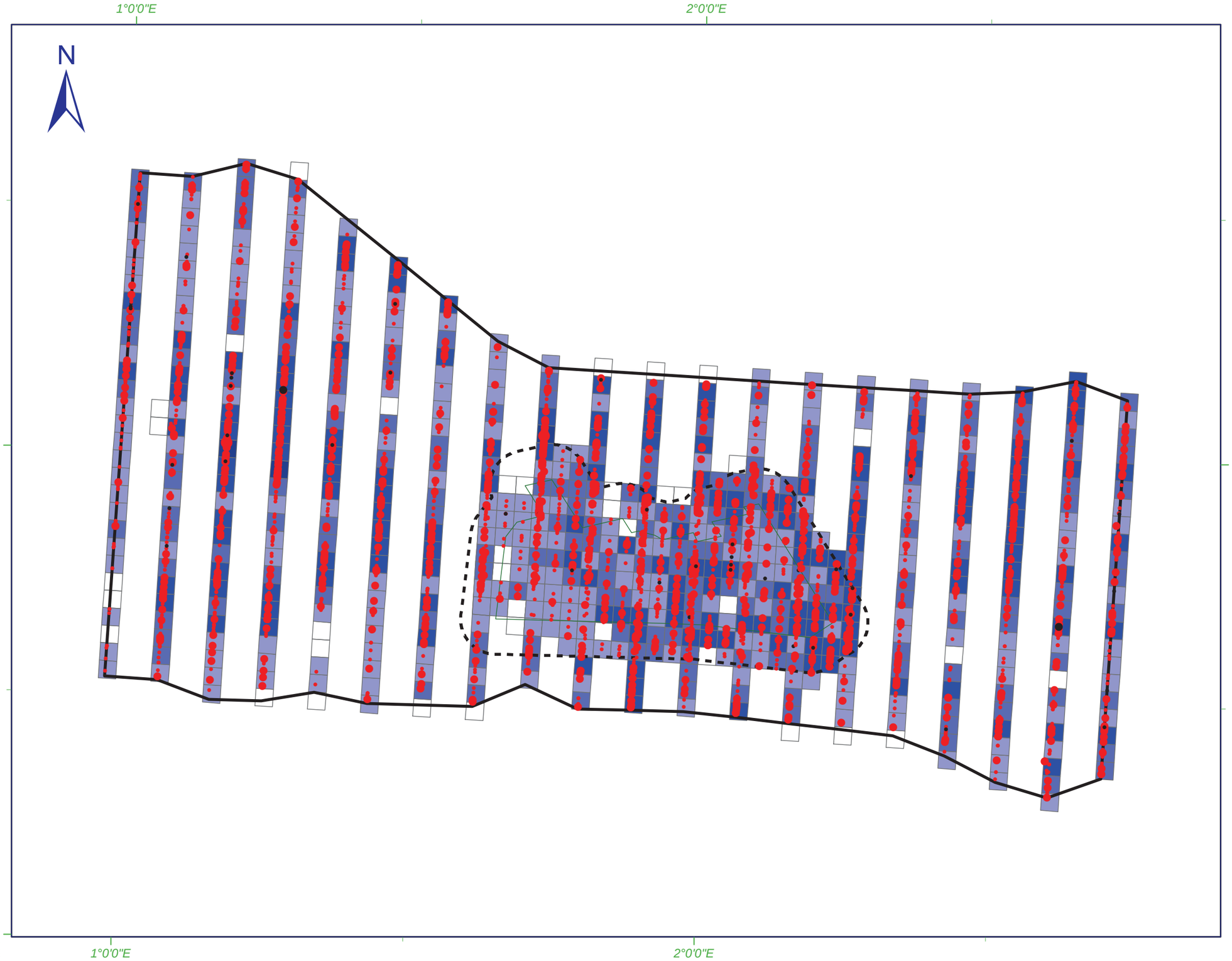
Guillemot Density
(April to June 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityAprilToJune2010_RJ_130517R1

Produced by RPSE - Woking



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

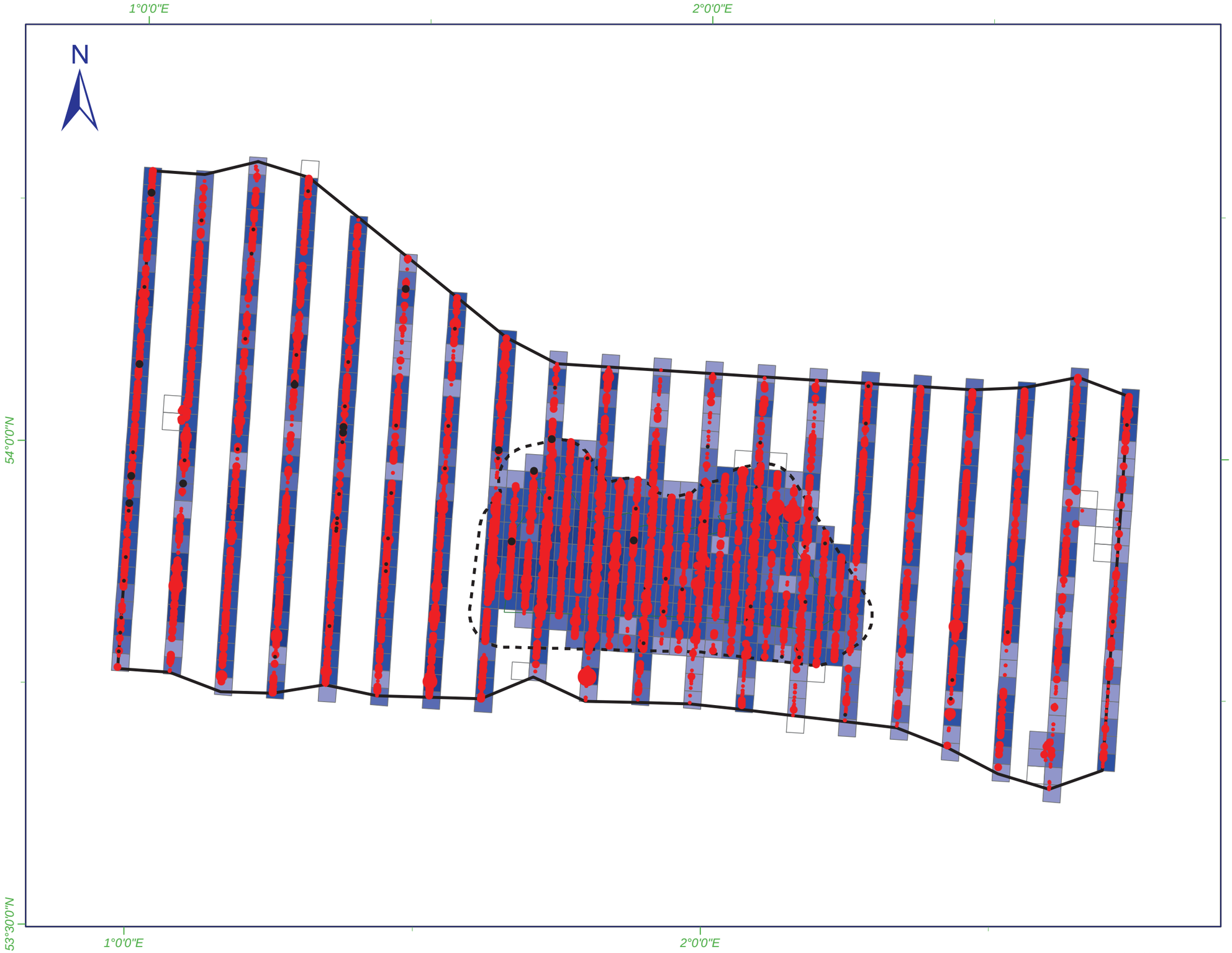
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(April to June 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityAprilToJune2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

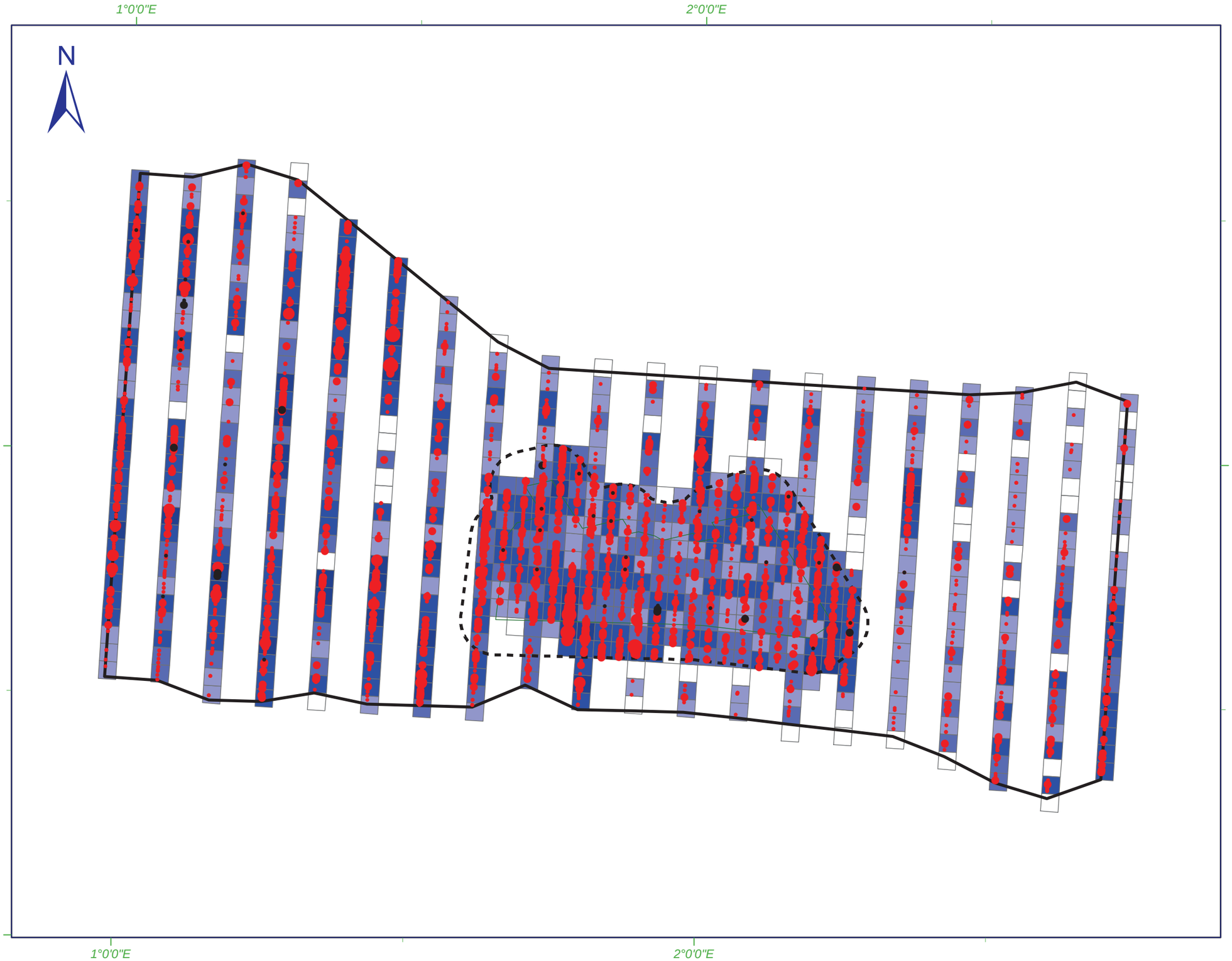
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(July to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityJulyToOctober2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

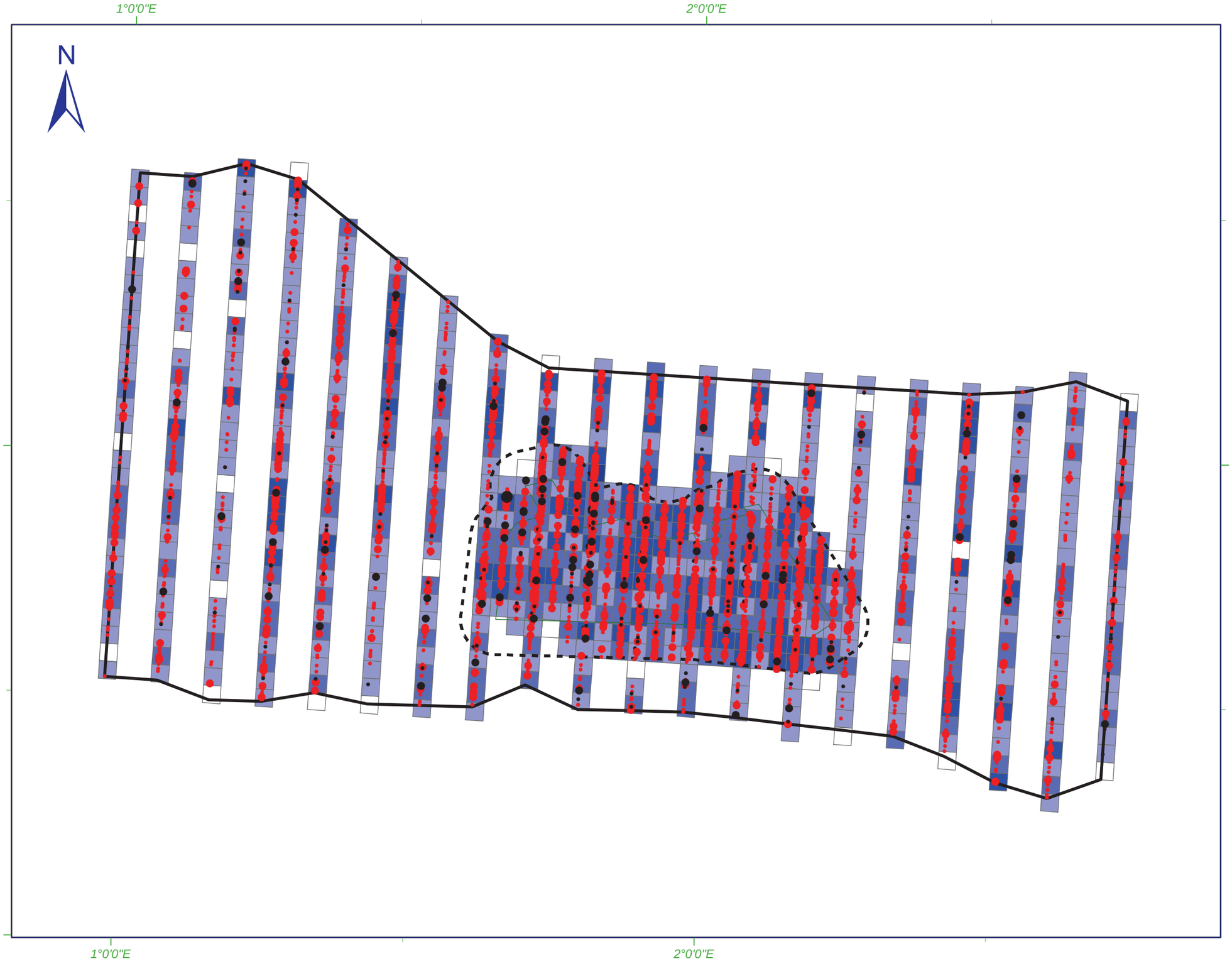
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(July to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityJulyToOctober2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

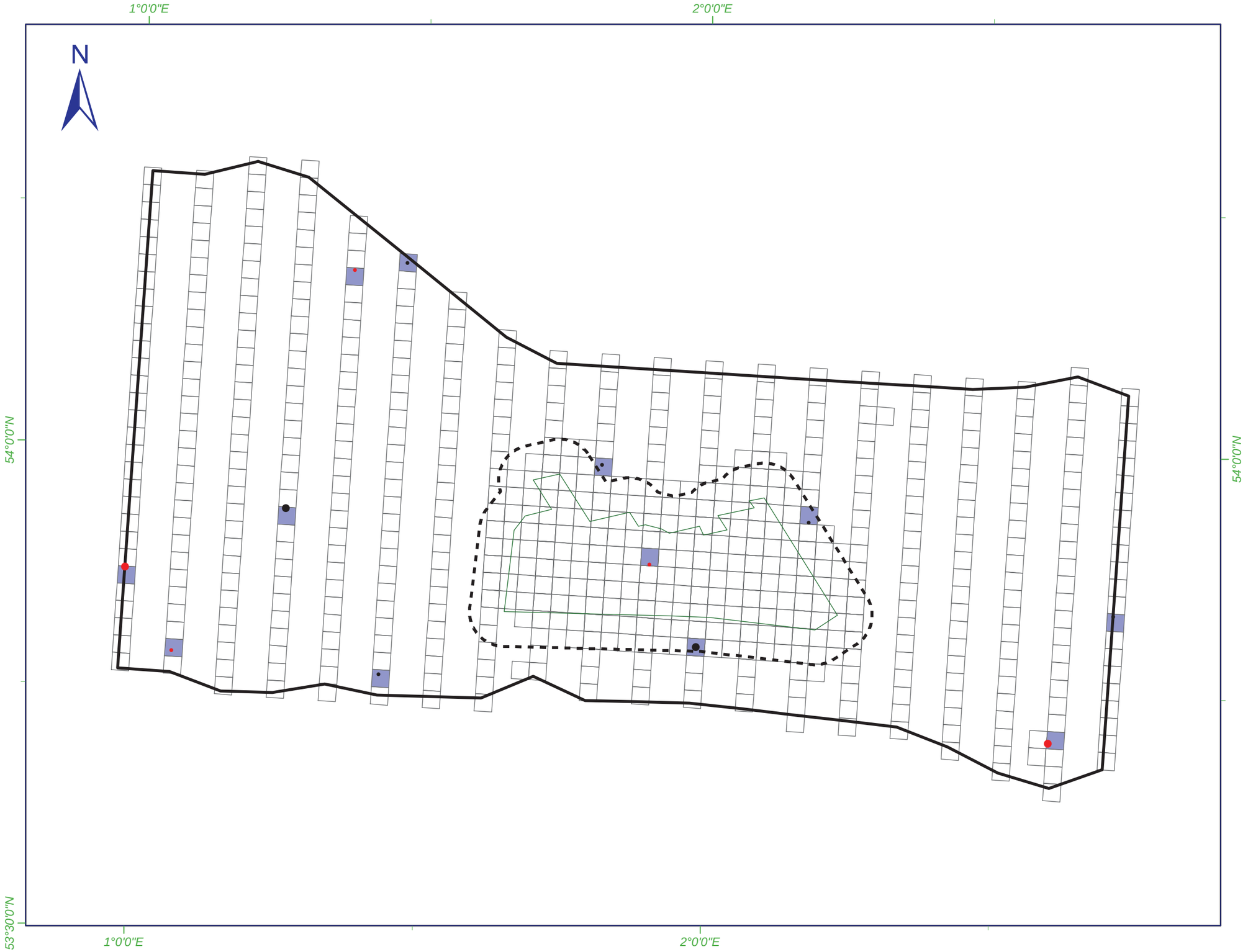
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(November 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityNov10ToMar11_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

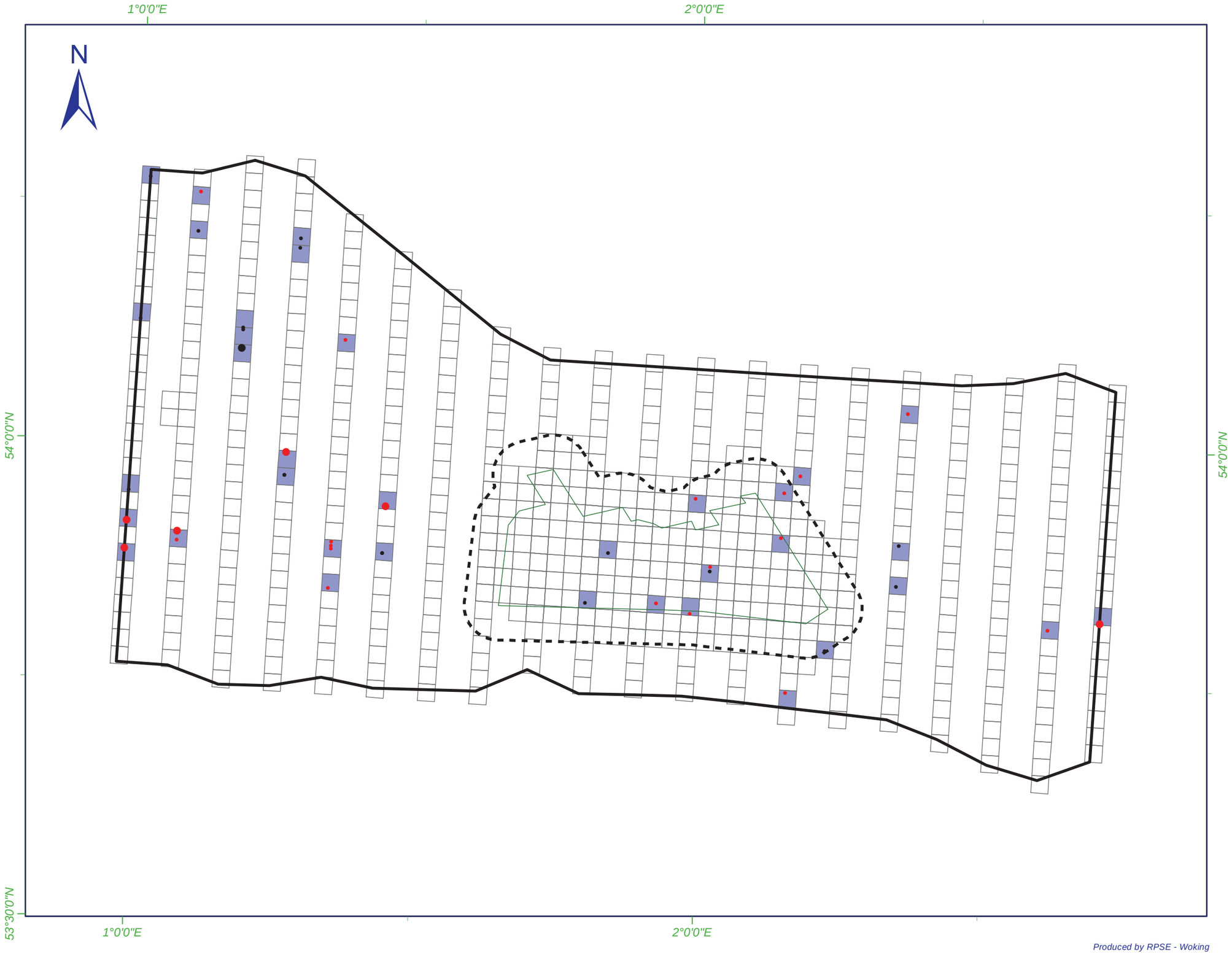
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(April to July 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: HerringGullDensityAprilToJuly2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

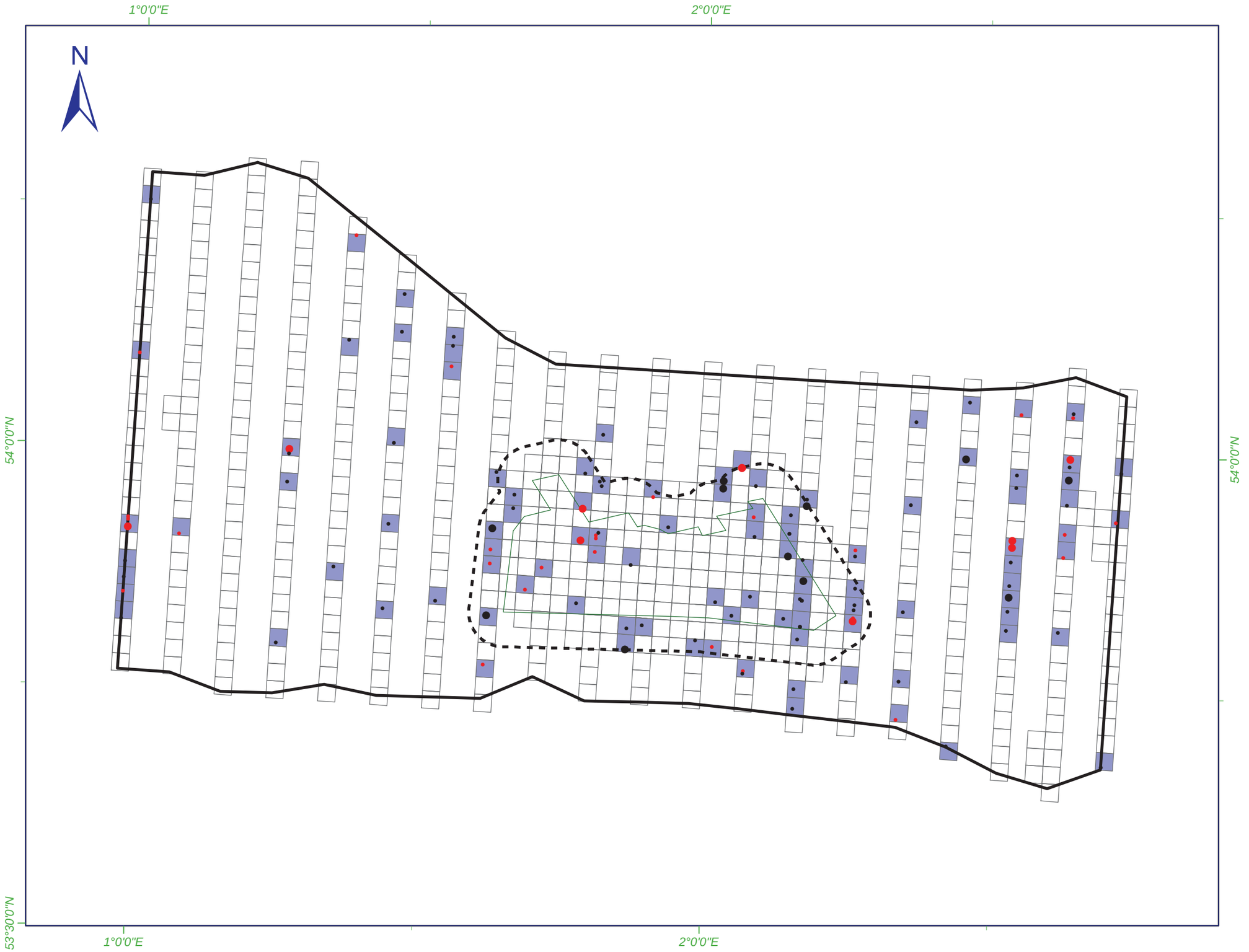
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Herring Gull Density (April to July 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: HerringGullDensityAprilToJuly2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

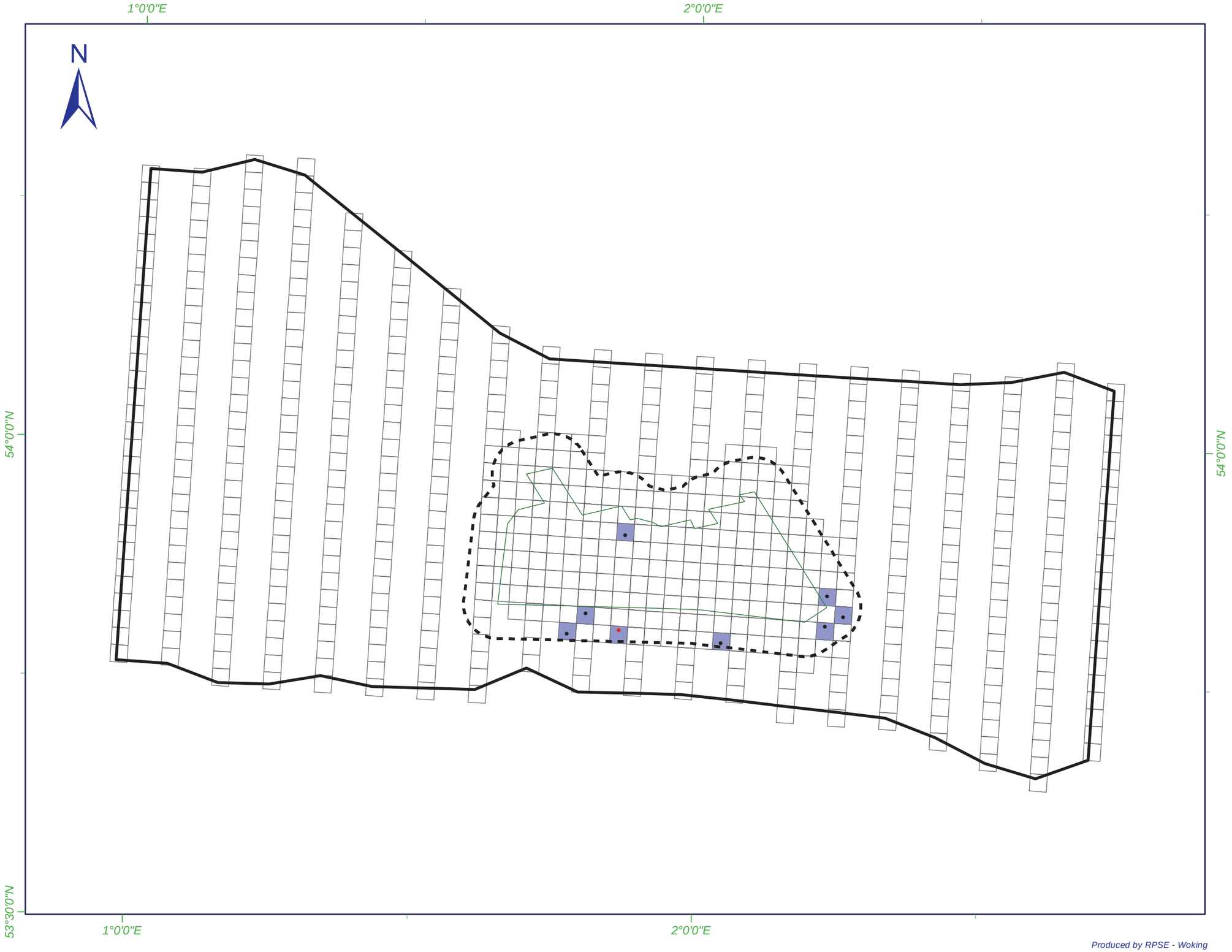
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(August 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: HerringGullDensityAug10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

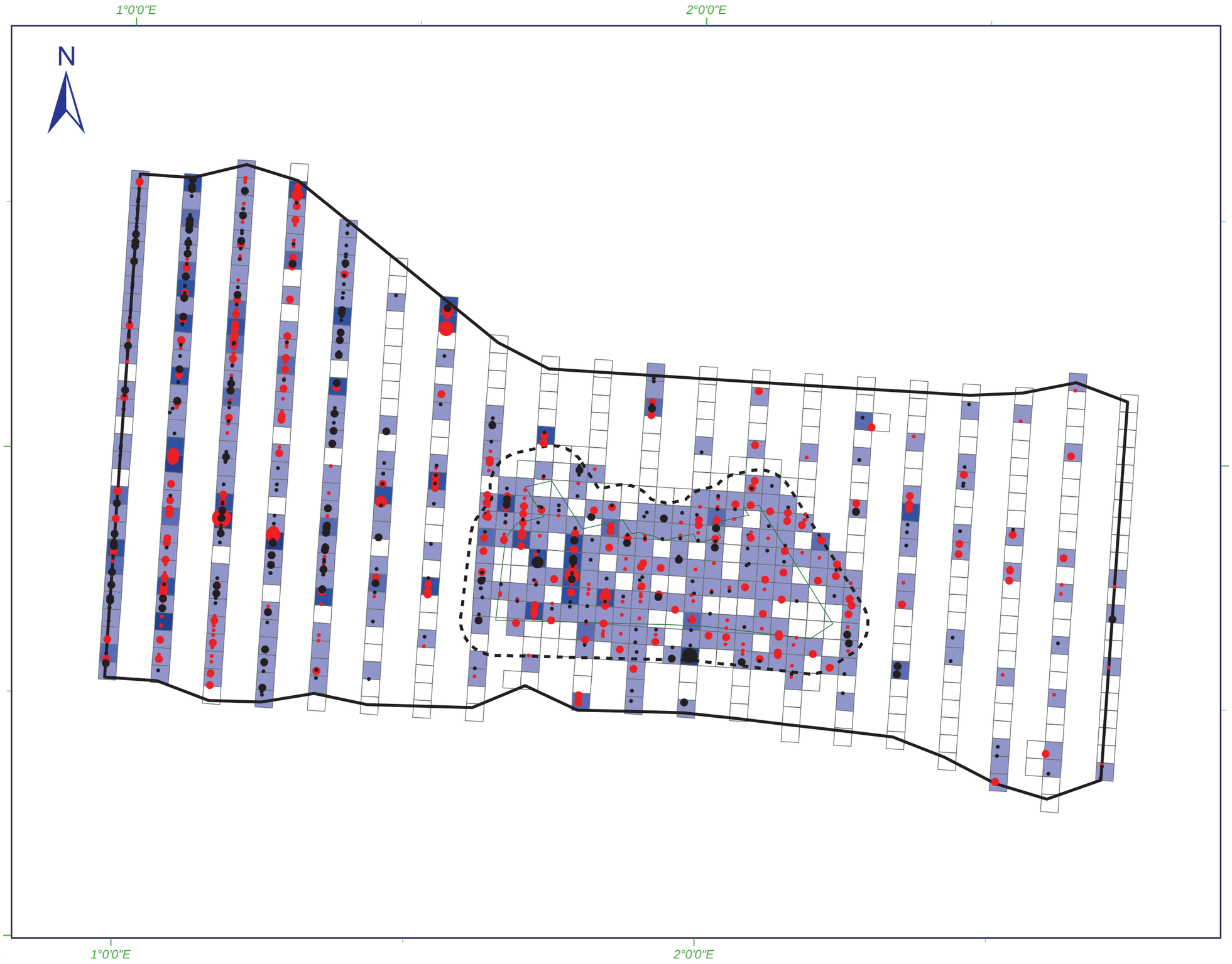
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(August 2011 to March 2012)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: HerringGullDensityAug11ToMar12_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

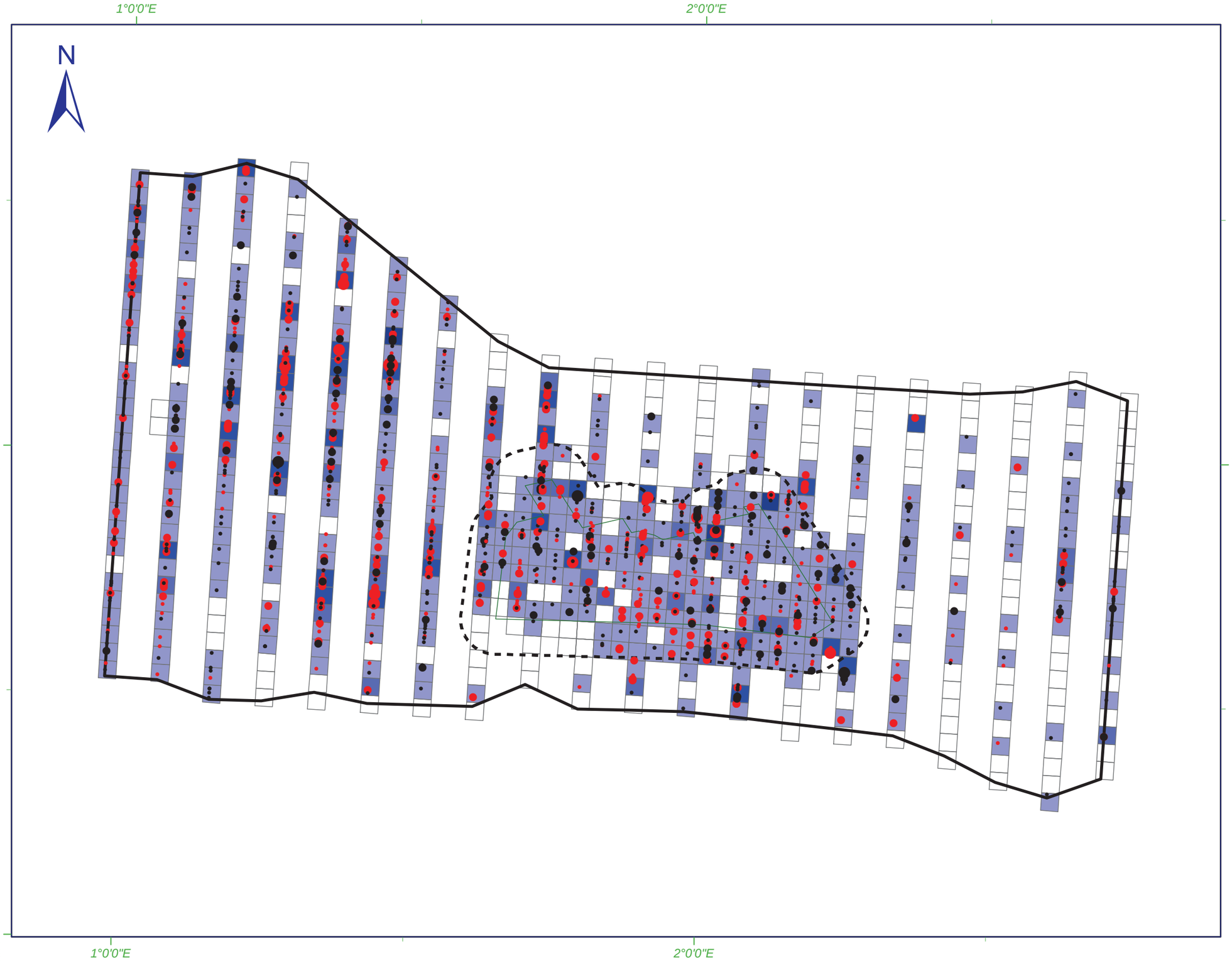
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(April to July 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: KittiwakeDensityAprilToJuly2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

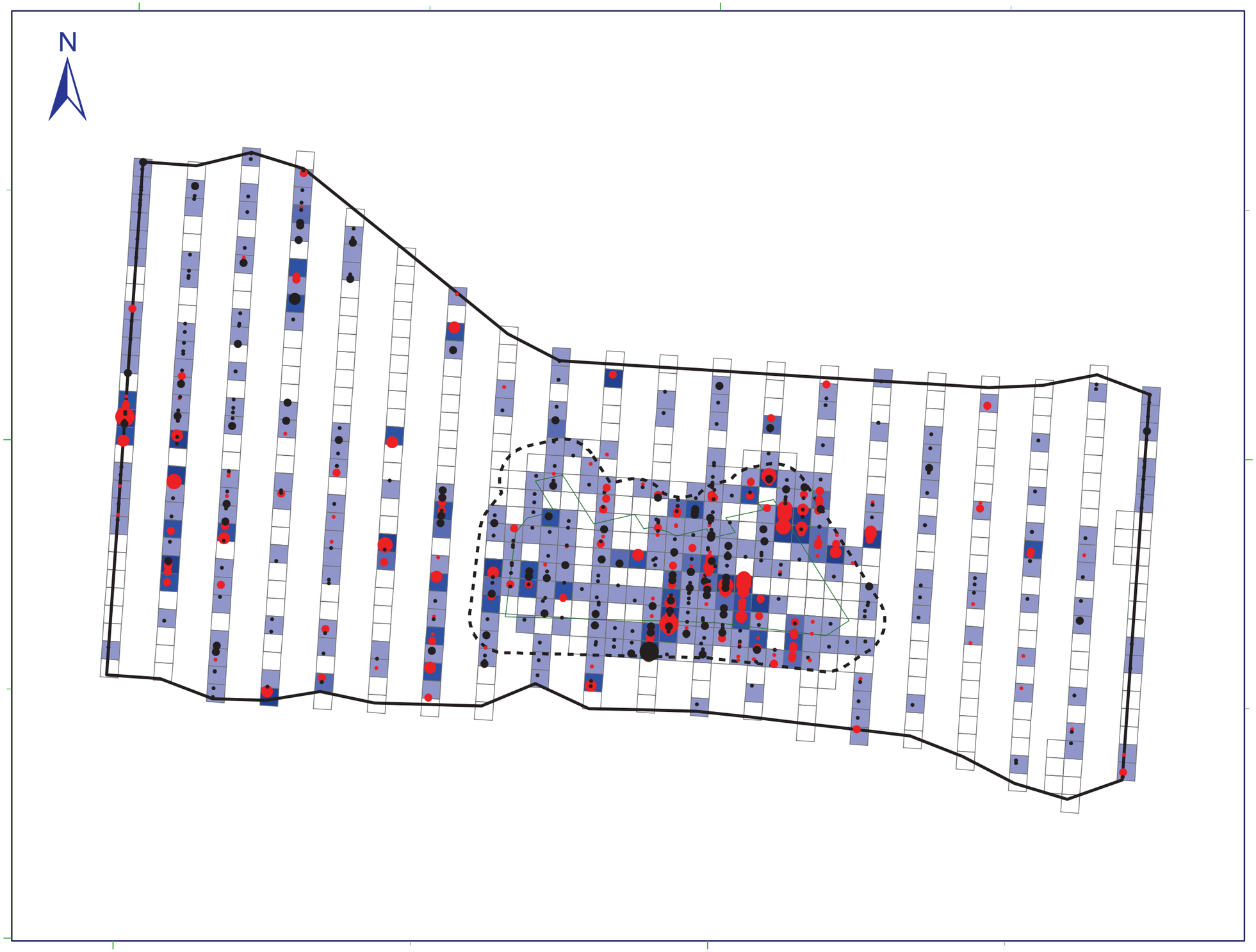
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(April to July 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: KittiwakeDensityAprilToJuly2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

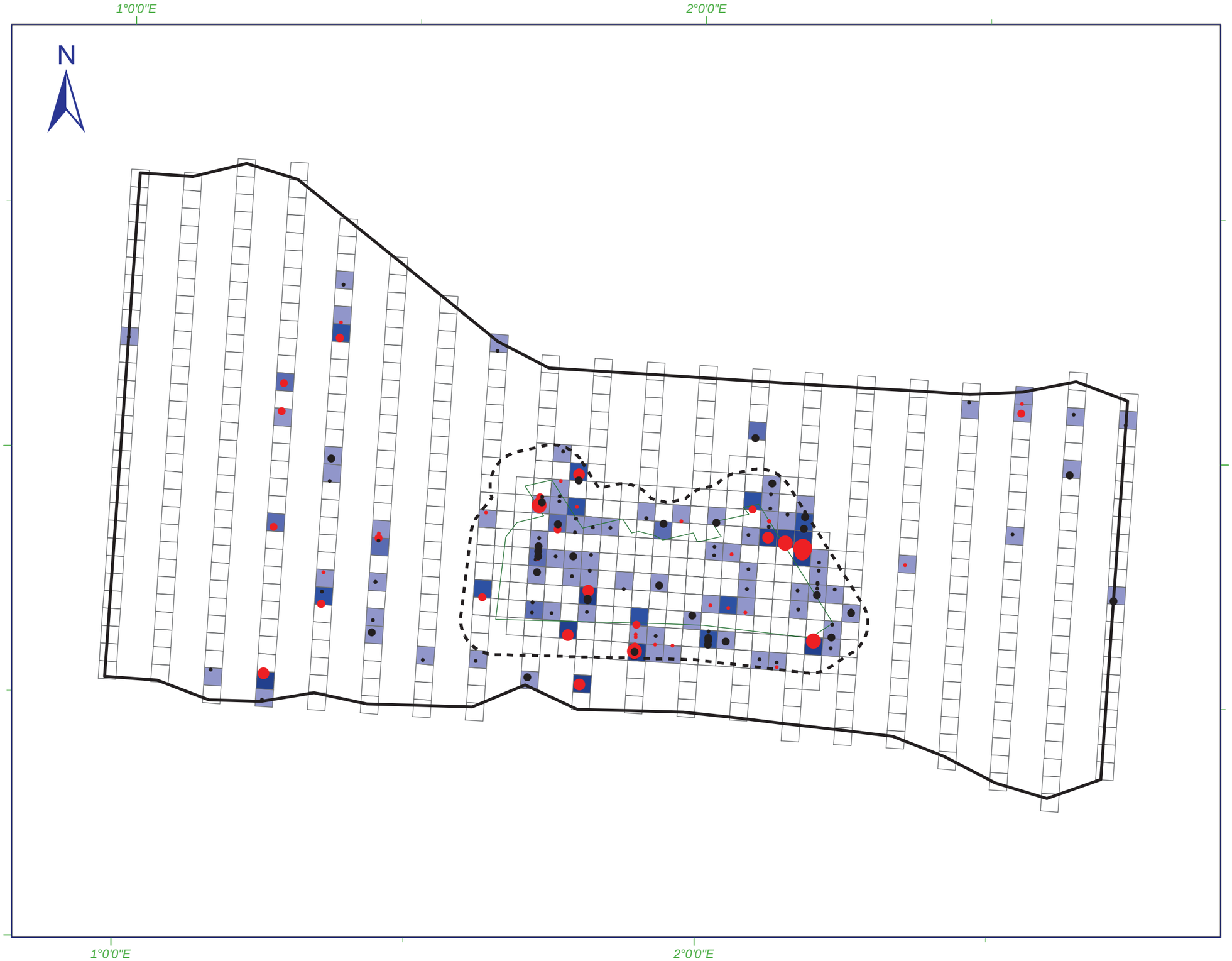
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(August & September 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: KittiwakeDensityAug&Sep2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

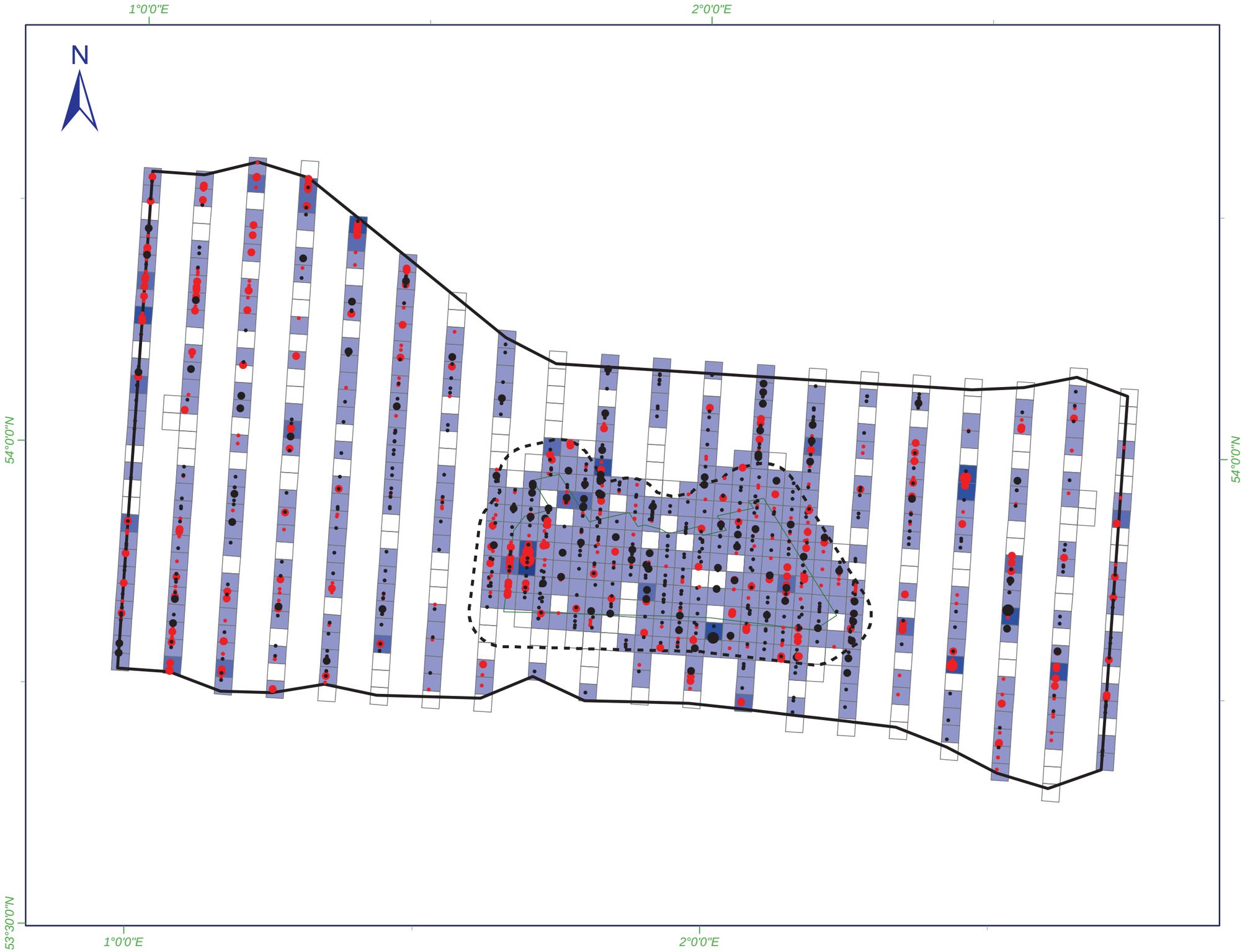
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(August & September 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: KittiwakeDensityAug&Sep2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

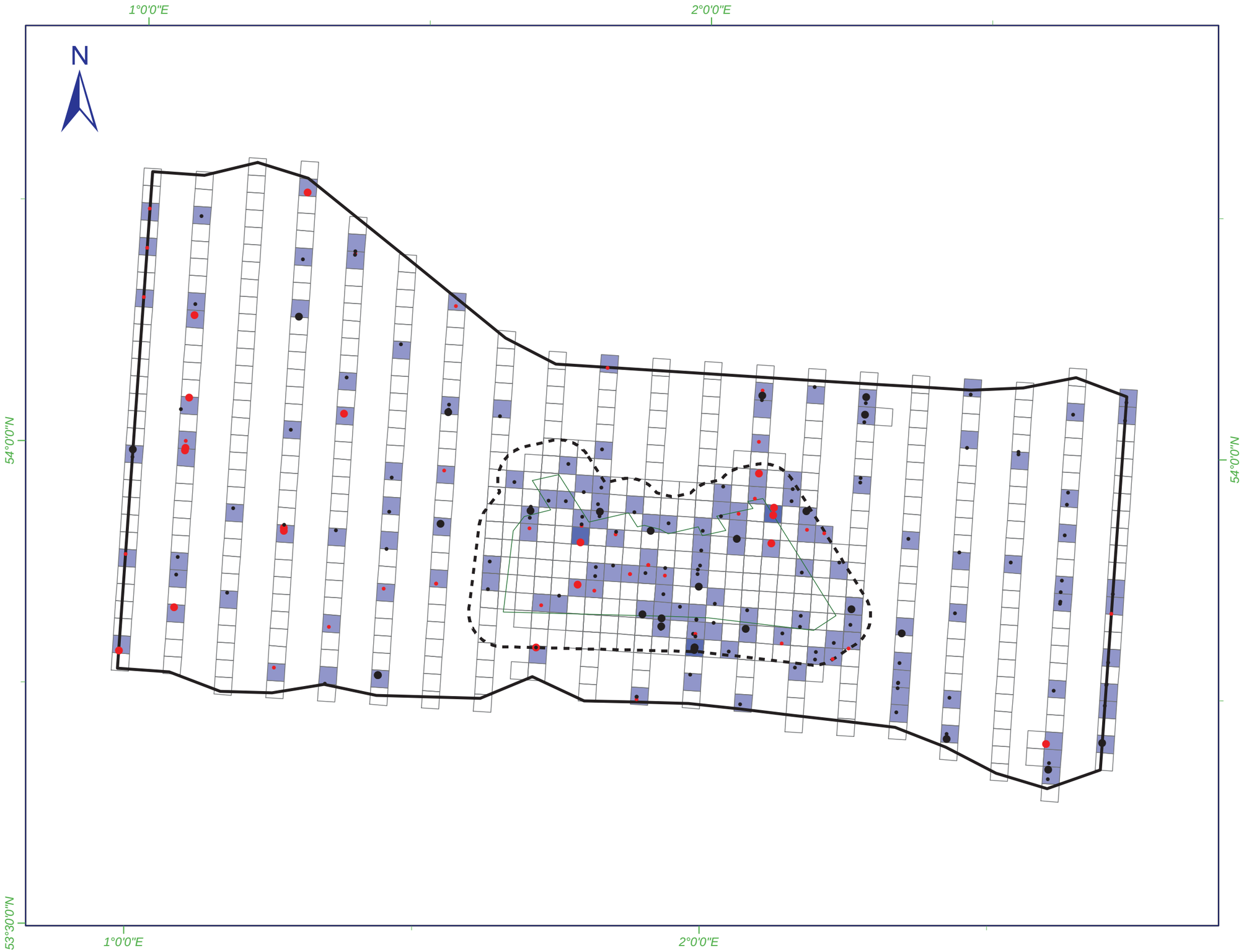
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(October 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: KittiwakeDensityOct10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

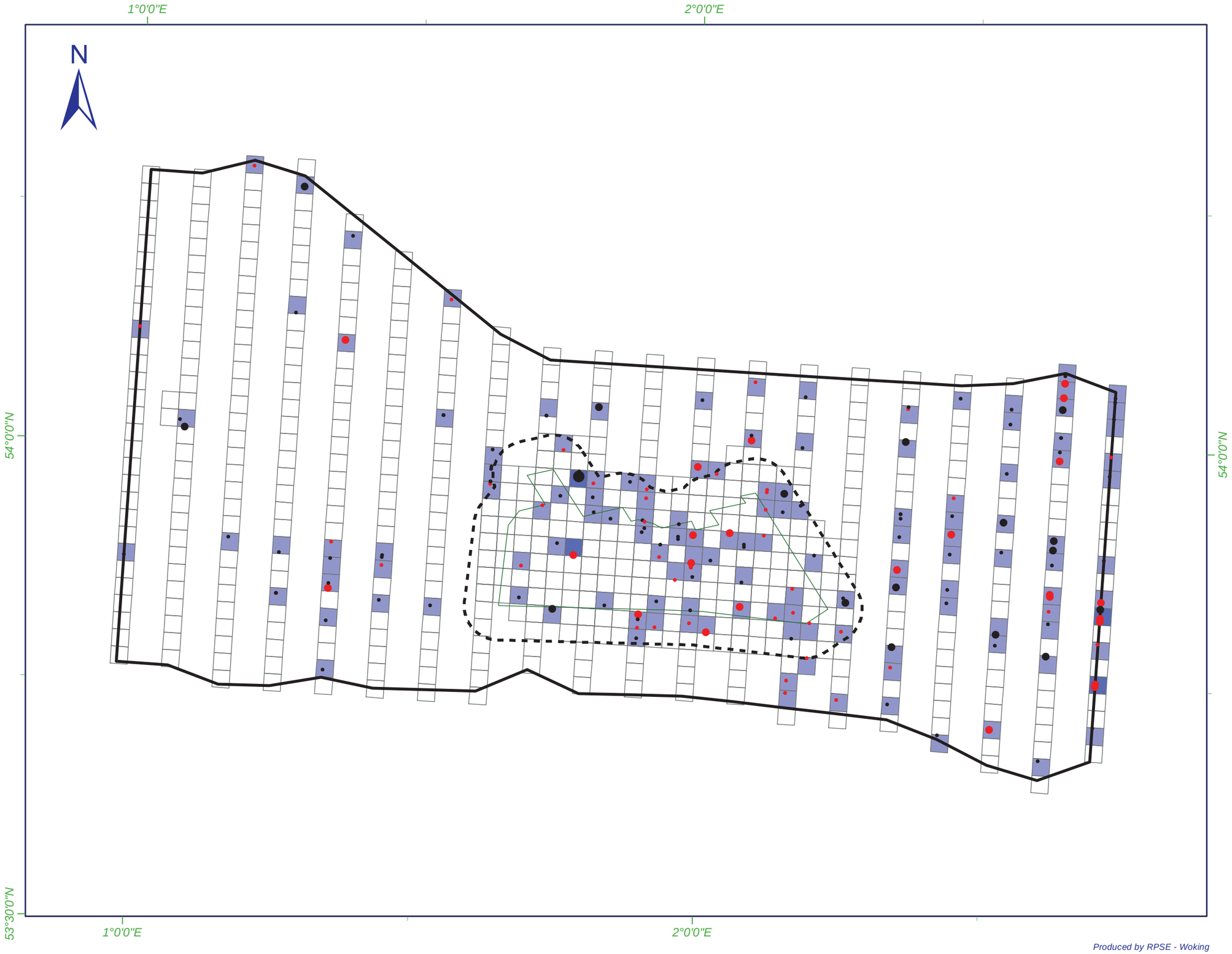
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Lesser Black-Backed Gull Density (April to August 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: LesserBBGullDensityAprilToAugust2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Lesser Black-Backed Gull Density (April to August 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: LesserBBGullDensityAprilToAugust2011_RJ_130517R1

Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

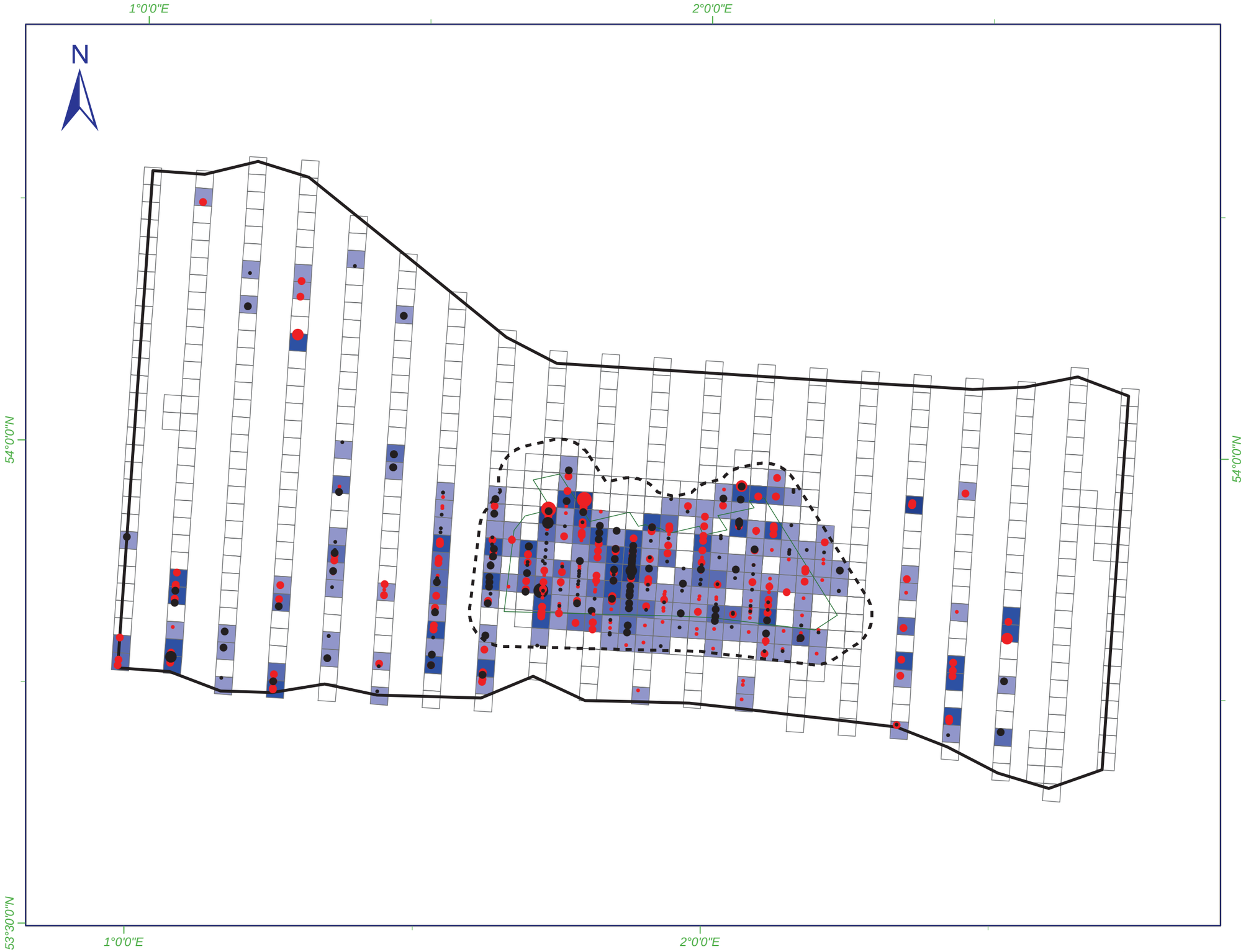
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Little Auk Density
(November 2010 to January 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: LittleAukDensityNov10ToJan11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

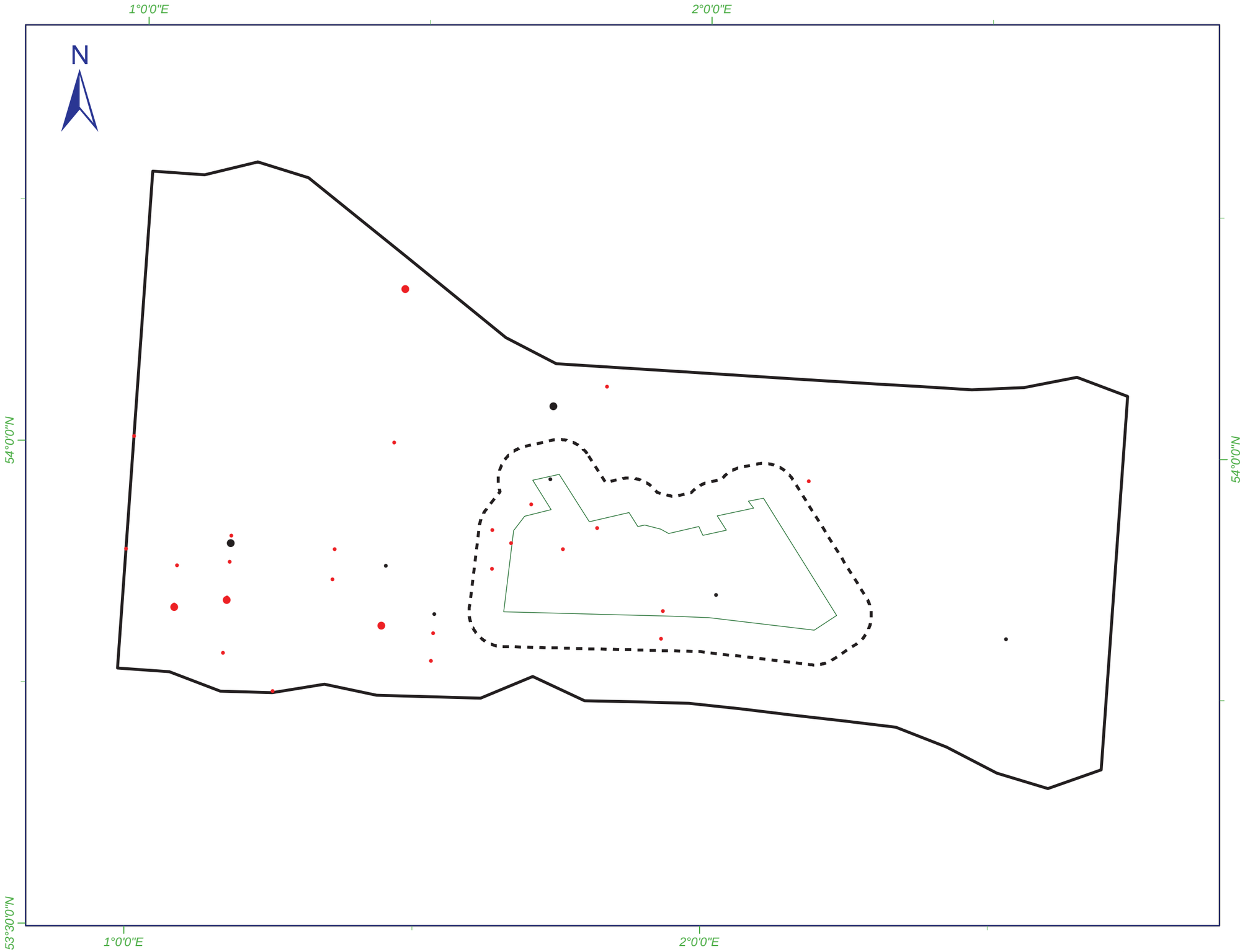
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Little Gull Density
(September to November 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: LittleGullDensitySeptemberToNovember2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

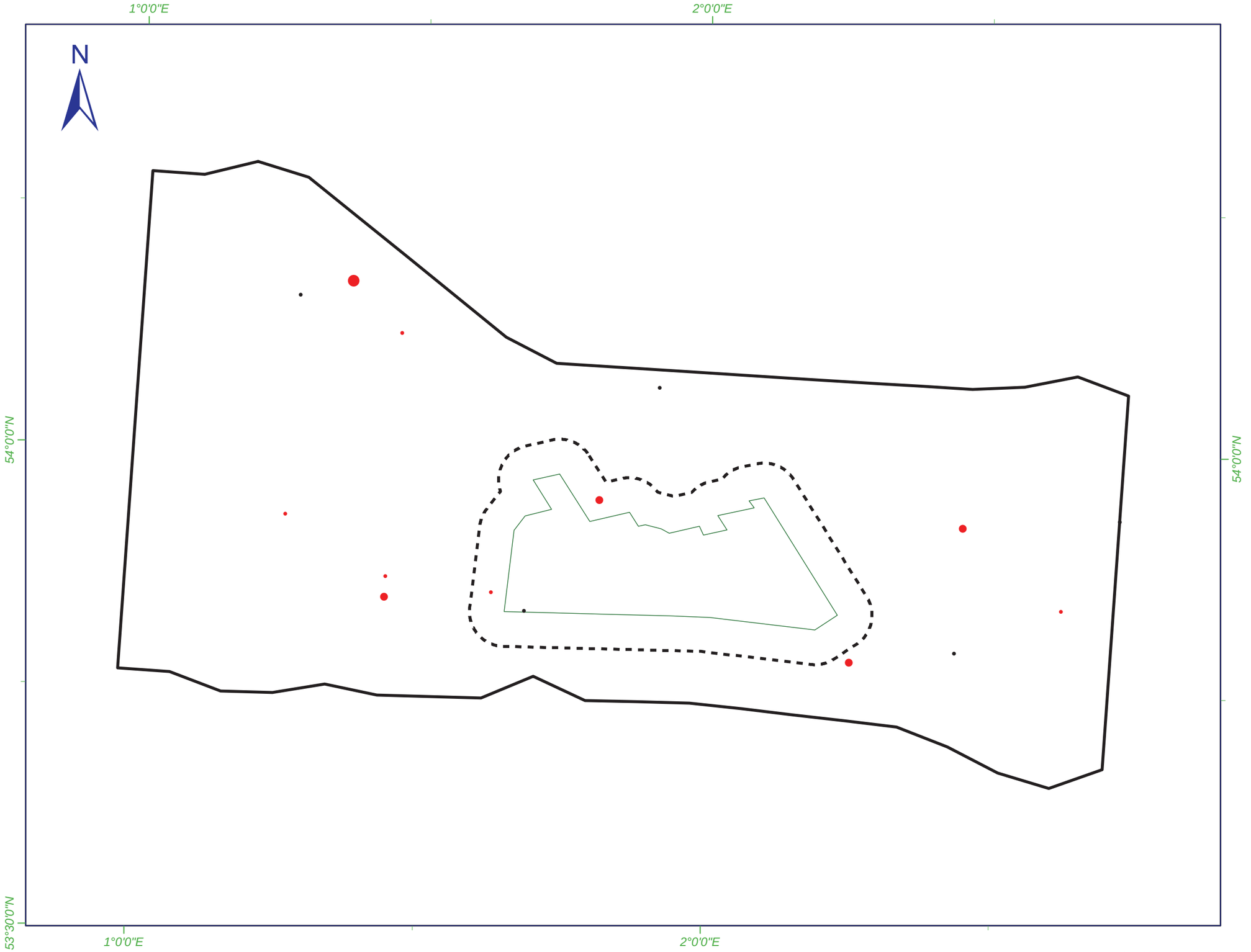
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Manx Shearwater Abundance (April to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ManxShearwaterAbundanceAprToOct2010_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Flying Birds

- 1
- 2 - 5
- 6 - 10
- 11 - 20
- > 20

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

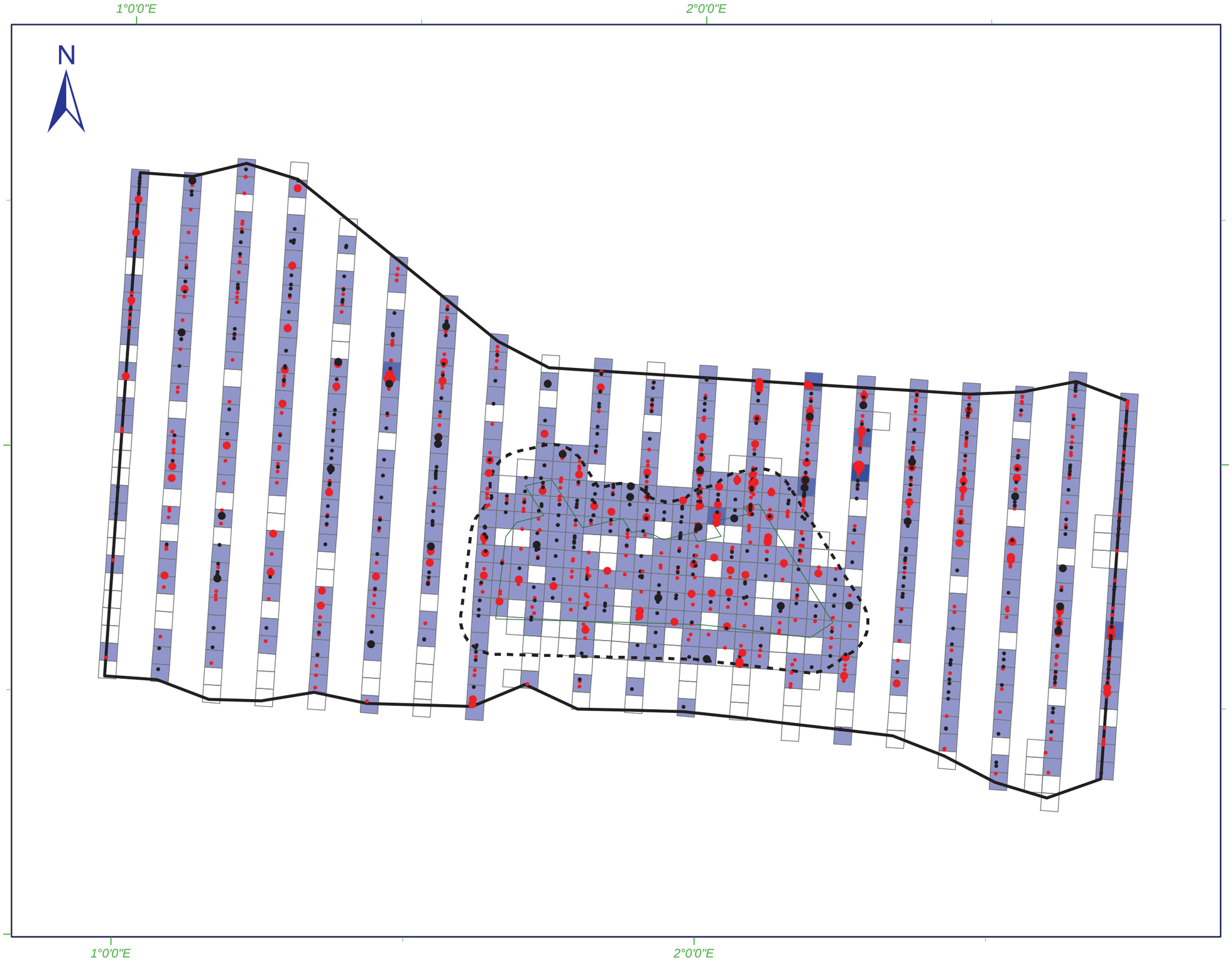
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Manx Shearwater Abundance (April to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: ManxShearwaterAbundanceAprToOct2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

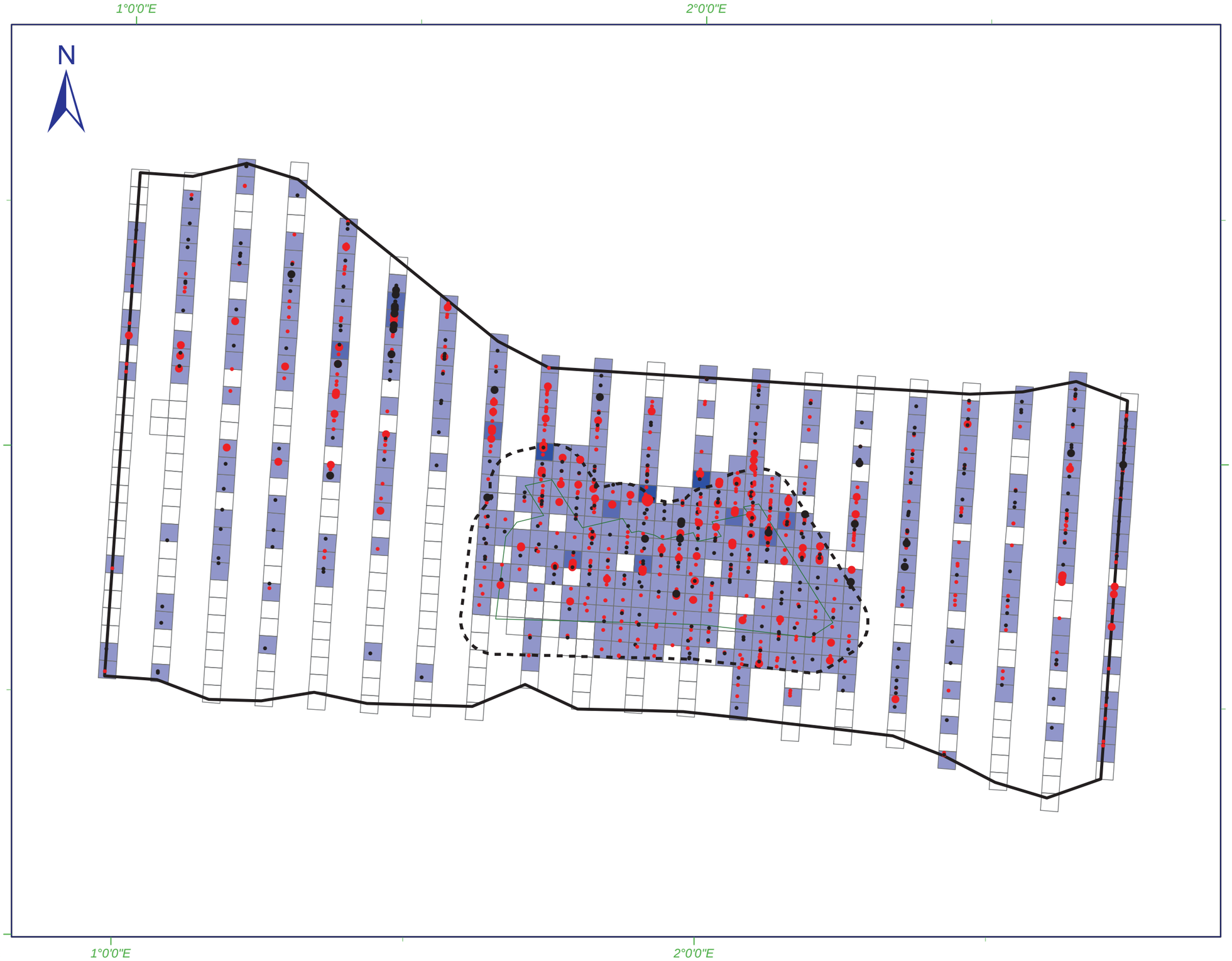
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Northern Fulmar Density (April to September 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: NorthernFulmarDensityAprilToSept2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

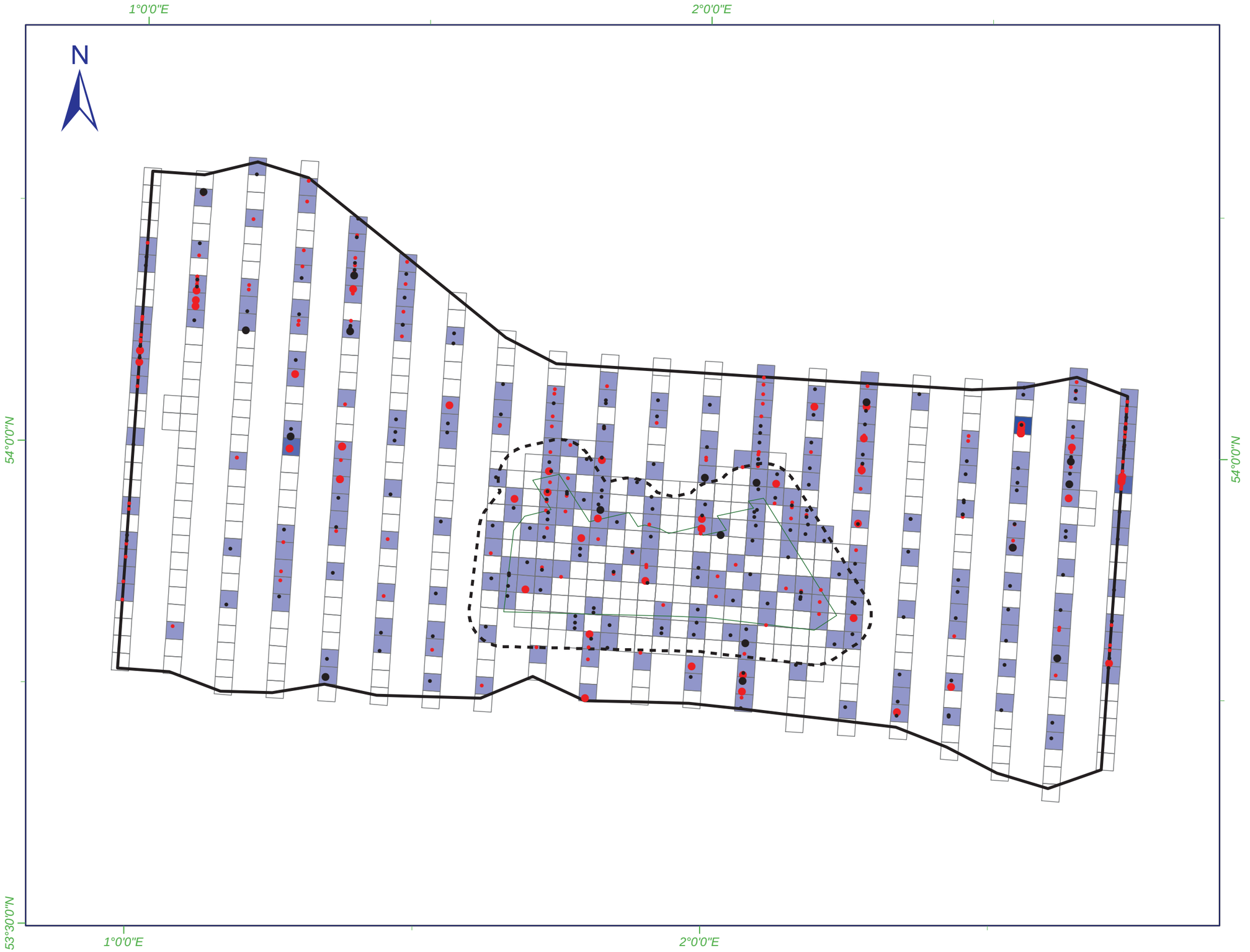
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Northern Fulmar Density (April to September 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: NorthernFulmarDensityAprilToSept2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

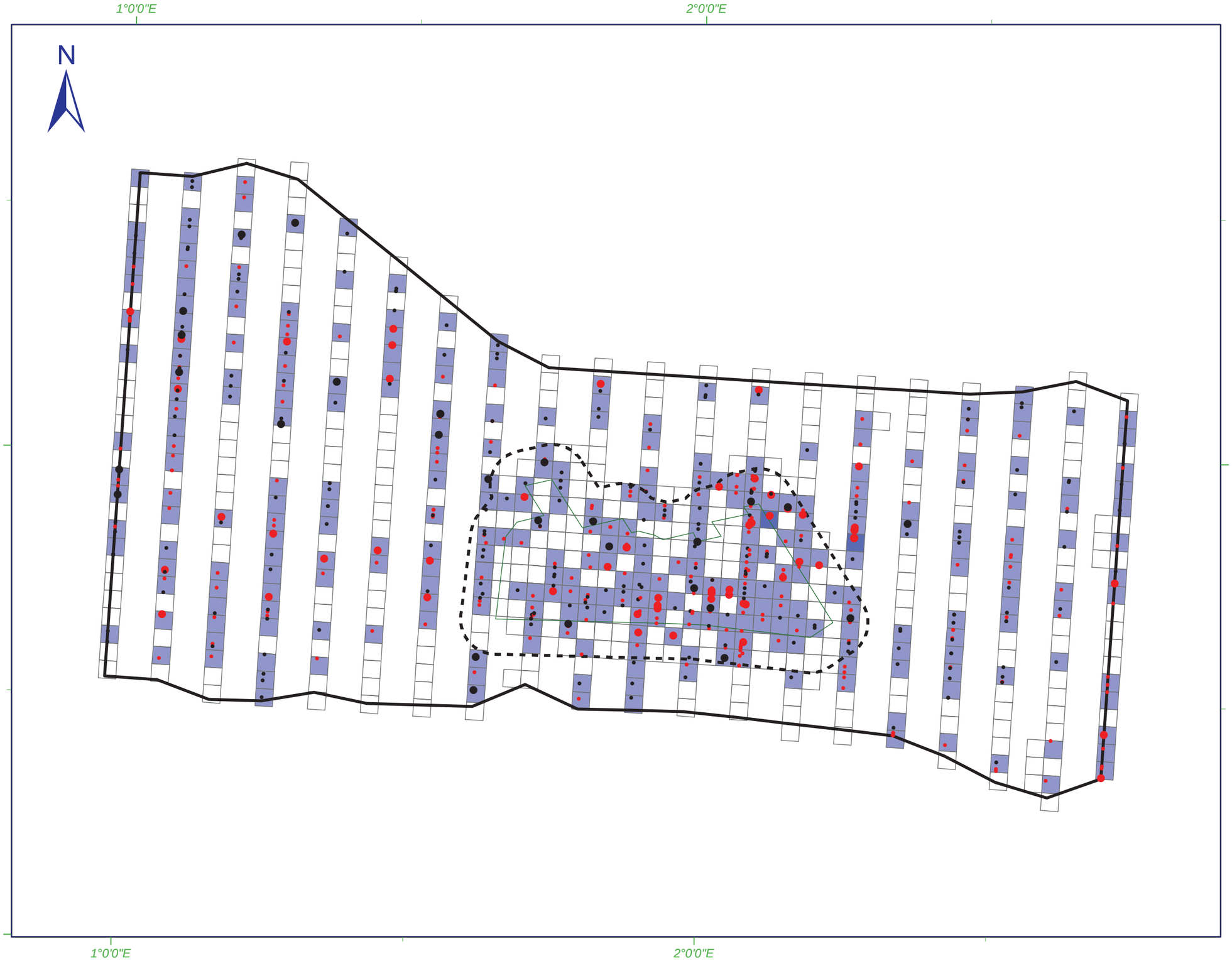
Northern Fulmar Density (October 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013 | DRAWN: RJ | CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: NorthernFulmarDensityOct10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

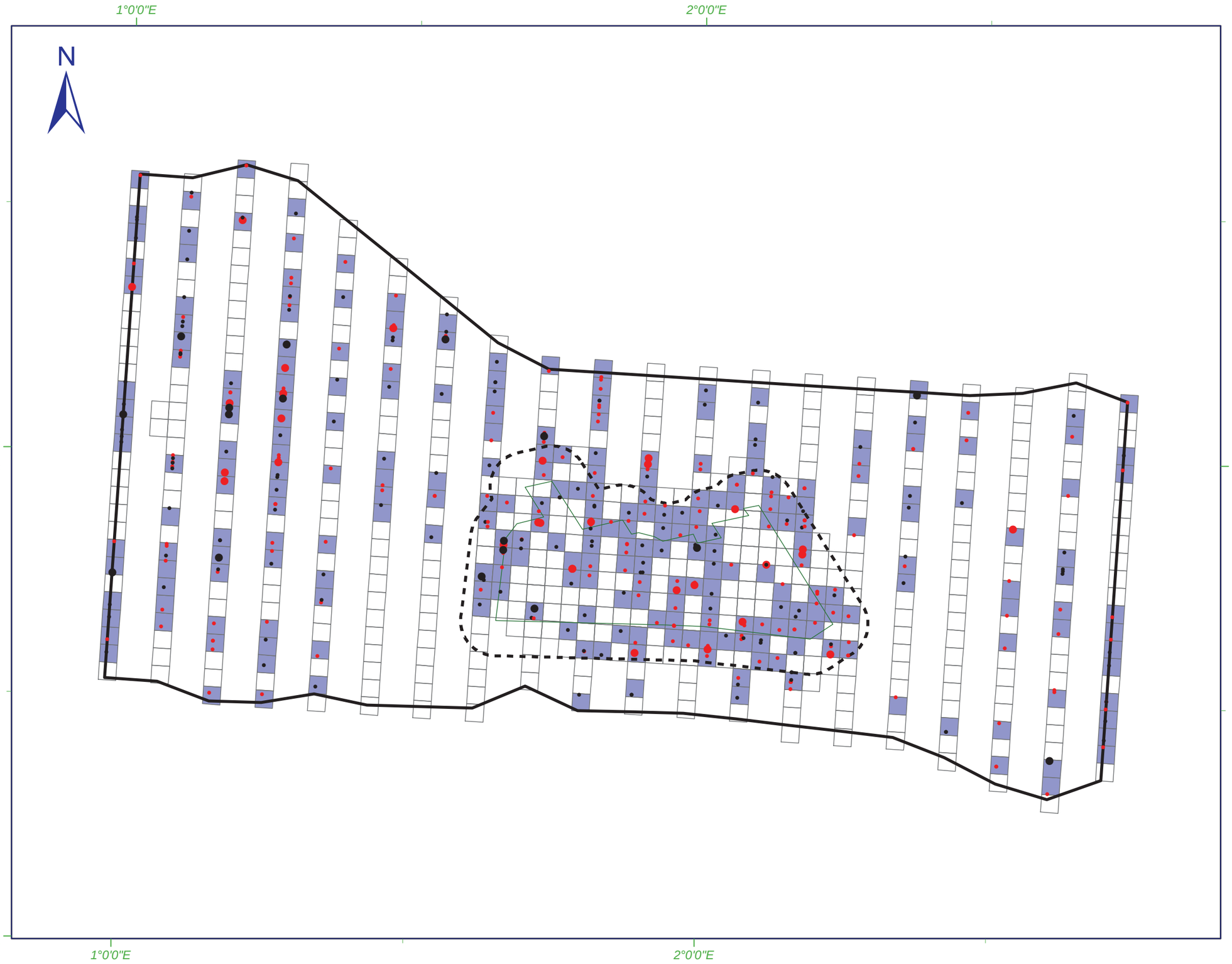
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density
(April to September 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: NorthernGannetDensityAprilToSept2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

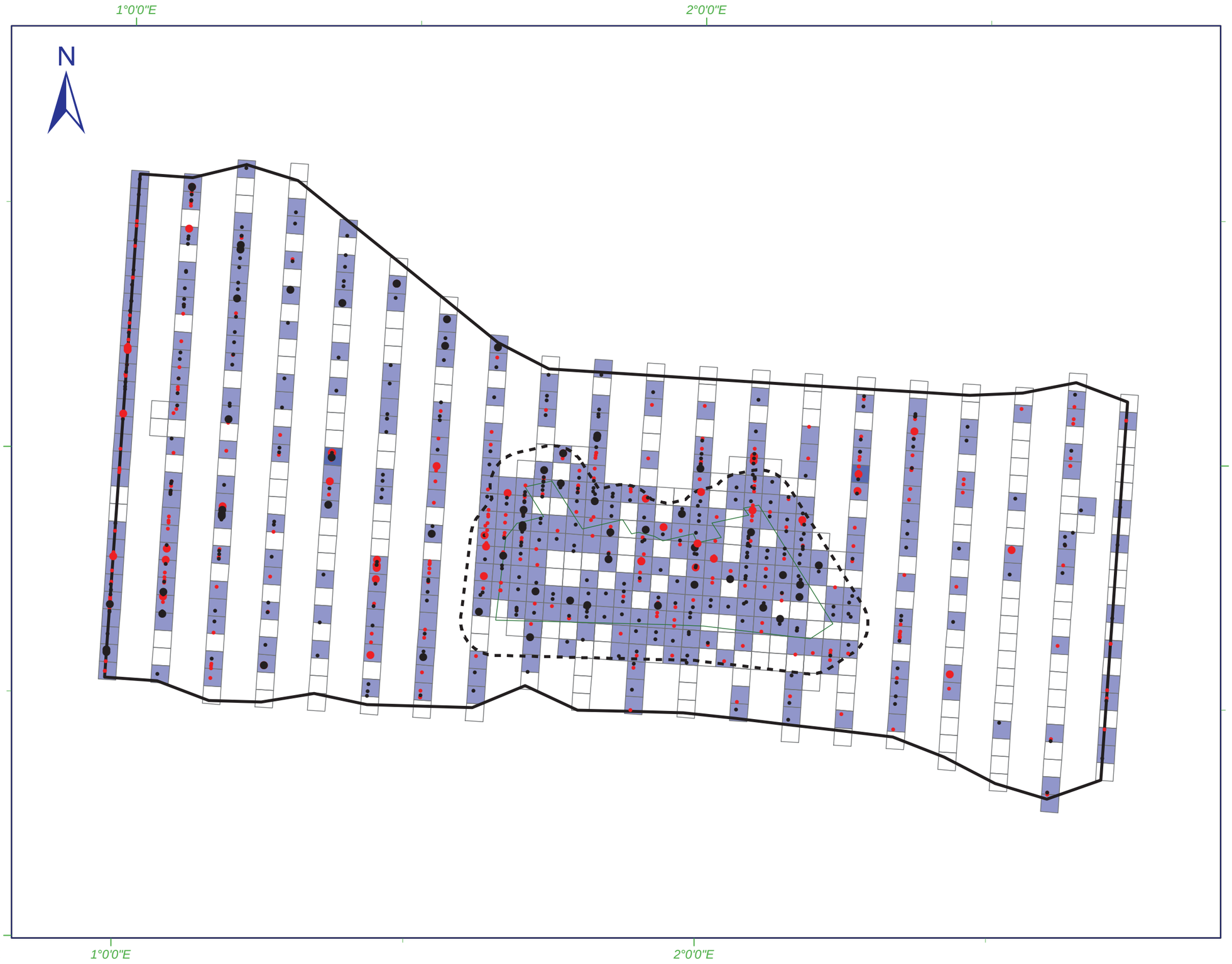
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density (April to September 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: NorthernGannetDensityAprilToSept2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

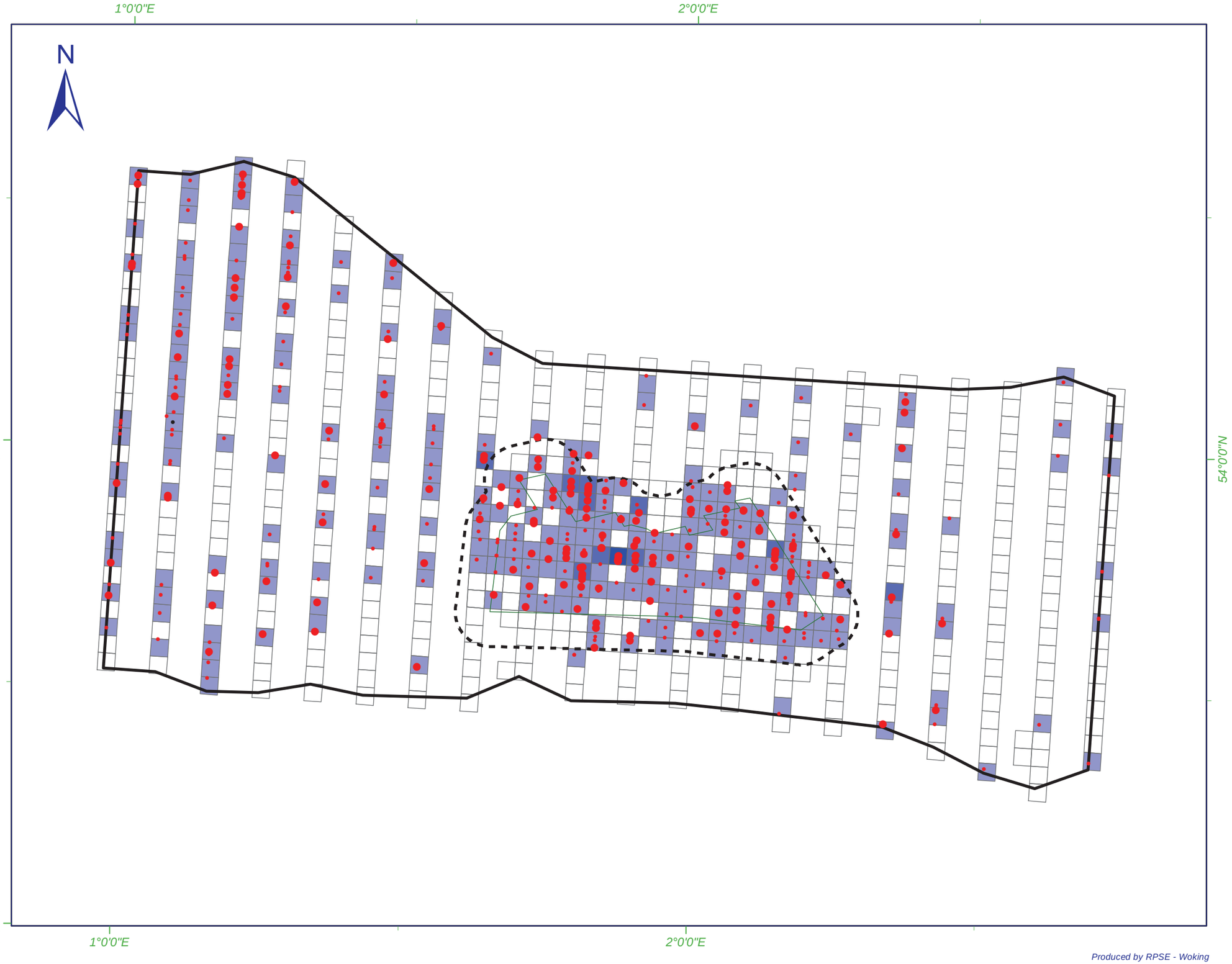
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density
(October 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: NorthernGannetDensityOct10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

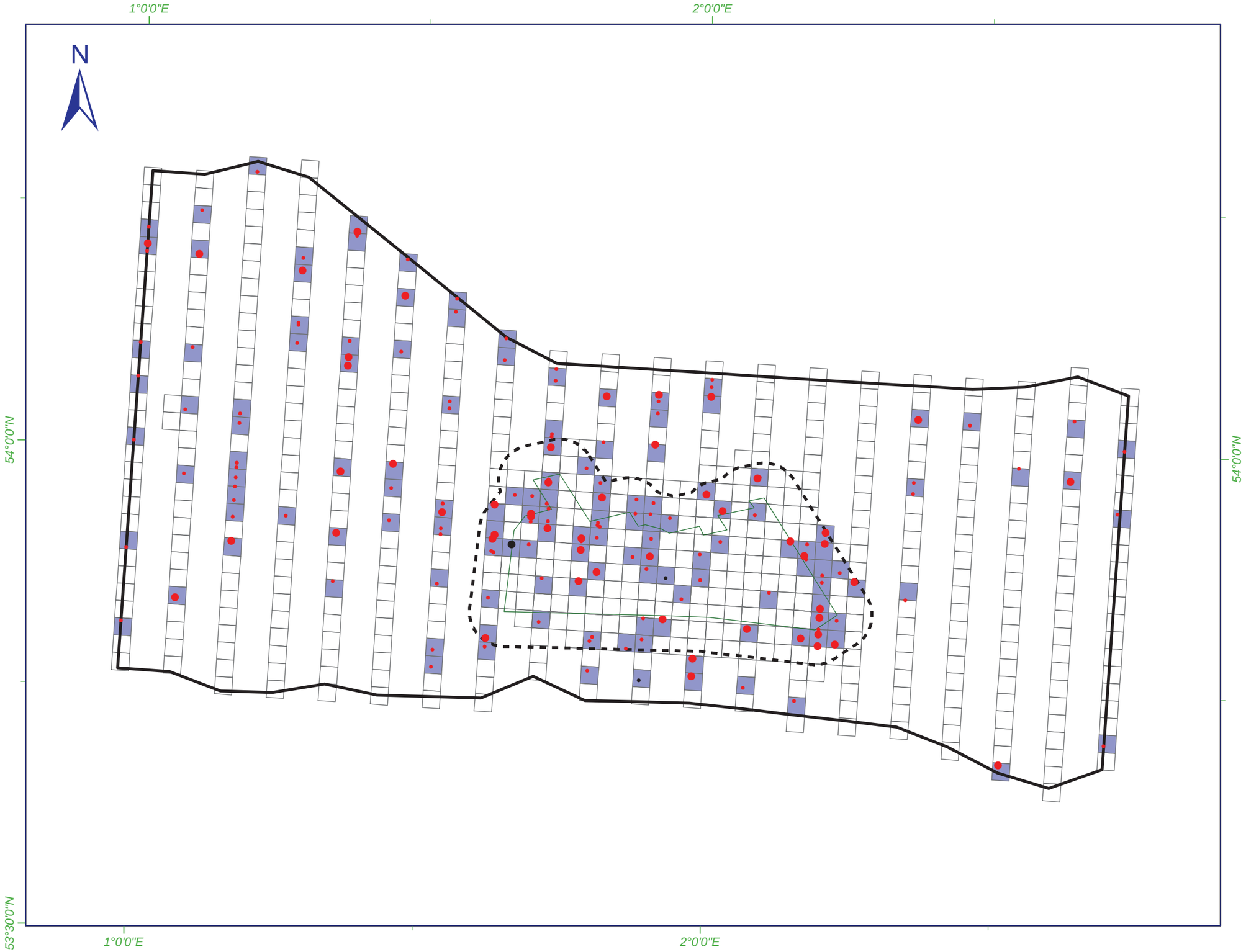
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Puffin Density
(April to July 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: PuffinDensityAprilToJuly2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

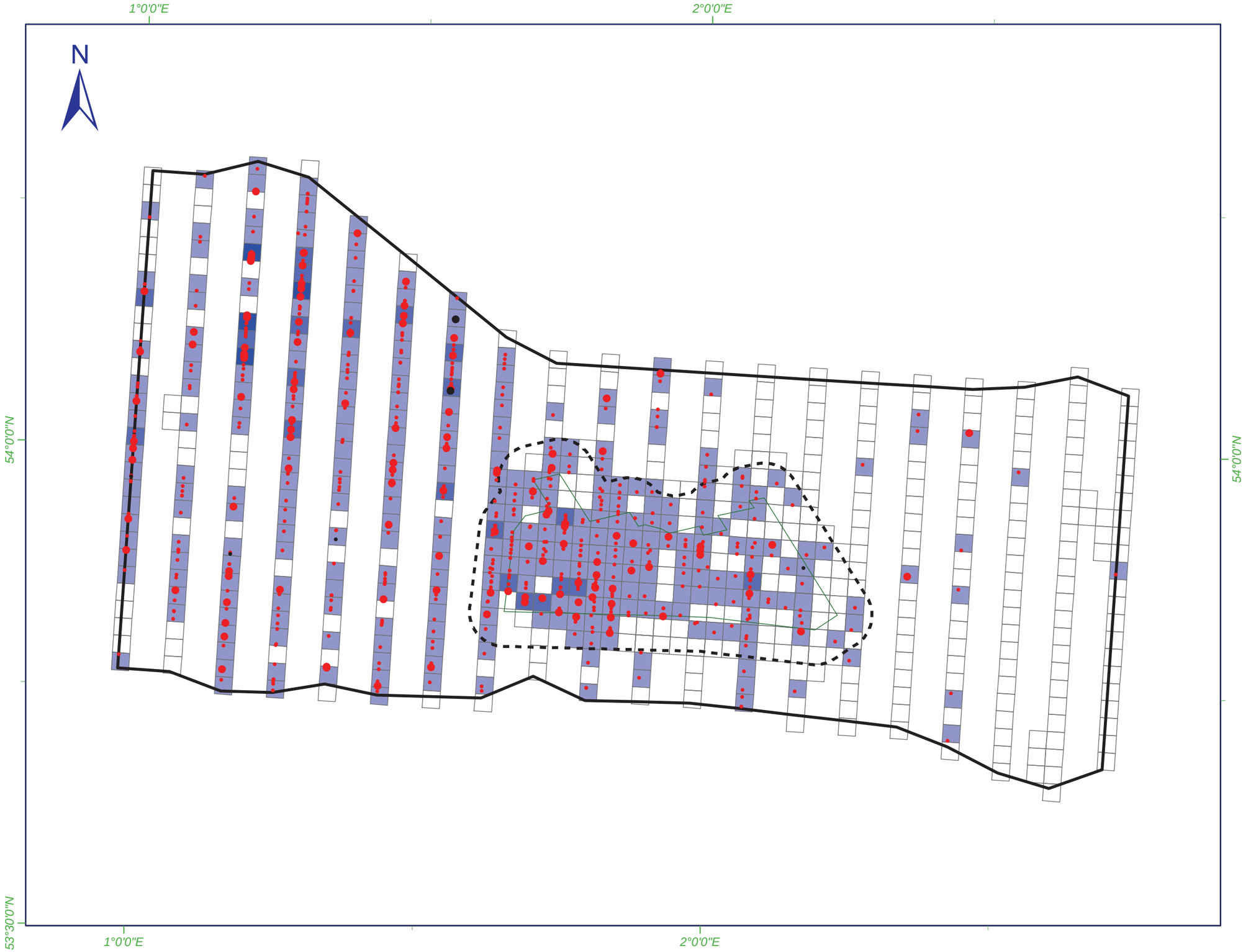
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Puffin Density
(April to July 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: PuffinDensityAprilToJuly2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

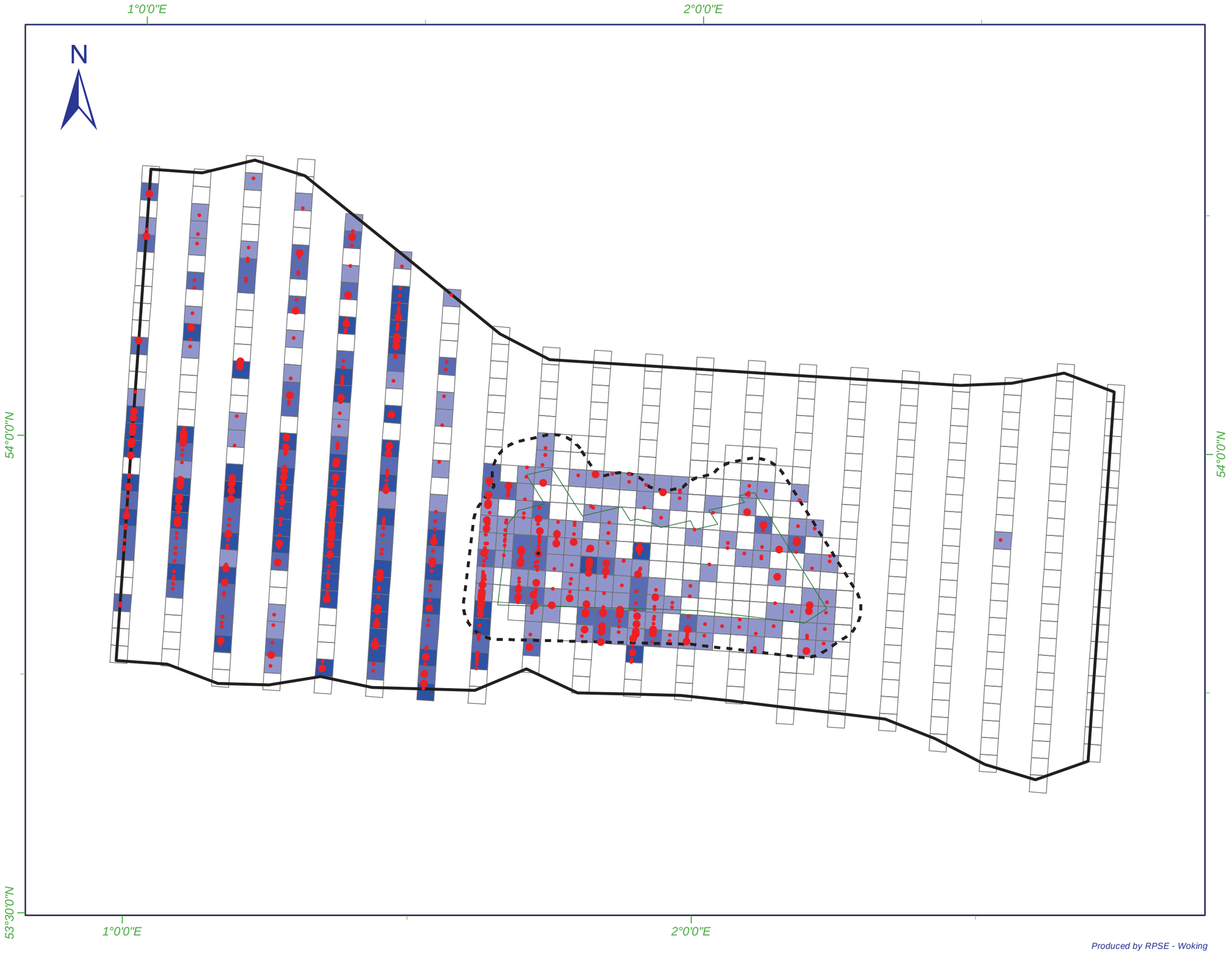
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Puffin Density
(August to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: PuffinDensityAugustToOctober2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

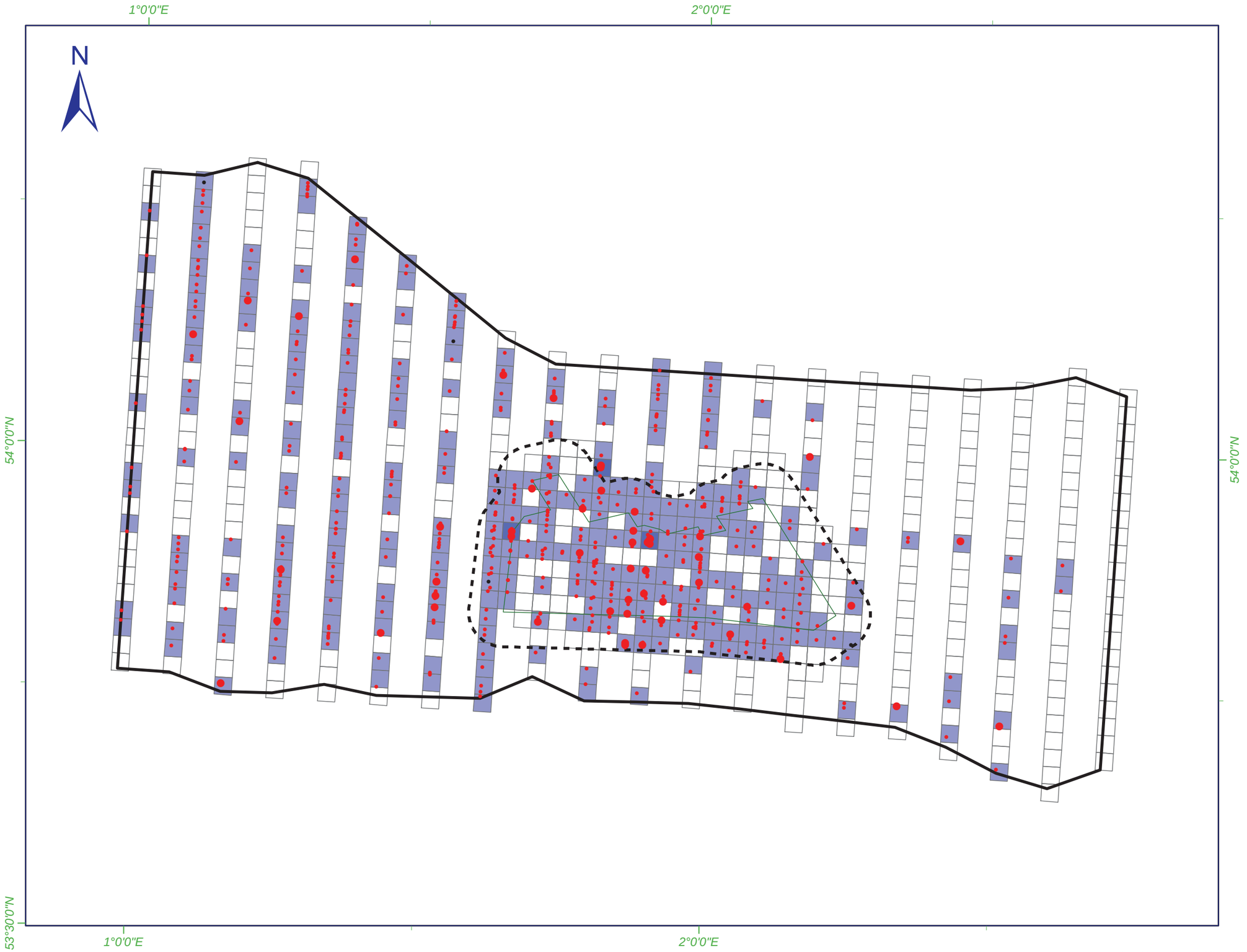
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Puffin Density
(August to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: PuffinDensityAugustToOctober2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

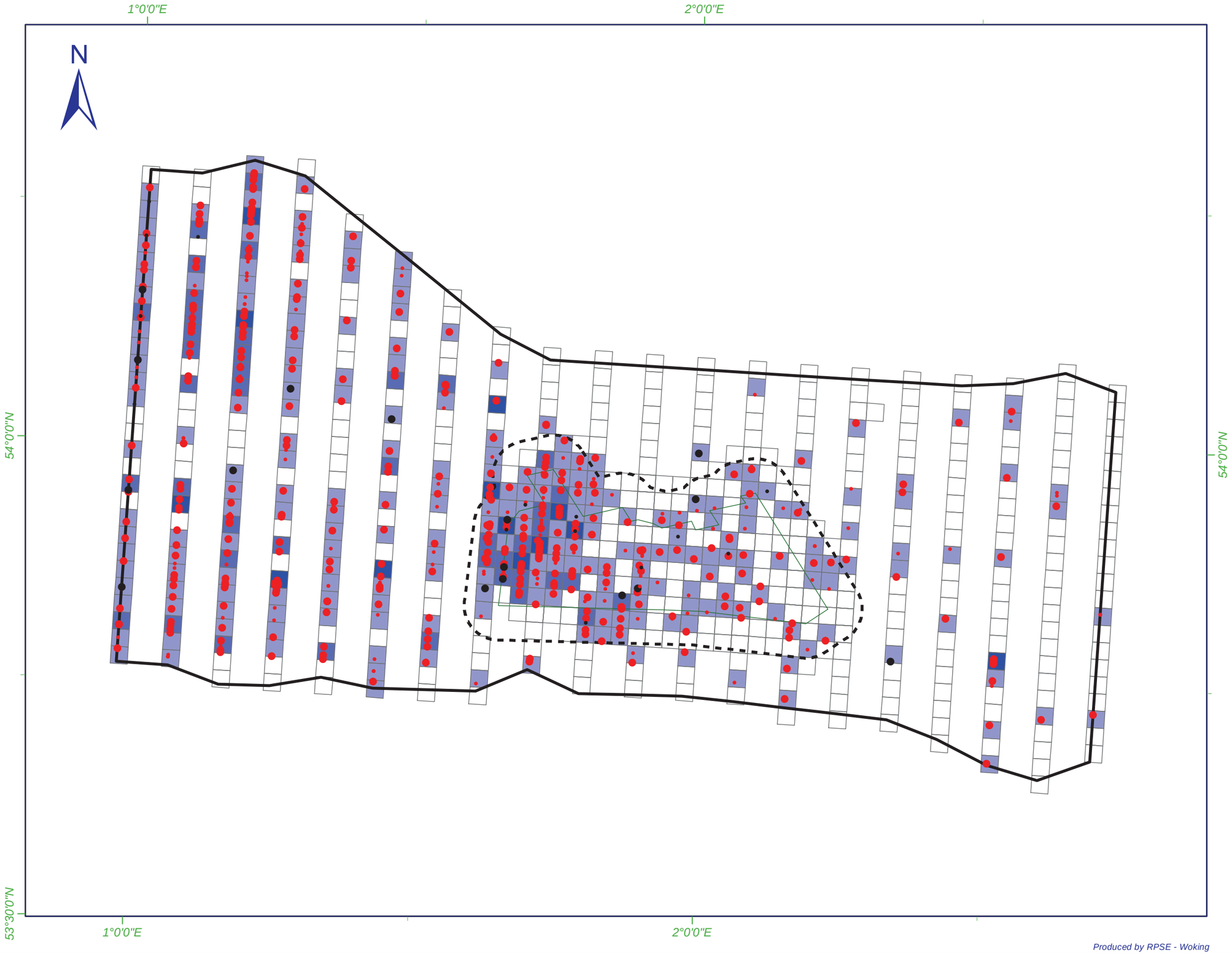
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Puffin Density
(November 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: PuffinDensityNov10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

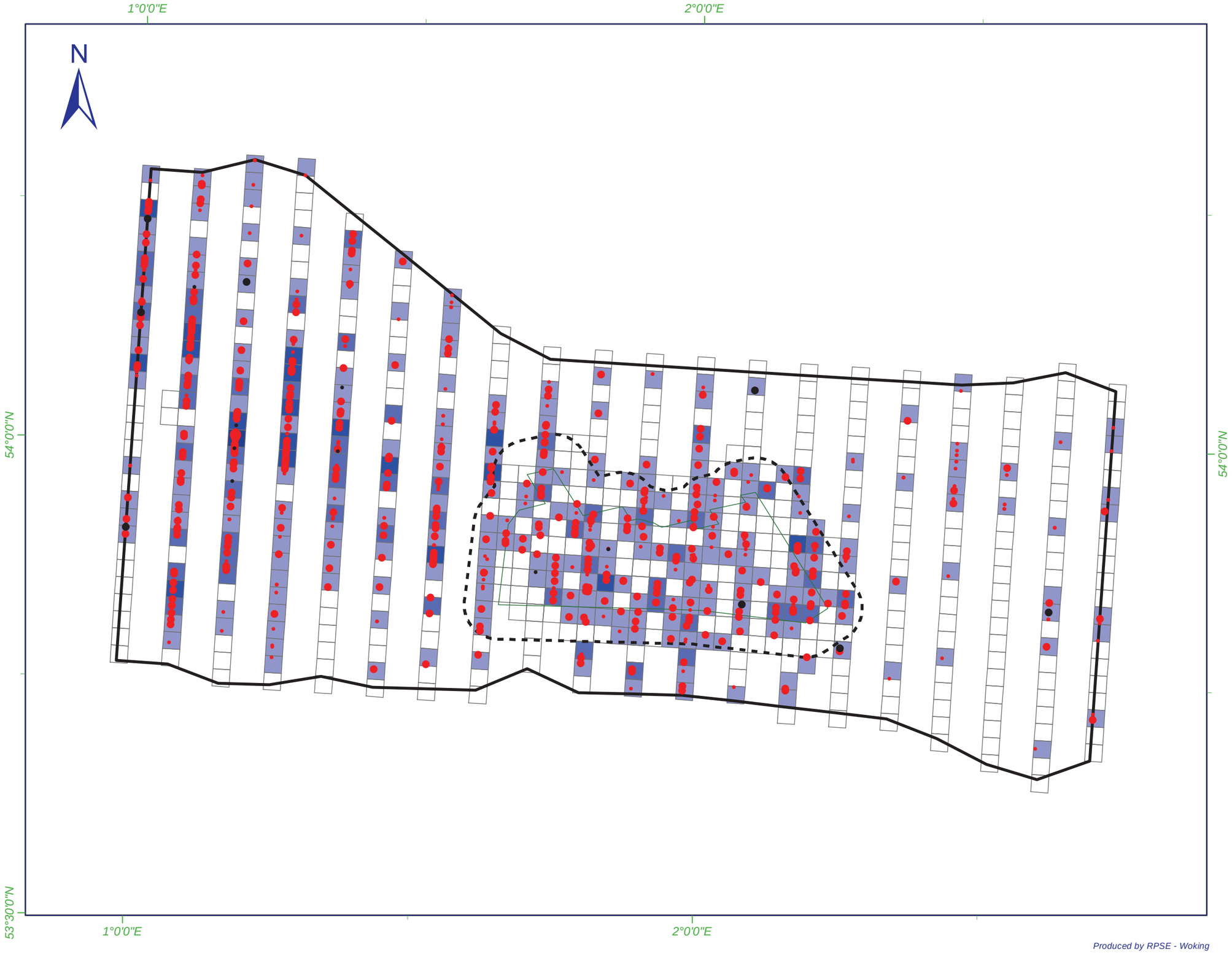
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(April to June 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: RazorbillDensityAprilToJune2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

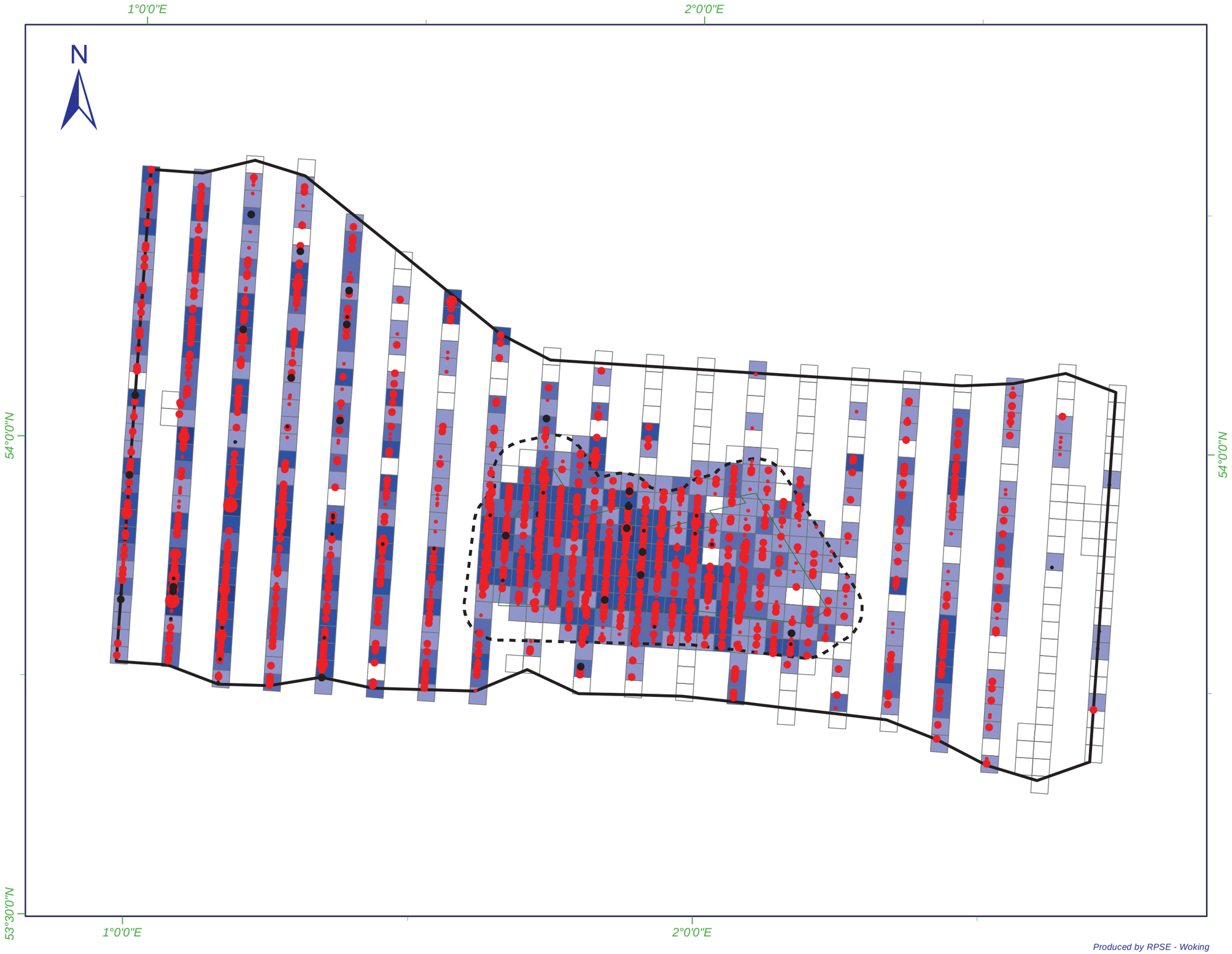
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(April to June 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: RazorbillDensityAprilToJune2011_RJ_130517R1



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

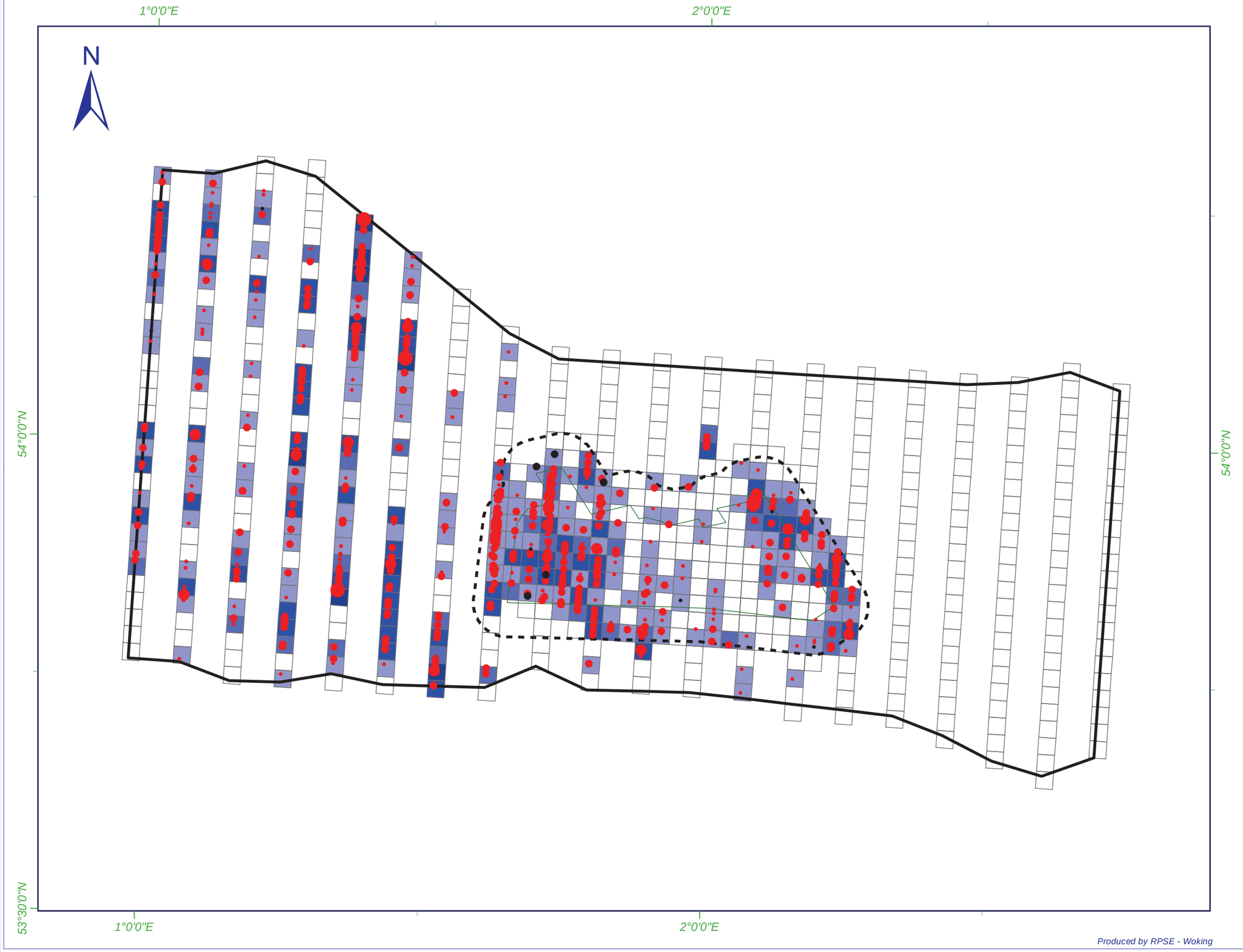
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(July to October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: RazorbillDensityJulyToOctober2010_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

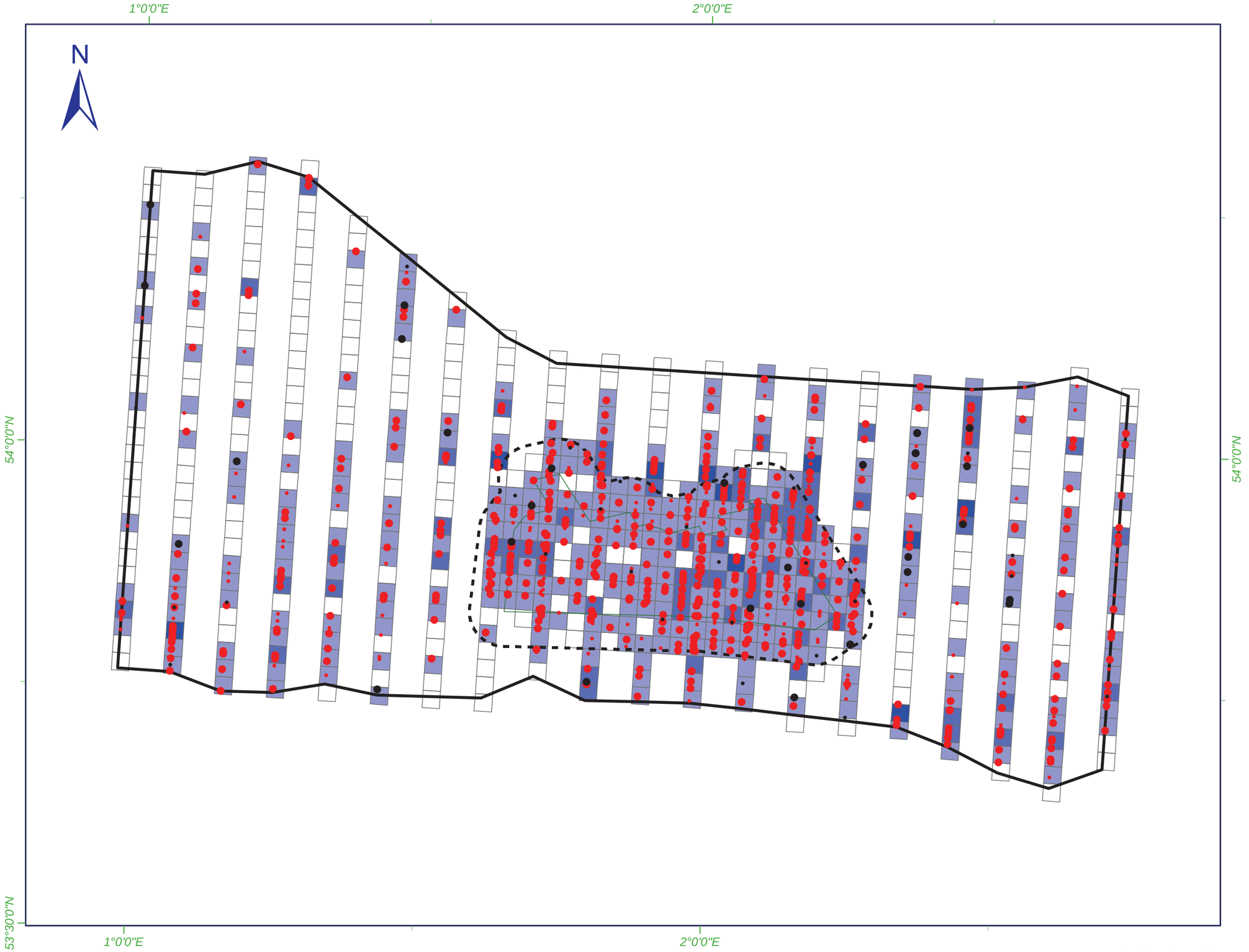
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(July to October 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: RazorbillDensityJulyToOctober2011_RJ_130517R1



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

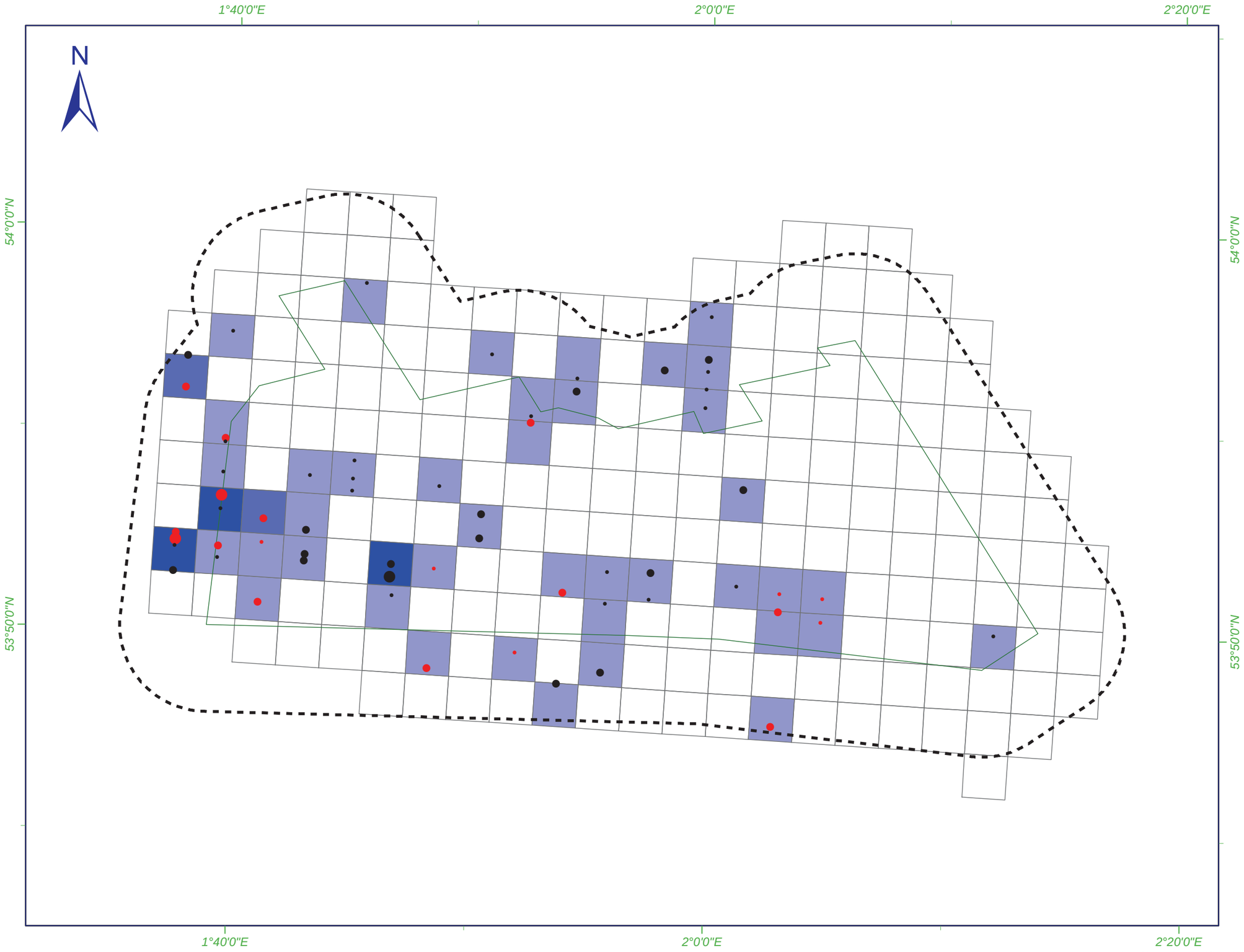
SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(November 2010 to March 2011)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: RazorbillDensityNov10ToMar11_RJ_130517R1



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Common Tern Density
(August & September 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_CommonTernDensityAug&Sep2010_RJ_121009R0

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

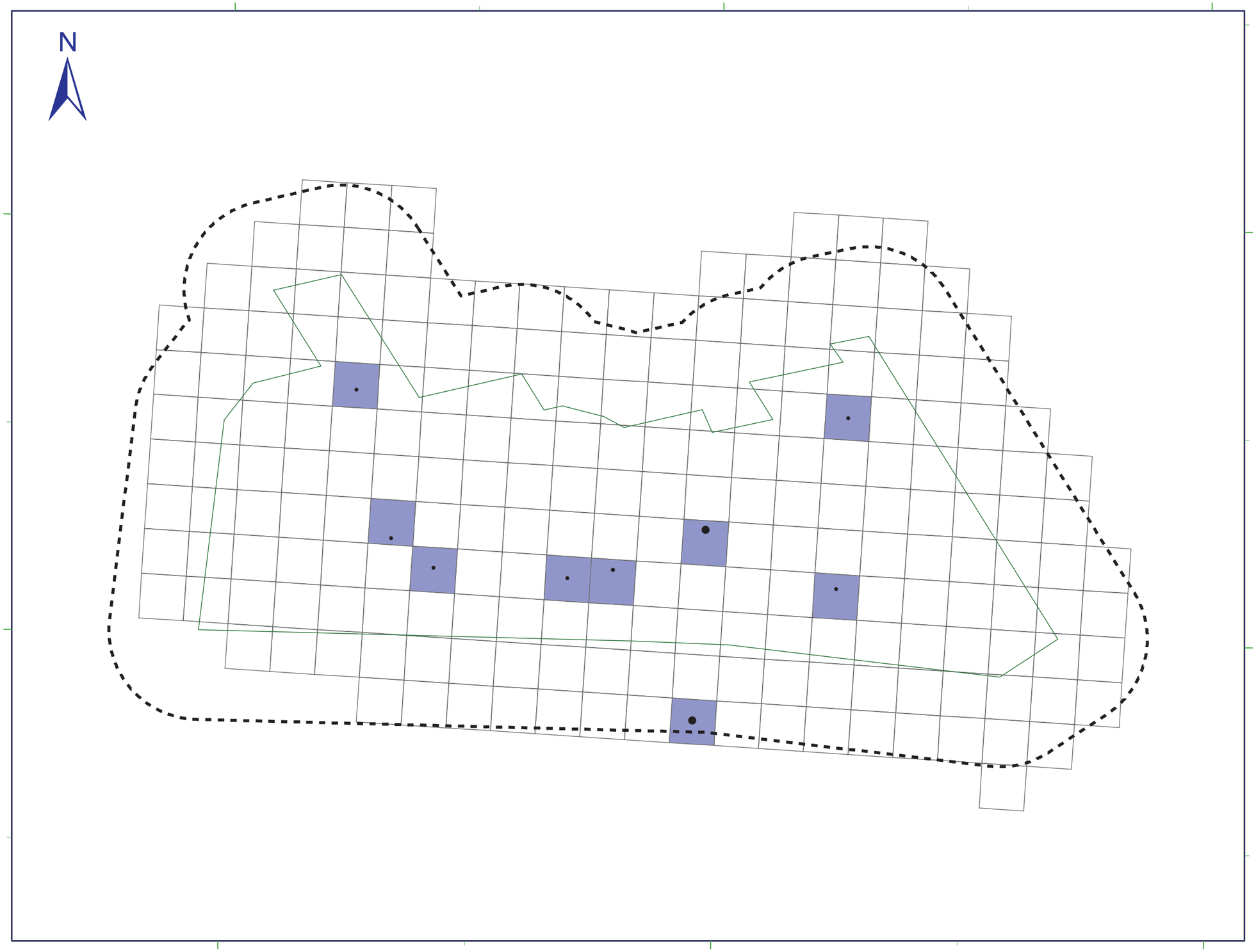
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Common Tern Density
(August & September 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_CommonTernDensityAug&Sep2011_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

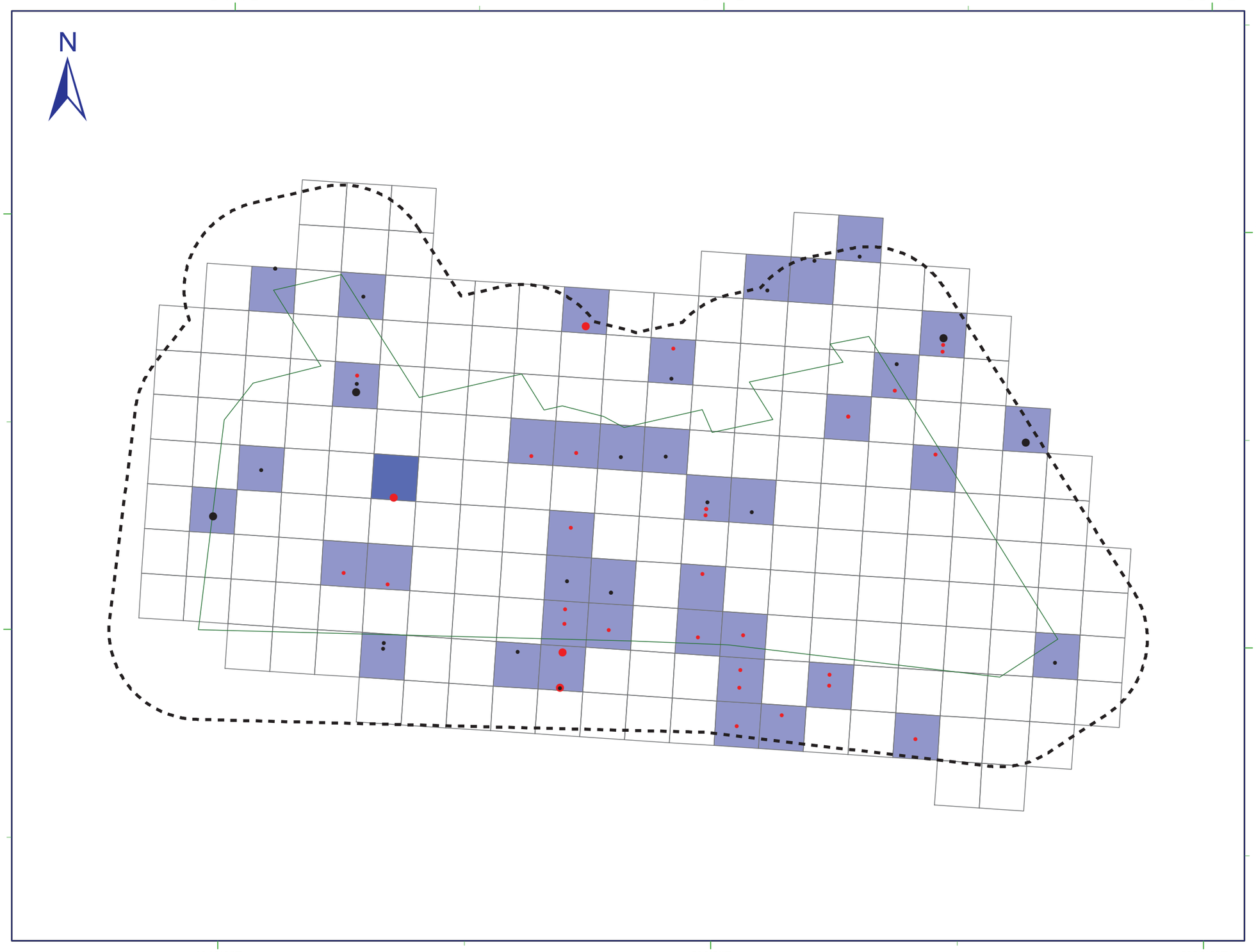
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (April to August 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_GreatBBGullDensityAprilToAugust2010_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

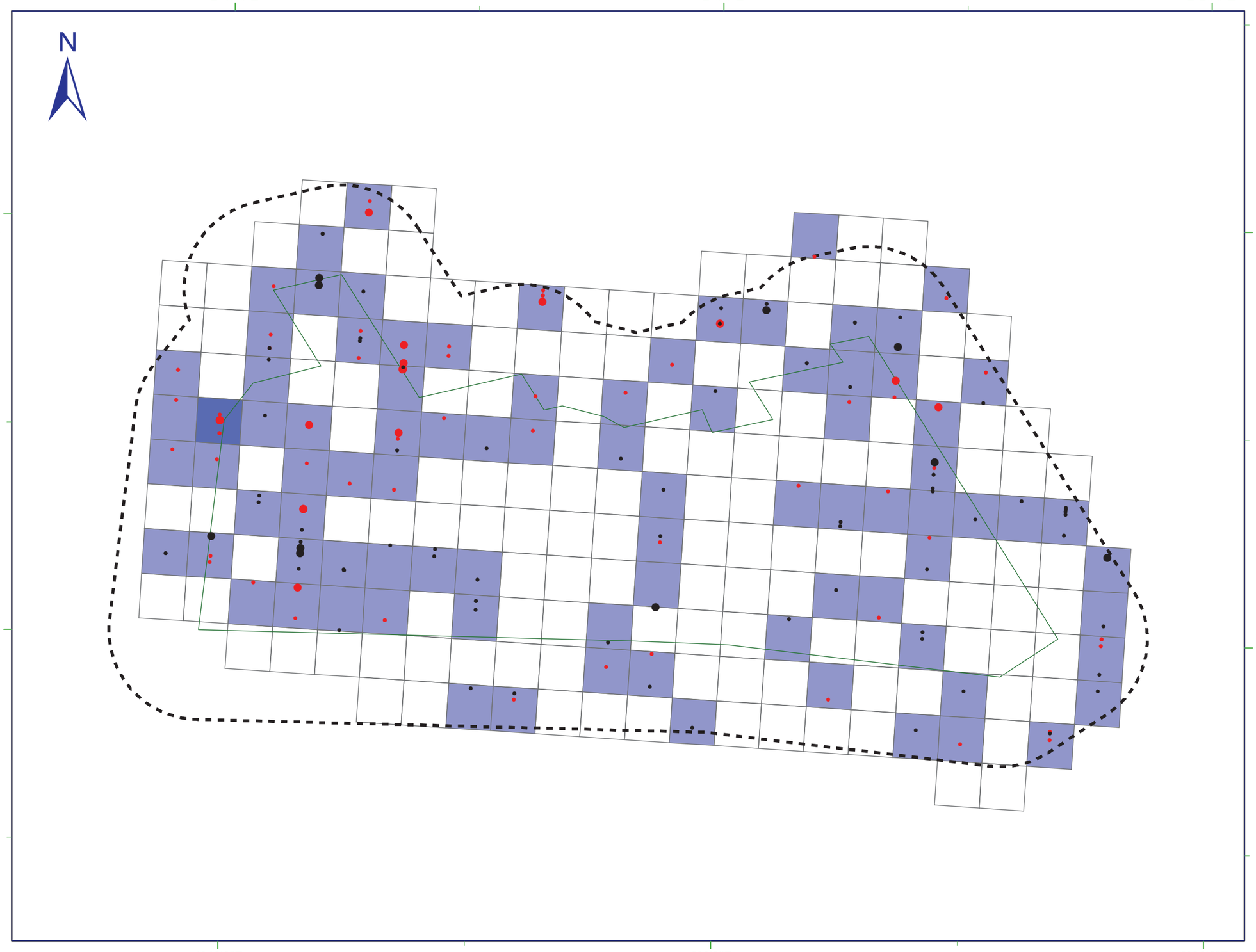
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (April to August 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_GreatBBGullDensityAprilToAugust2011_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

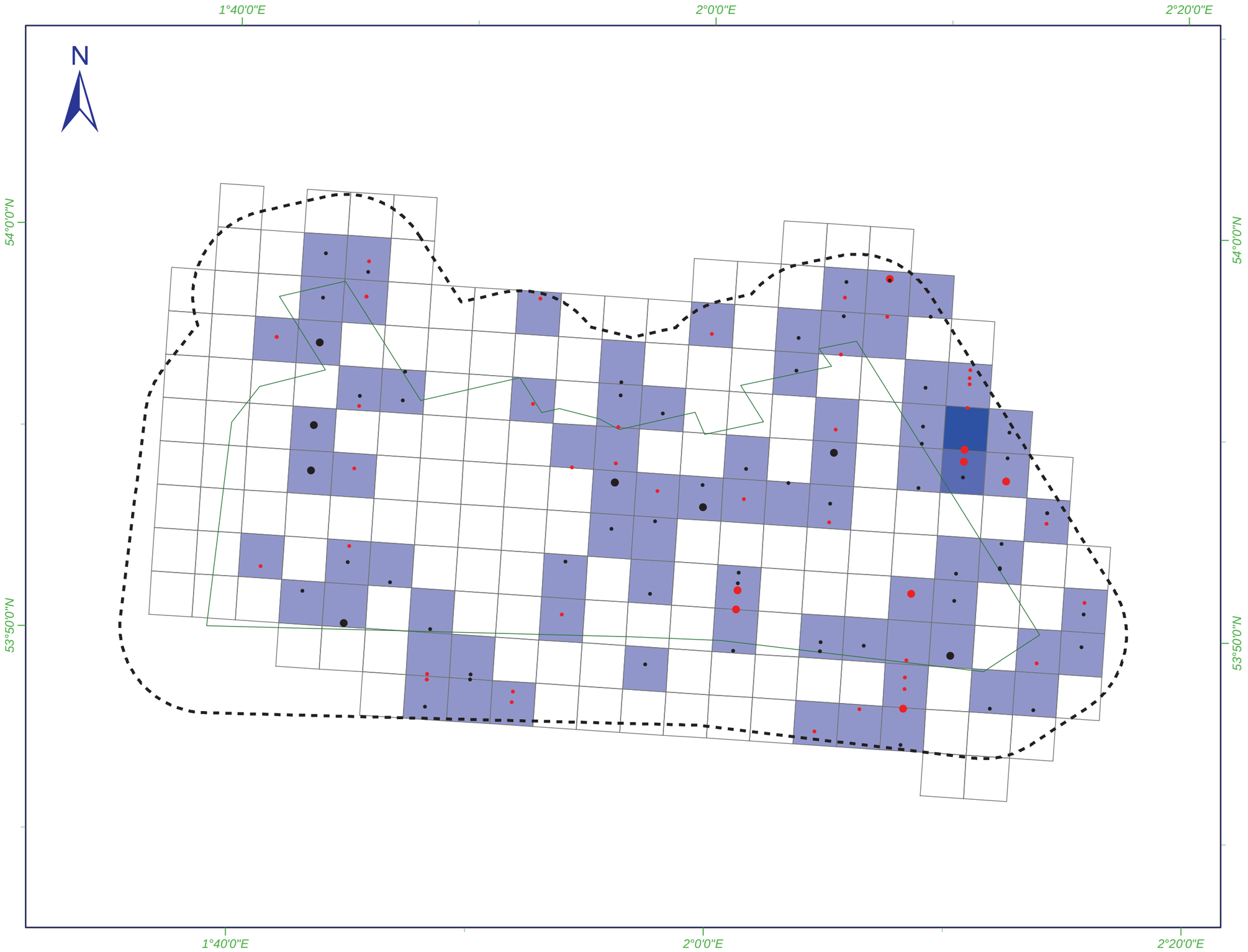
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Great Black-Backed Gull Density (September 2010 to March 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_GreatBBGullDensitySep10toMar11_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

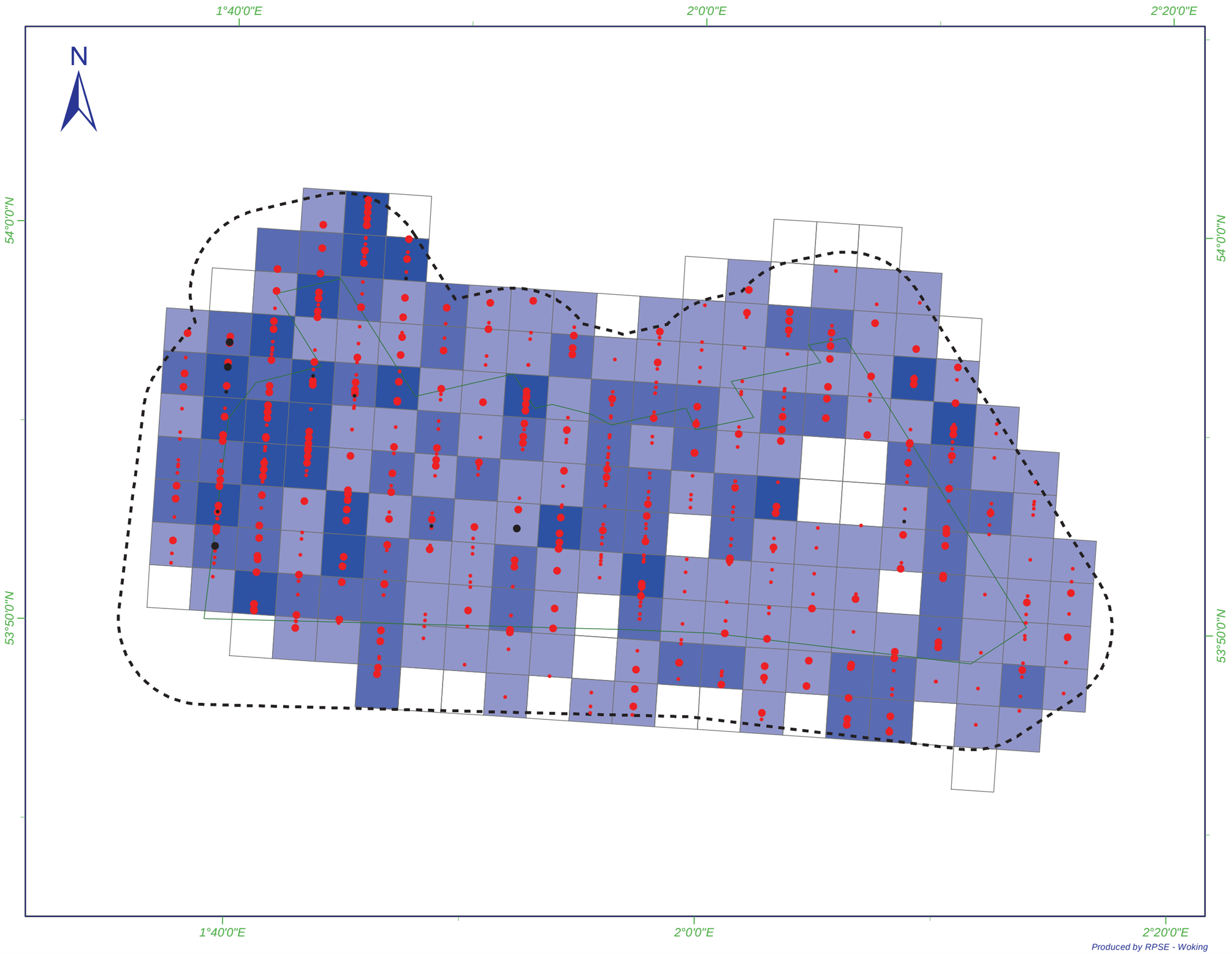
Great Black-Backed Gull Density (September 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_GreatBBGullDensitySep11toMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

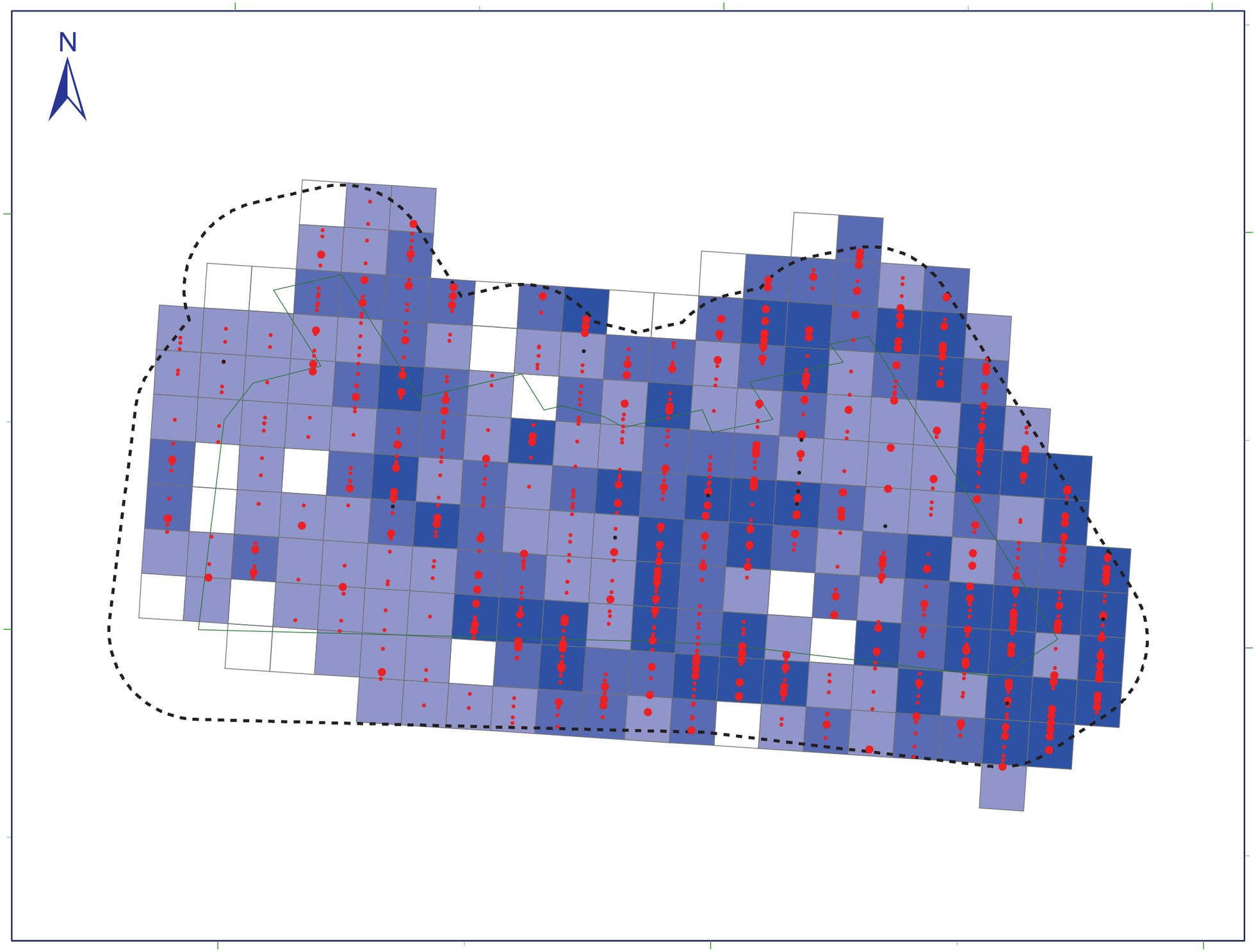
Guillemot Density
(April to June 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_GuillemotDensityAprilToJune2010_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

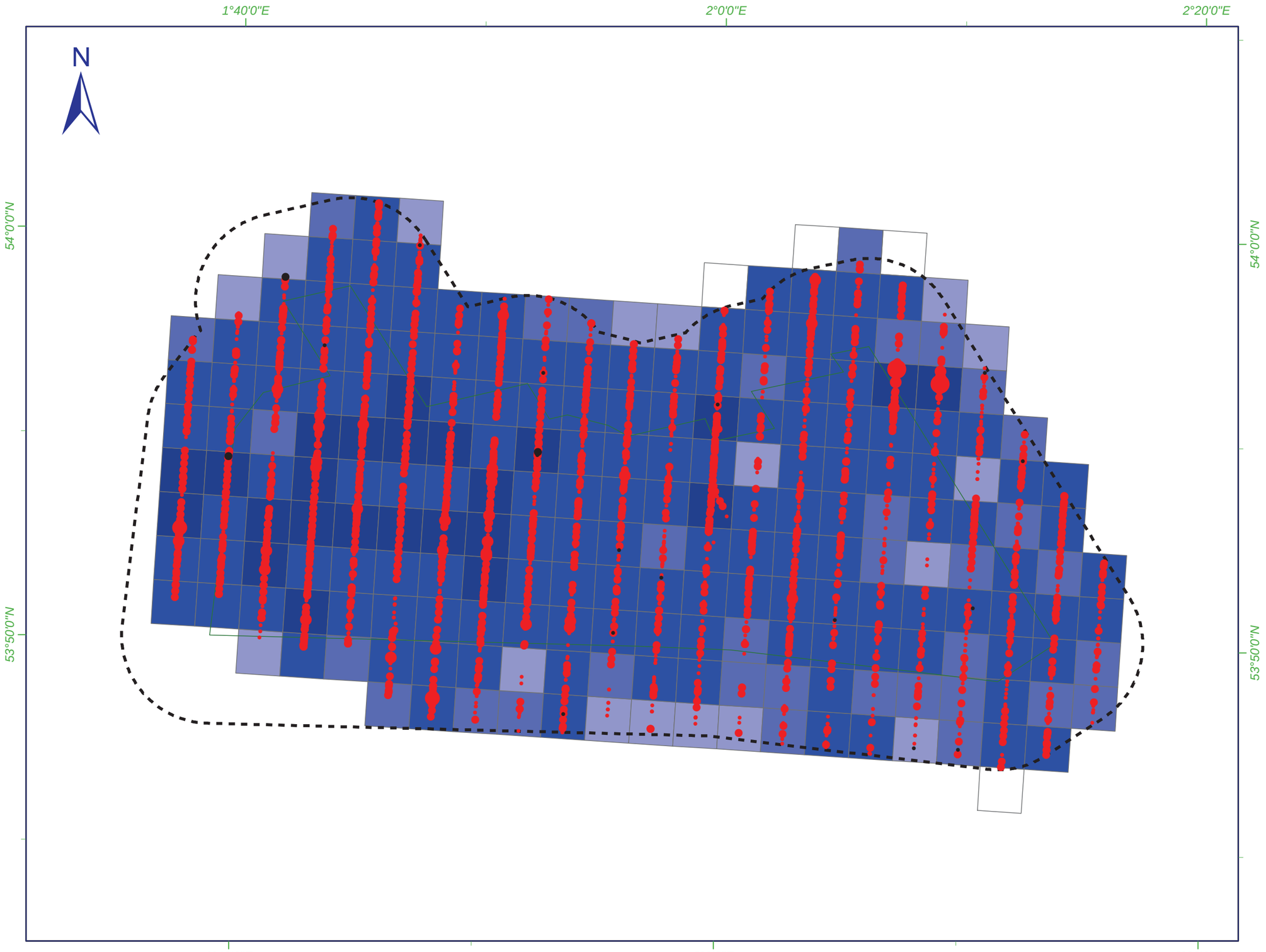
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(April to June 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_GuillemotDensityAprilToJune2011_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

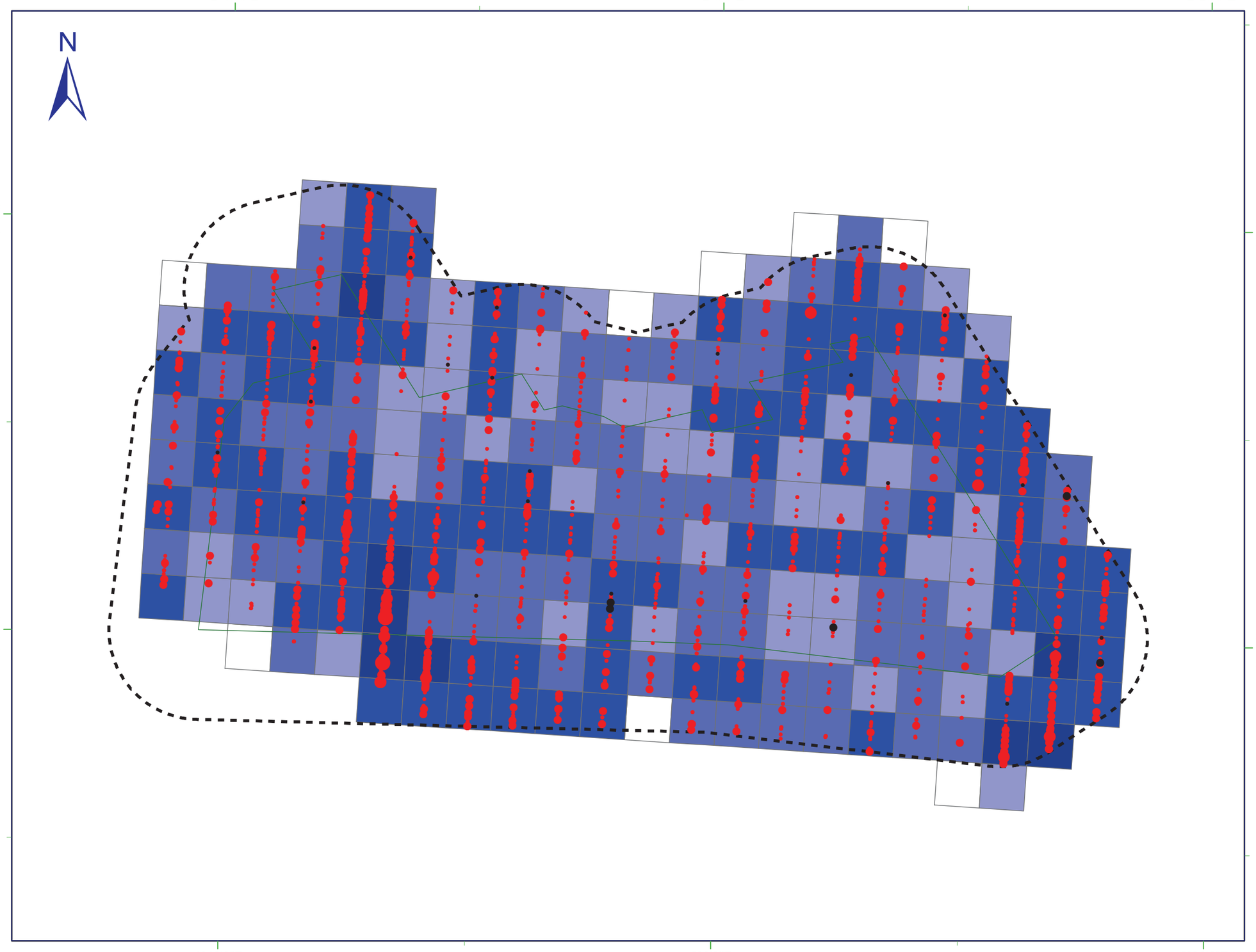
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(July to October 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityJulyToOctober2010_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

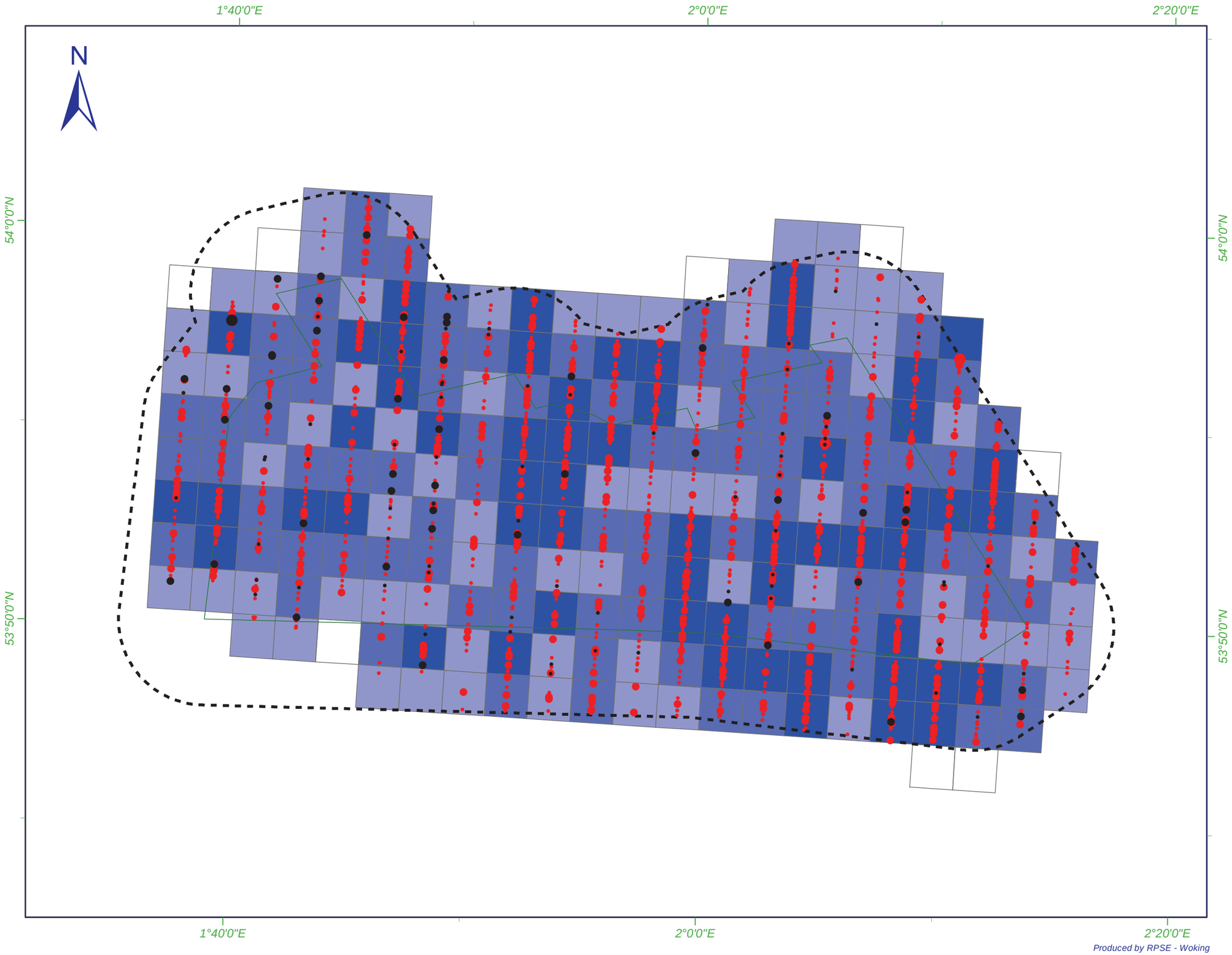
Guillemot Density
(July to October 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: GuillemotDensityJulyToOctober2011_RJ_121009R0

Produced by RPSE - Woking



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

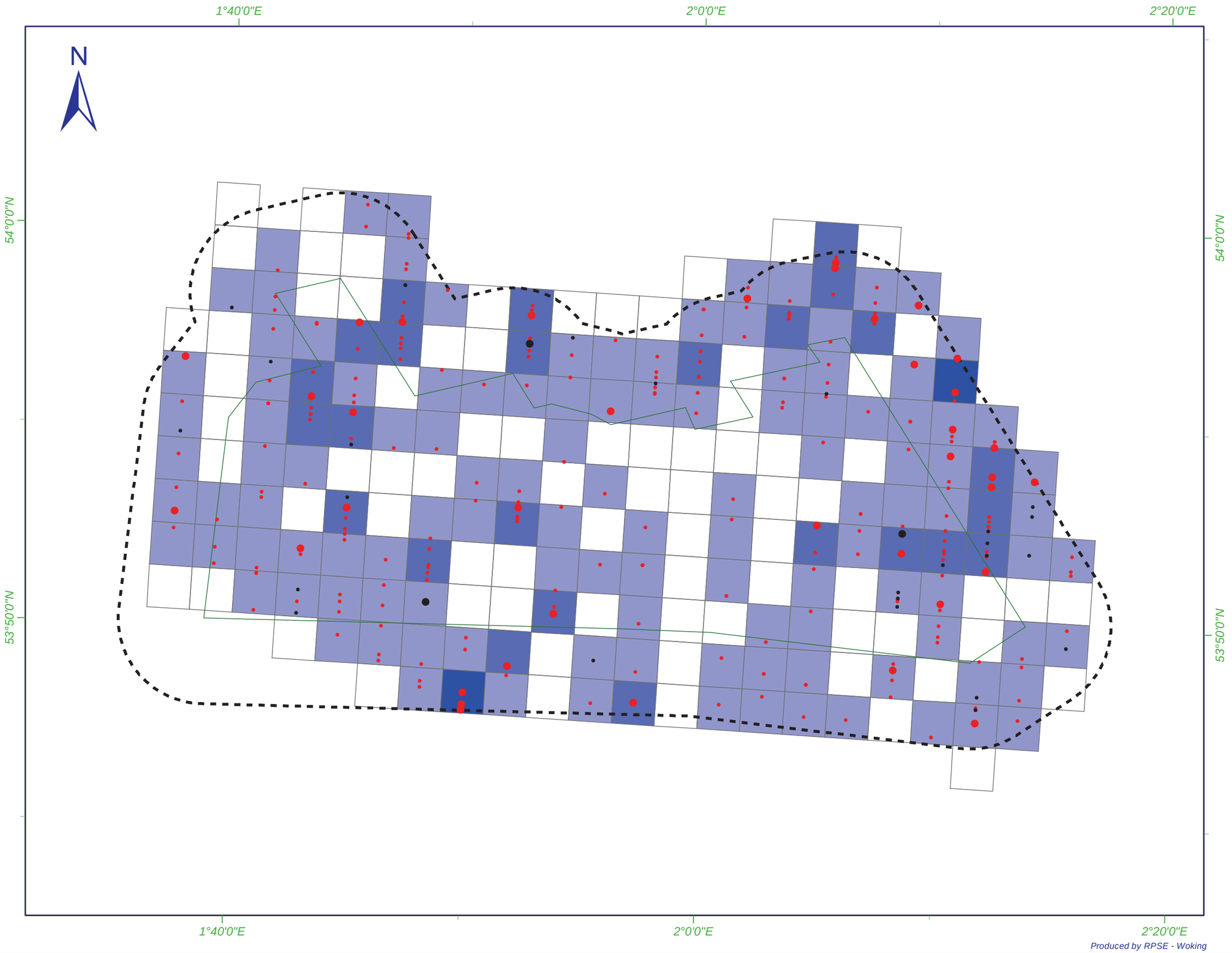
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(November 2010 to March 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_GuillemotDensityNov10ToMar11_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Guillemot Density
(November 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_GuillemotDensityNov11ToMar12_RJ_121009R0

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Herring Gull Density (April to July 2010)

SMart Wind | RPS

DATE: 11/10/2012 | DRAWN: RJ | CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_HerringGullDensityAprilToJuly2010_RJ_121009R0

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

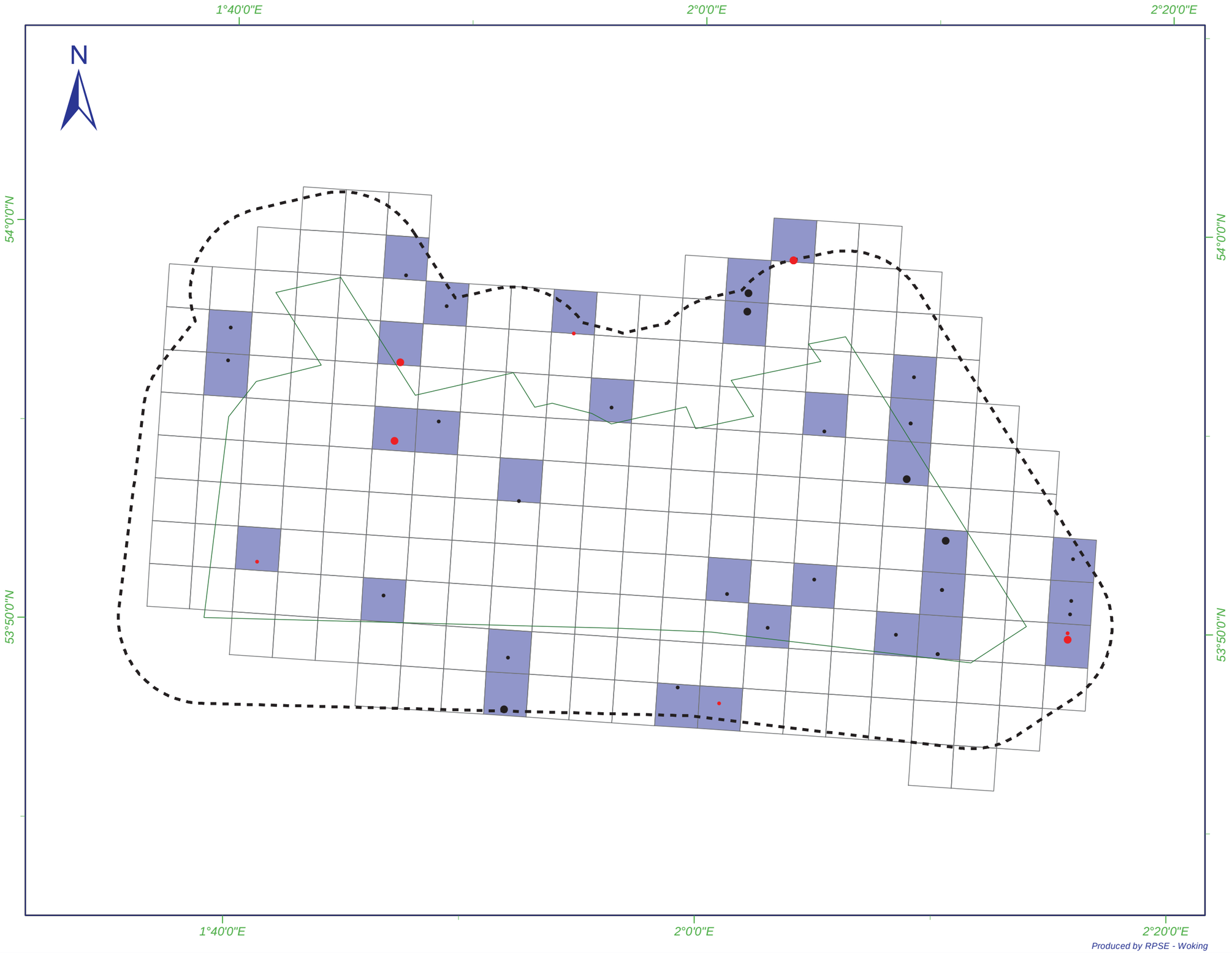
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(April to July 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_HerringGullDensityAprilToJuly2011_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

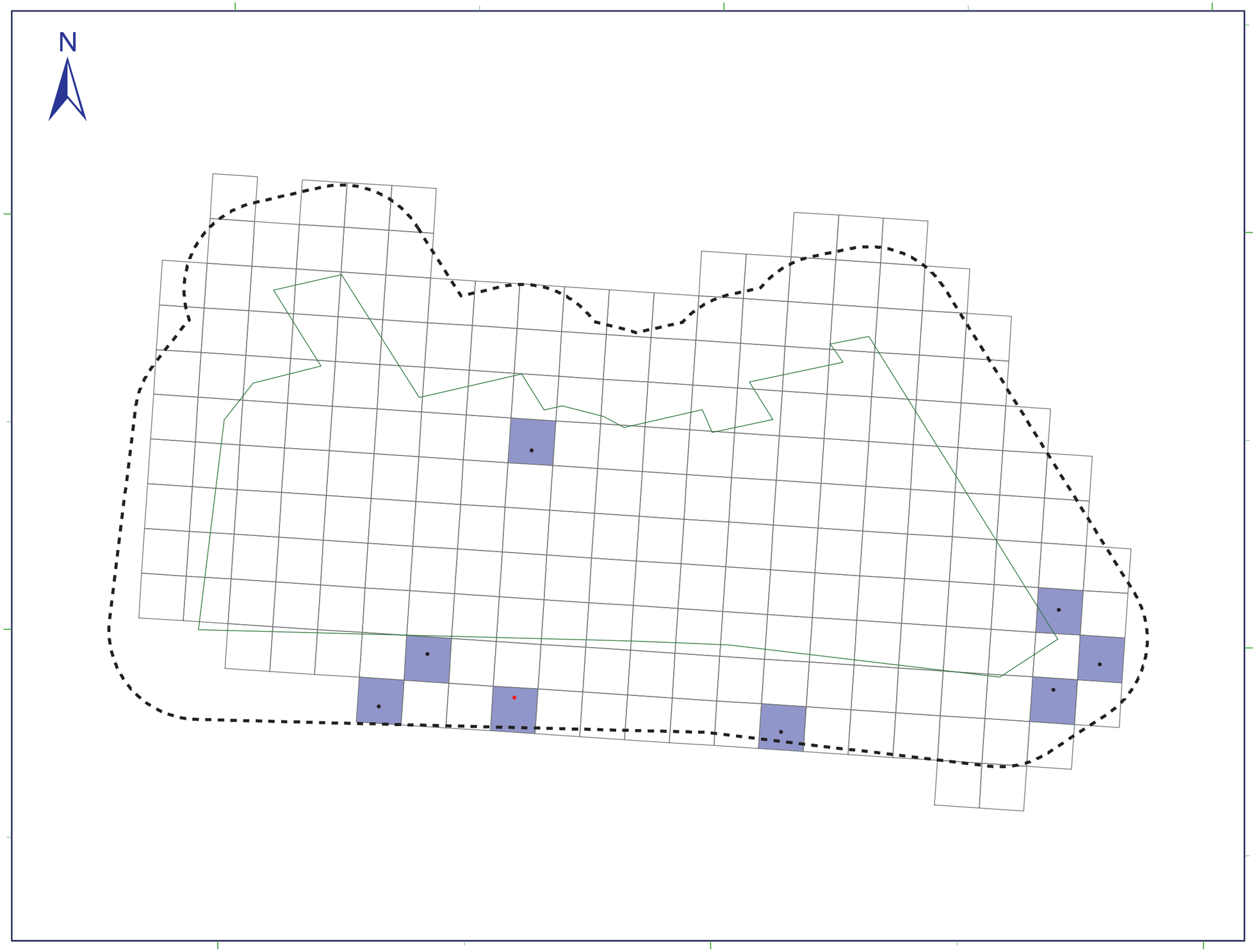
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(August 2010 to March 2011)

SMart Wind
RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_HerringGullDensityAug10ToMar11_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

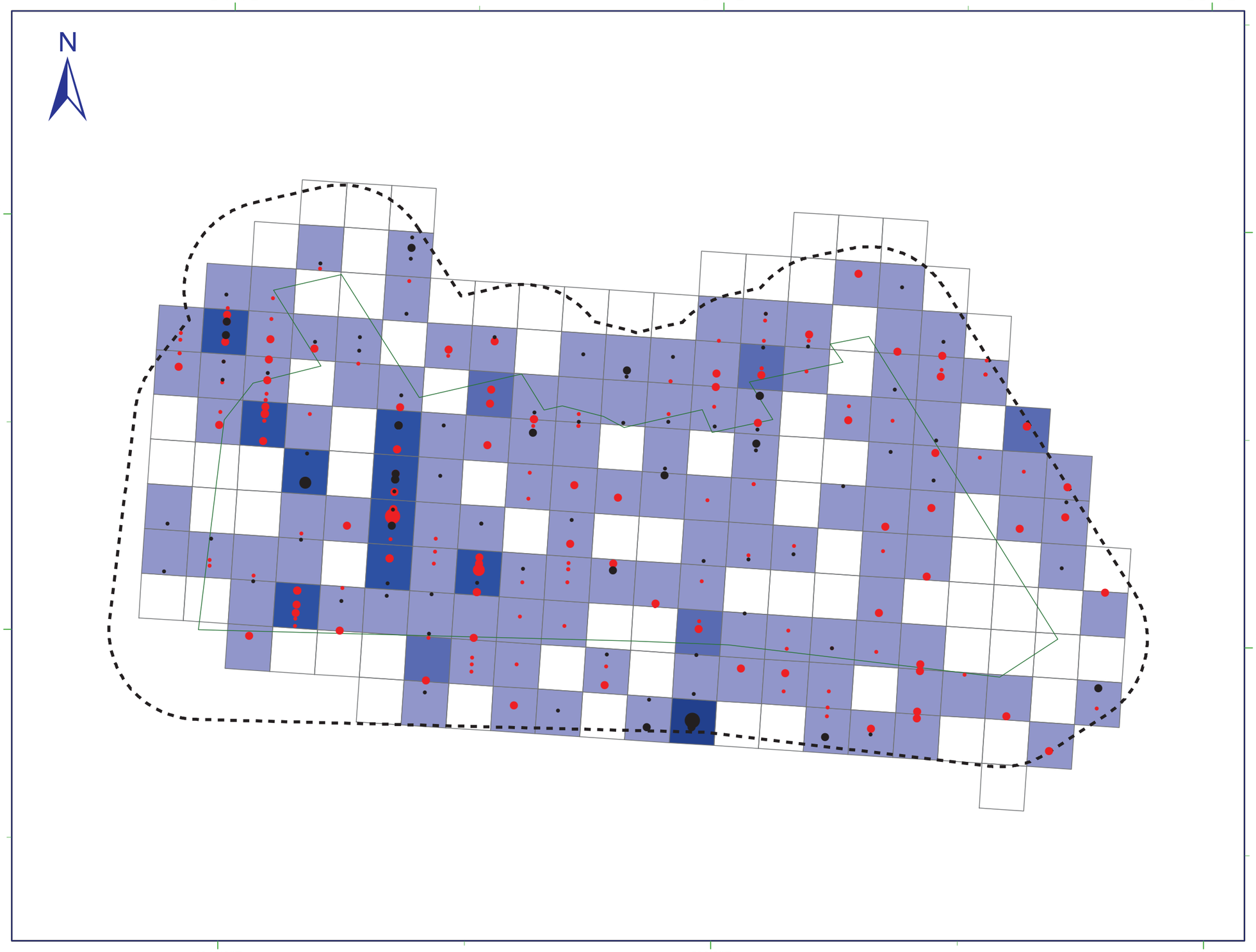
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Herring Gull Density
(August 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_HerringGullDensityAug11ToMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

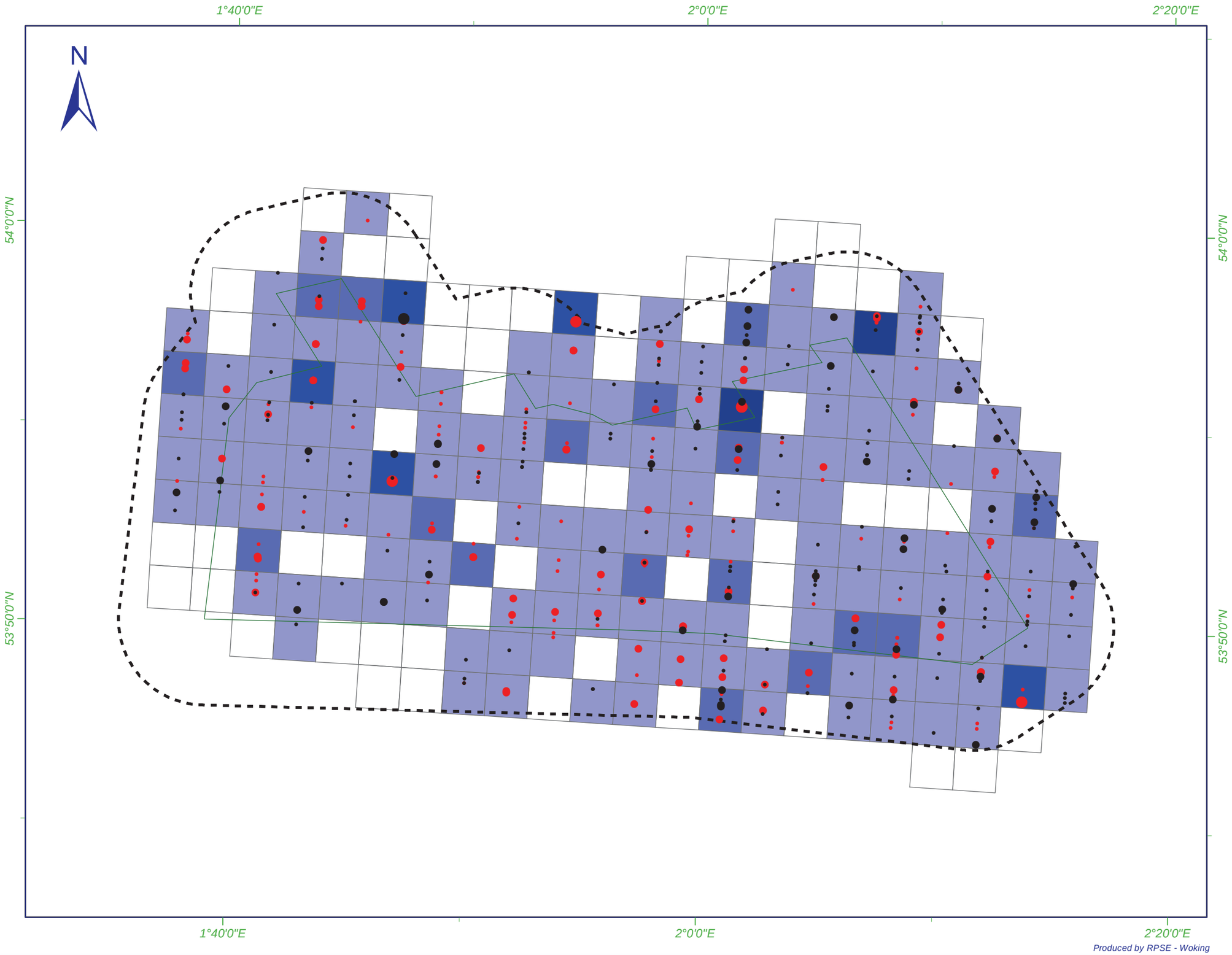
Kittiwake Density
(April to July 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_KittiwakeDensityAprilToJuly2010_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

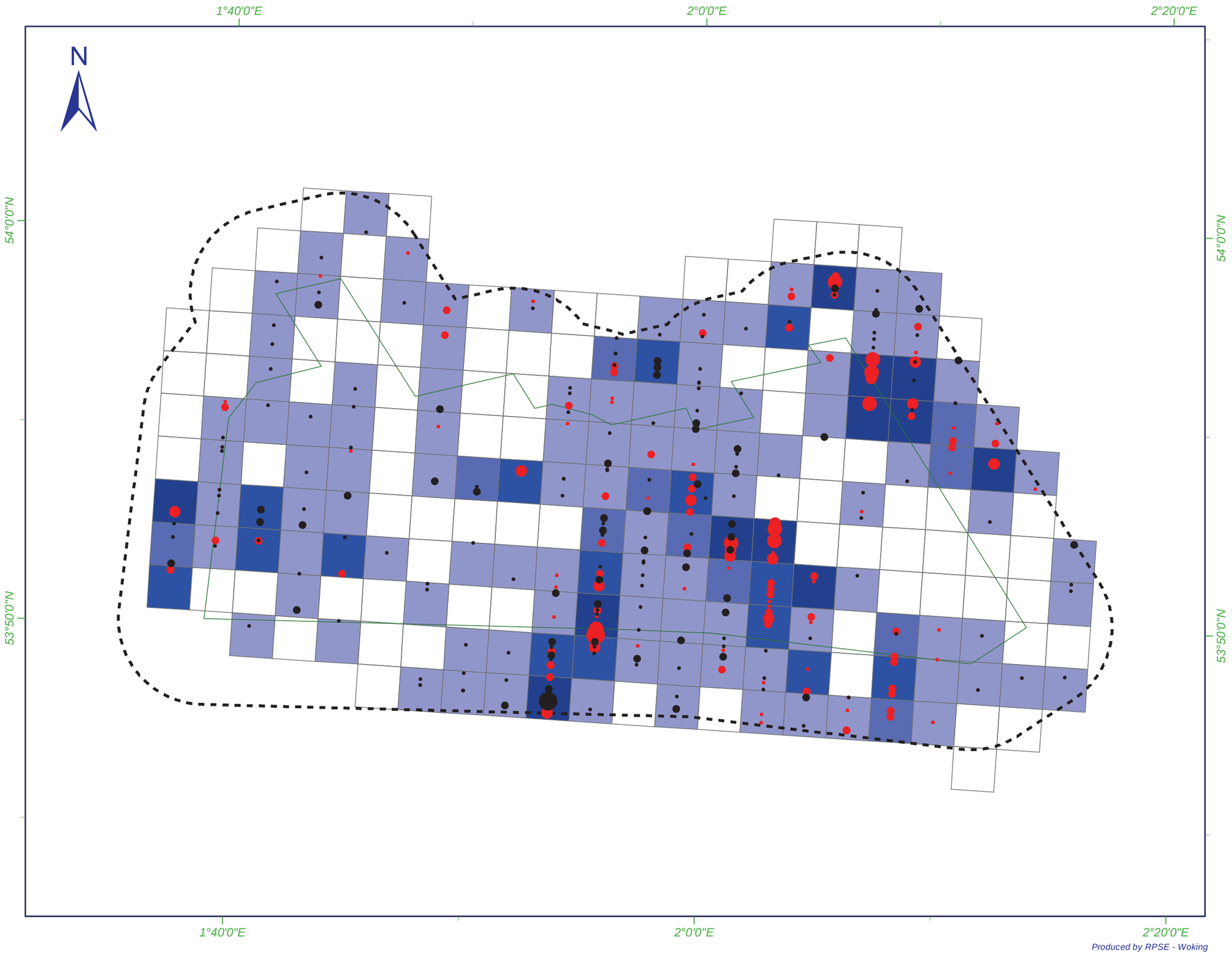
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(April to July 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_KittiwakeDensityAprilToJuly2011_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

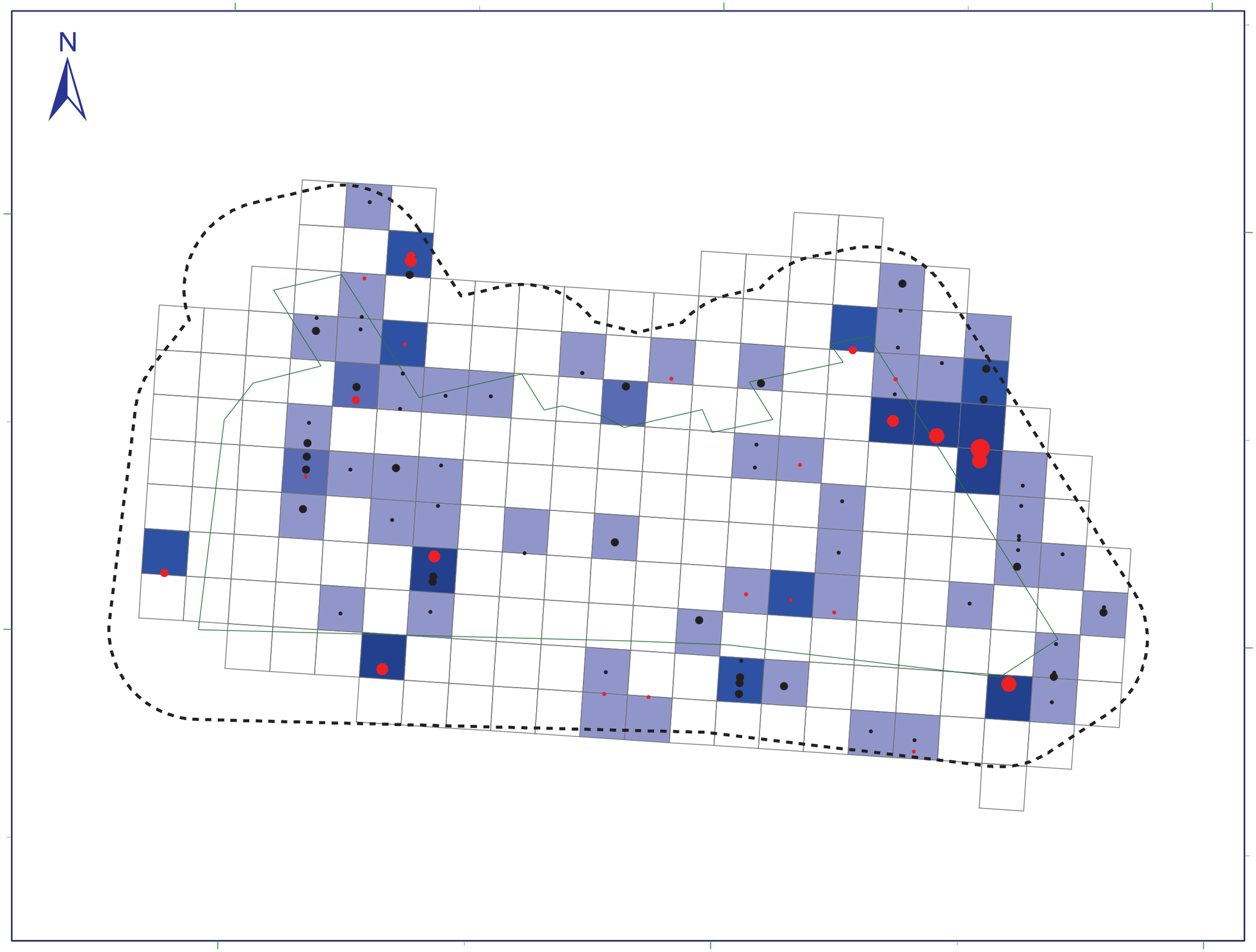
Kittiwake Density
(August & September 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_KittiwakeDensityAug&Sep2010_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

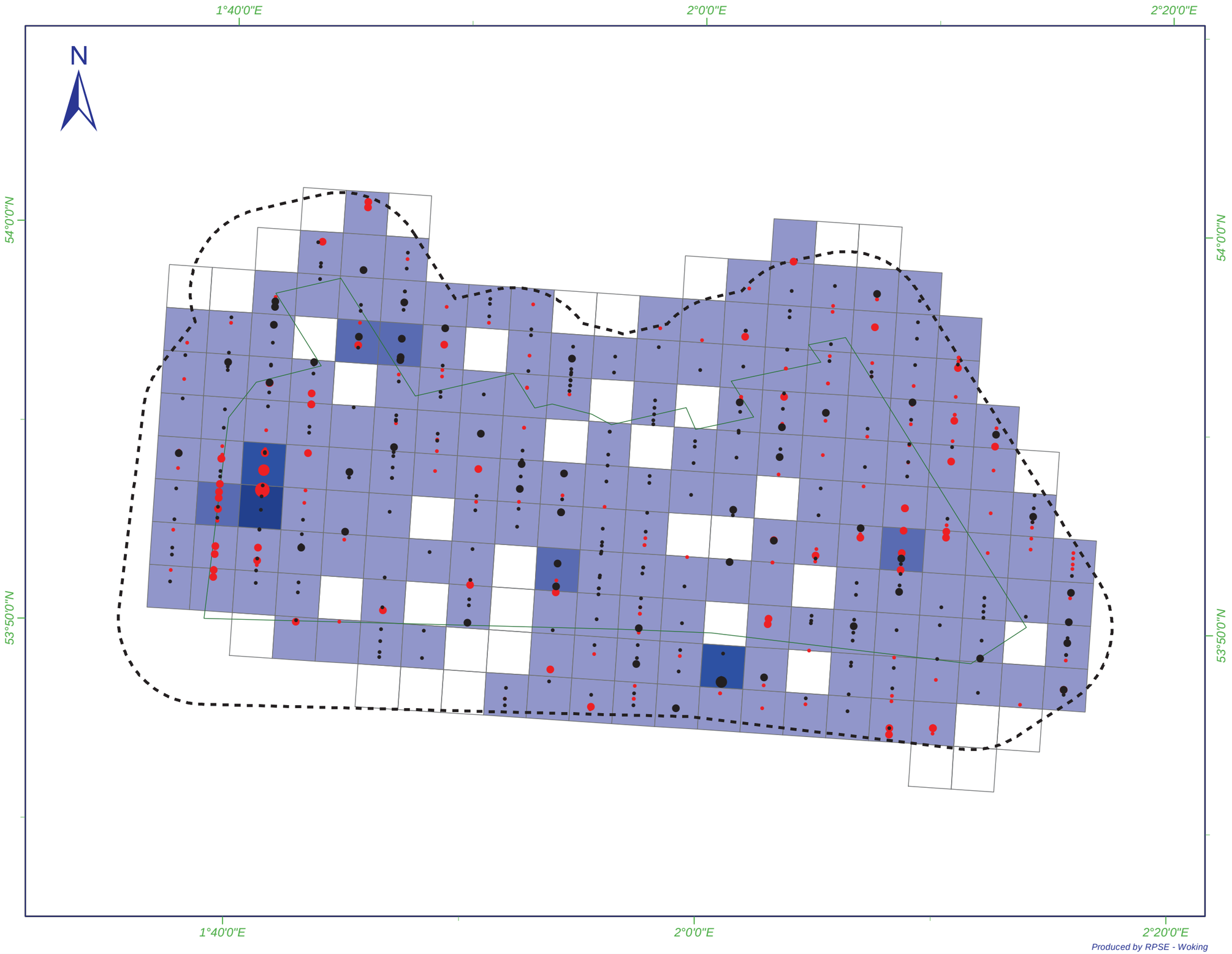
Kittiwake Density
(August & September 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_KittiwakeDensityAug&Sep2011_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Kittiwake Density
(October 2010 to March 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_KittiwakeDensityOct10ToMar11_RJ_121009R0

Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

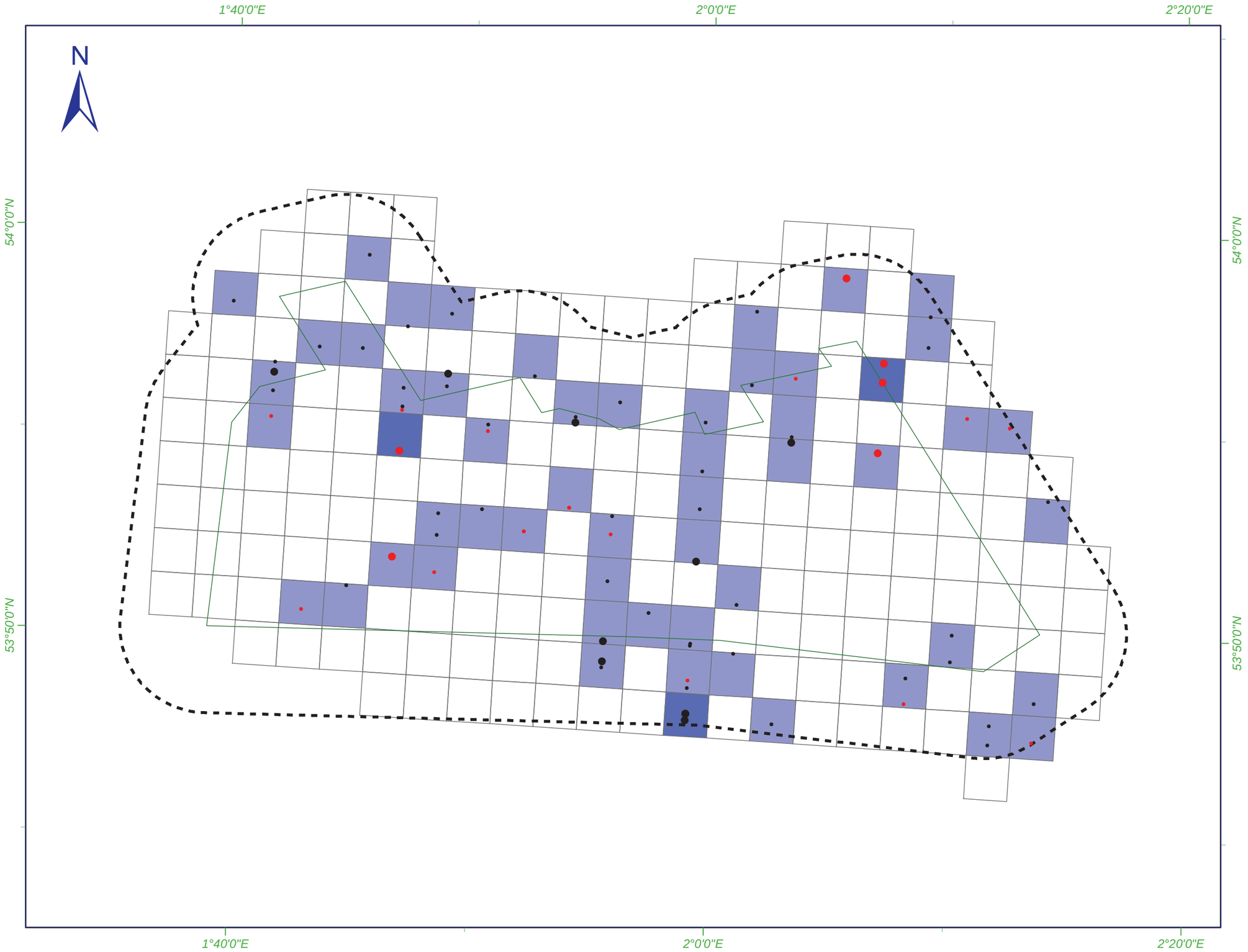
Kittiwake Density
(October 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_KittiwakeDensityOct11ToMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

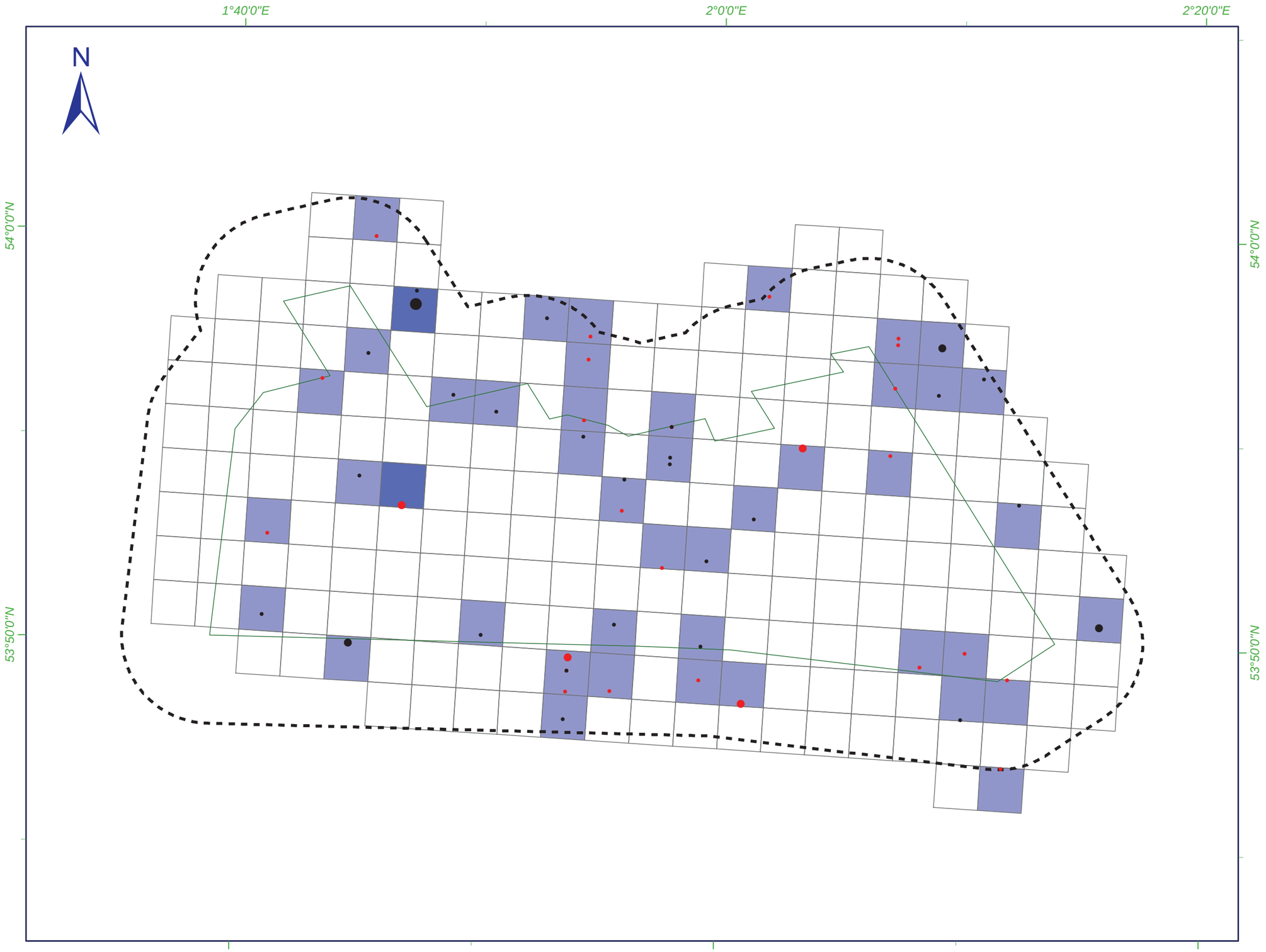
Lesser Black-Backed Gull Density (April to August 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_LesserBBGullDensityAprilToAugust2010_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

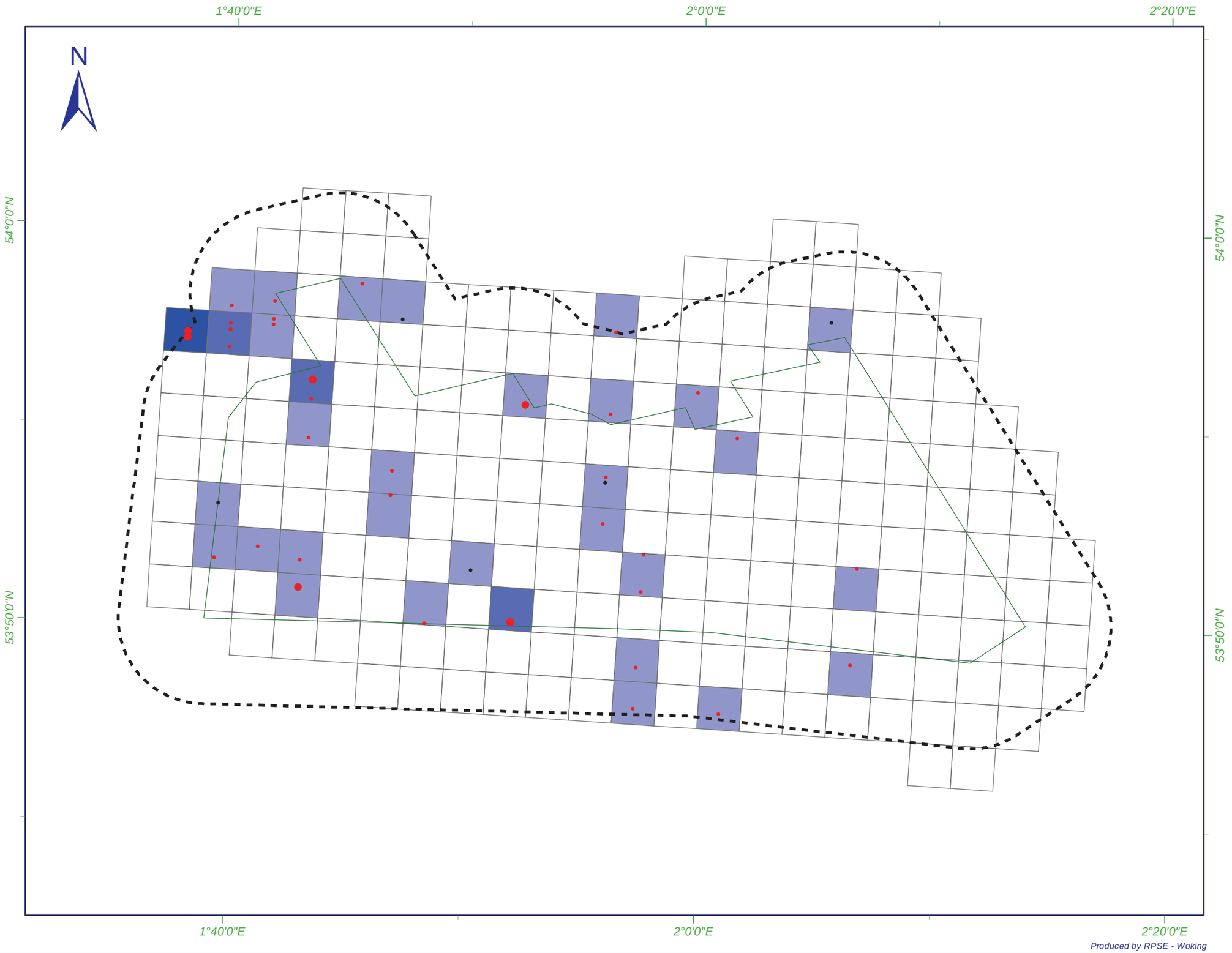
Lesser Black-Backed Gull Density (April to August 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_LesserBBGullDensityAprilToAugust2011_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Little Auk Density
(November 2010 to January 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_LittleAukDensityNov10ToJan11_RJ_121009R0

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

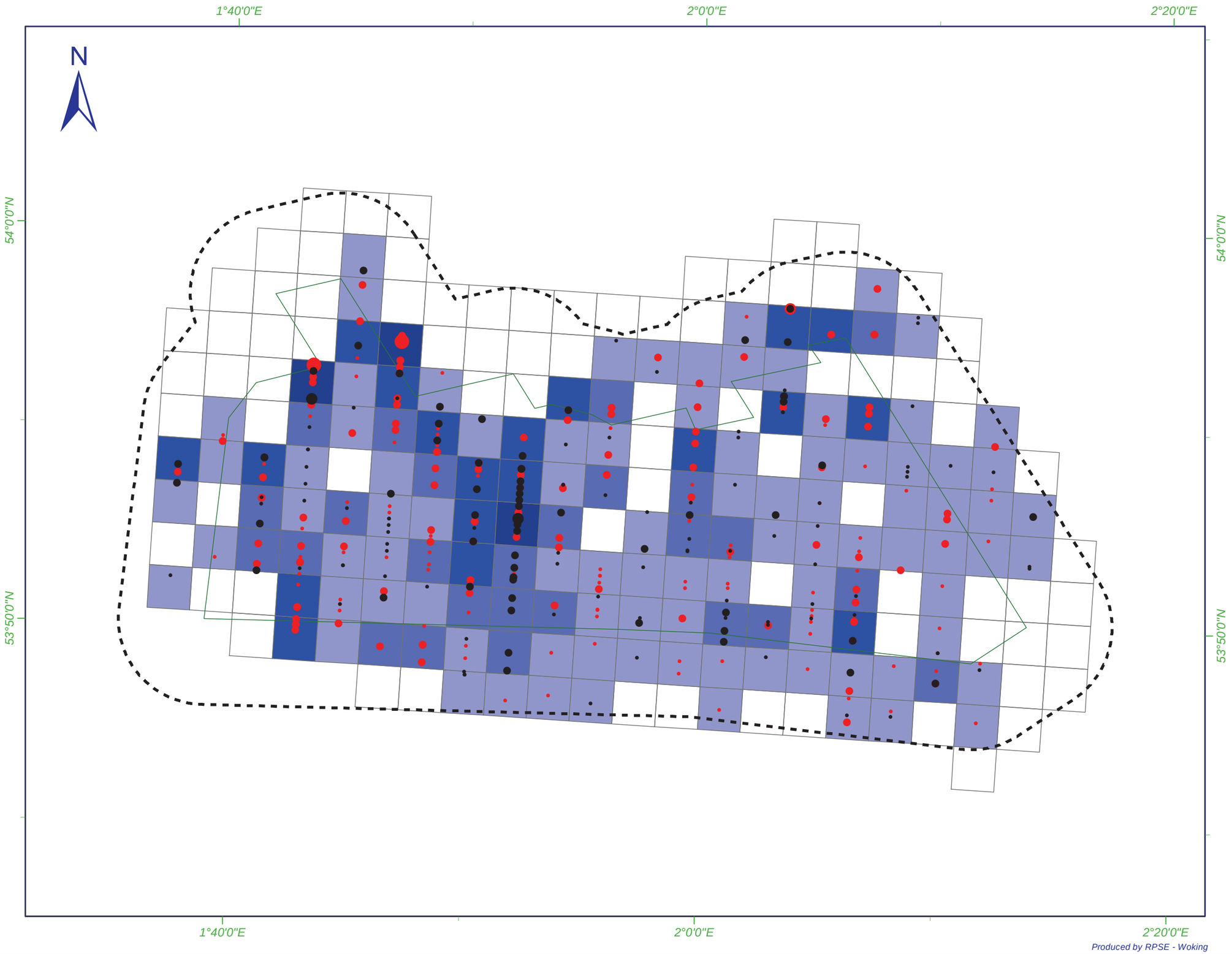
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Little Auk Density
(November 2011 to January 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_LittleAukDensityNov11ToJan12_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Little Gull Density
(September to November 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_LittleGullDensitySeptemberToNov2010_RJ_121009R0

Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

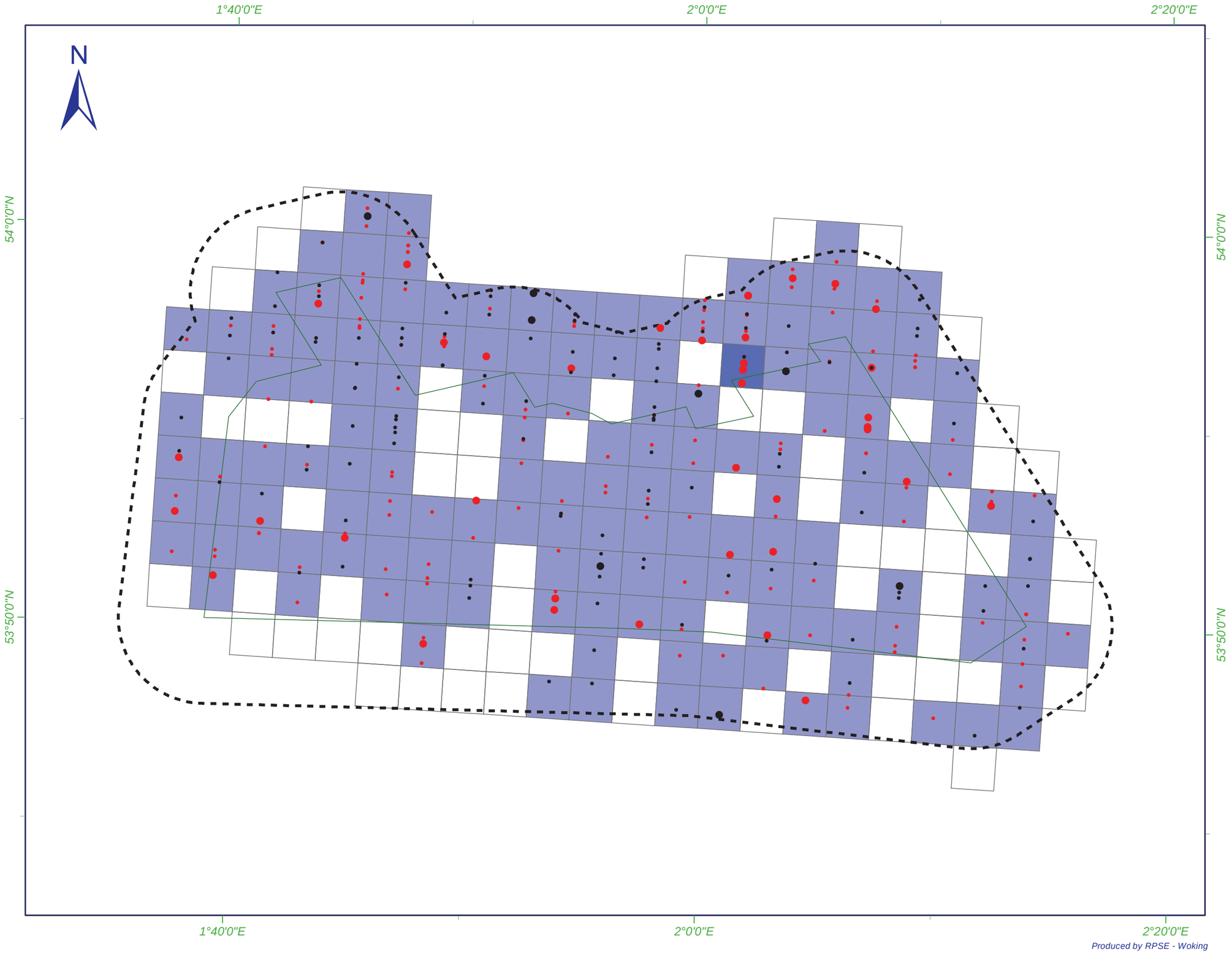
Little Gull Density
(September to November 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_LittleGullDensitySeptemberToNov2011_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

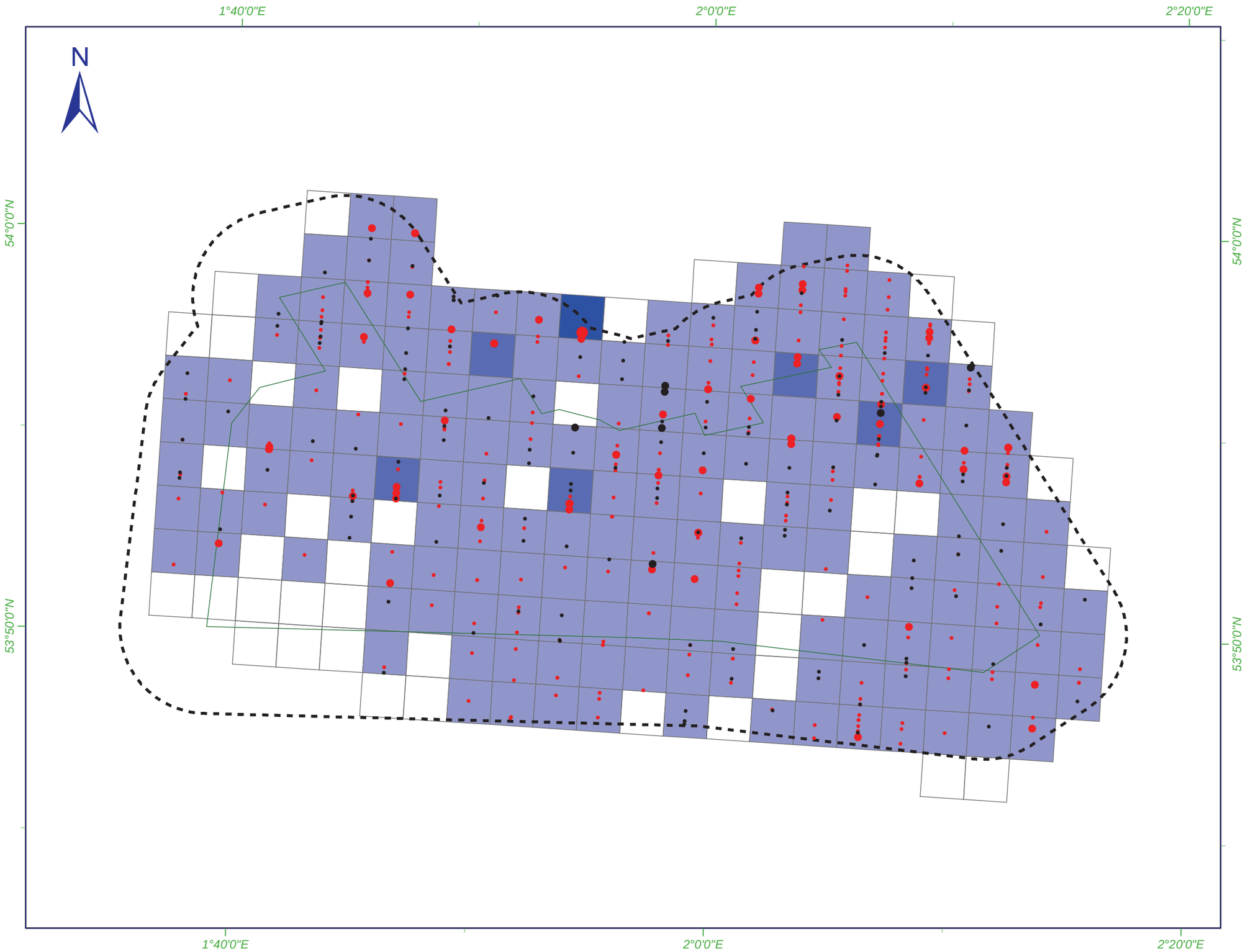
Northern Fulmar Density (April to September 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_NorthernFulmarDensityAprilToSept2010_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

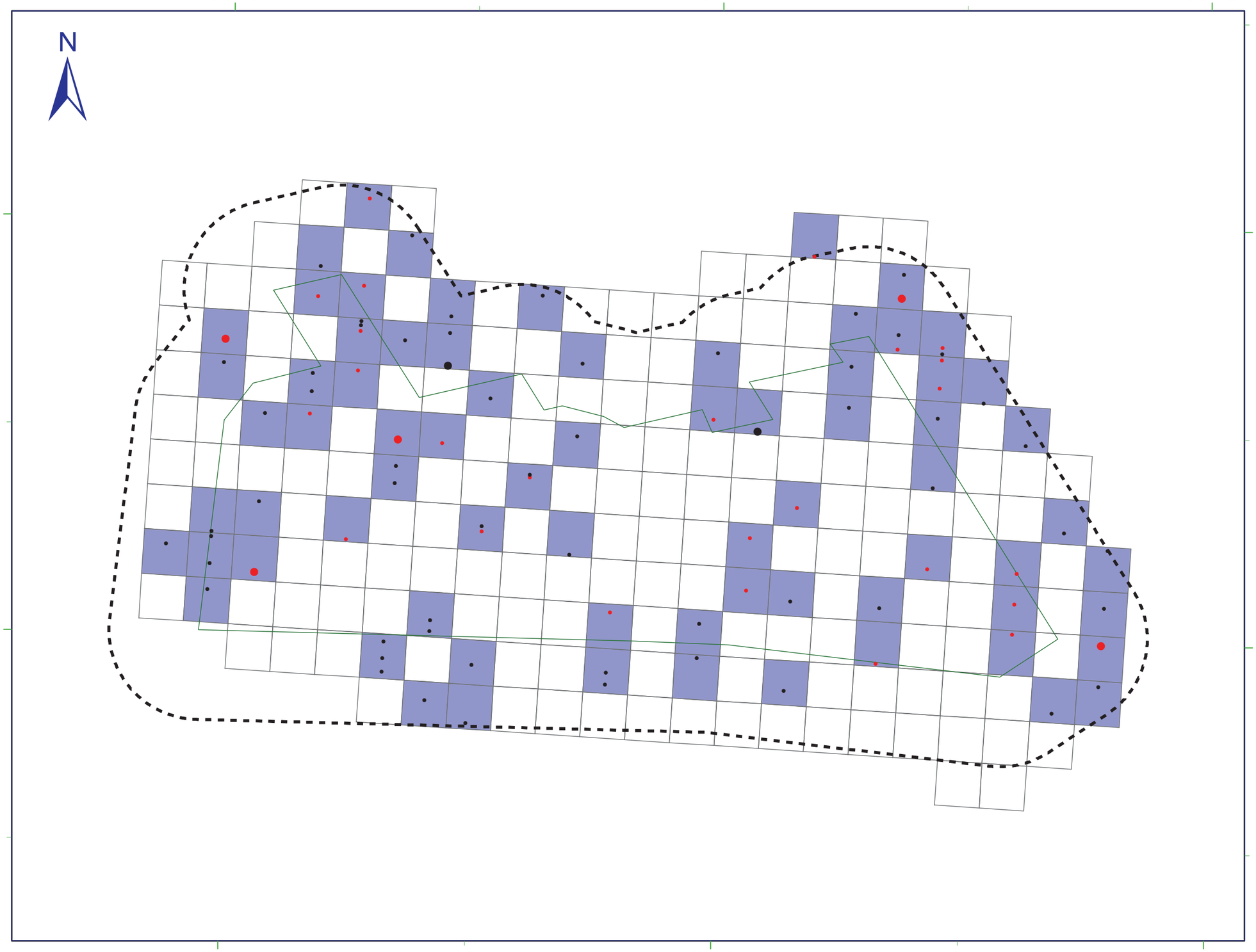
Northern Fulmar Density (April to September 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_NorthernFulmarDensityAprilToSept2011_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

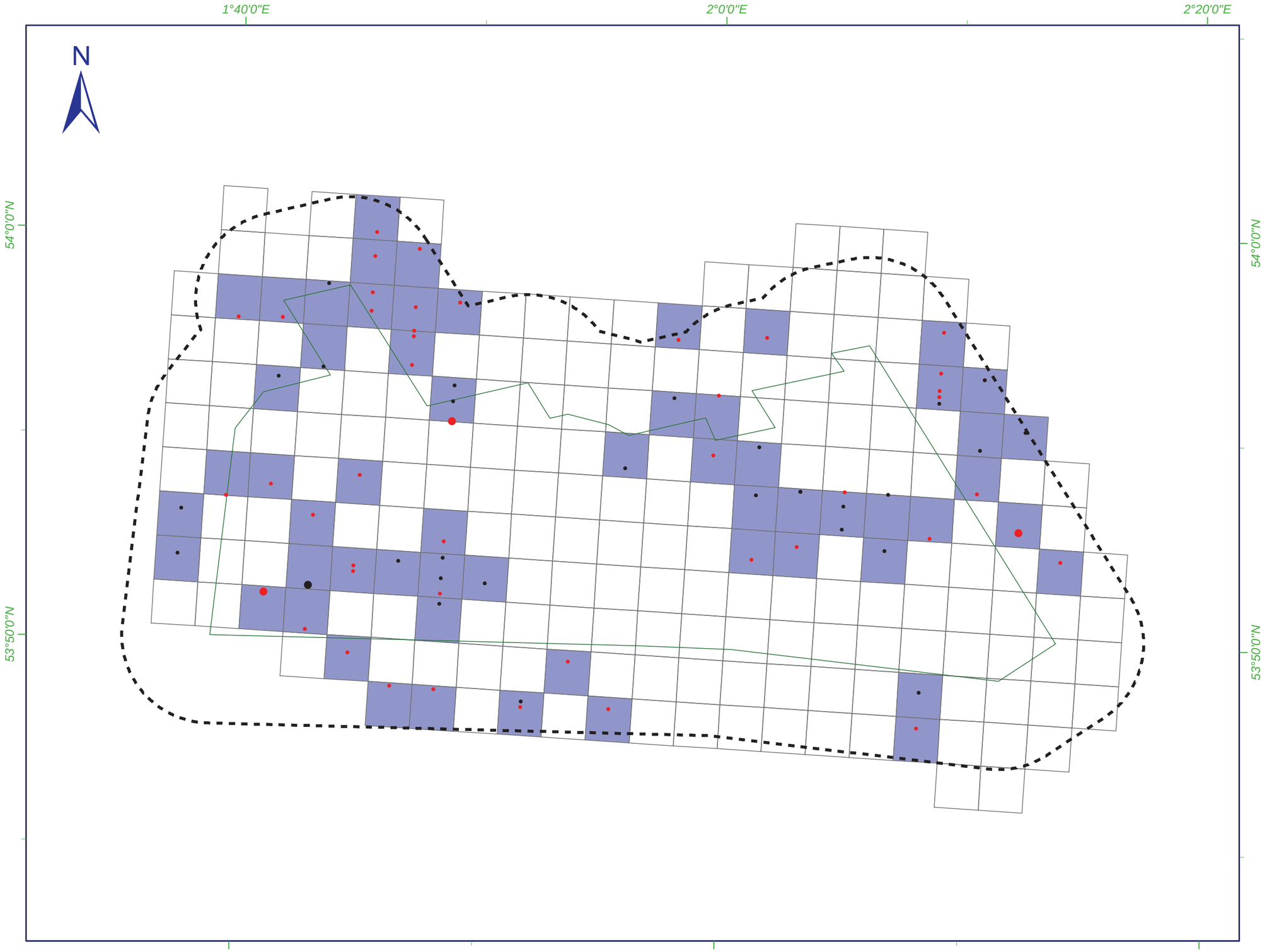
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Northern Fulmar Density
(October 2010 to March 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_NorthernFulmarDensityOct10ToMar11_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

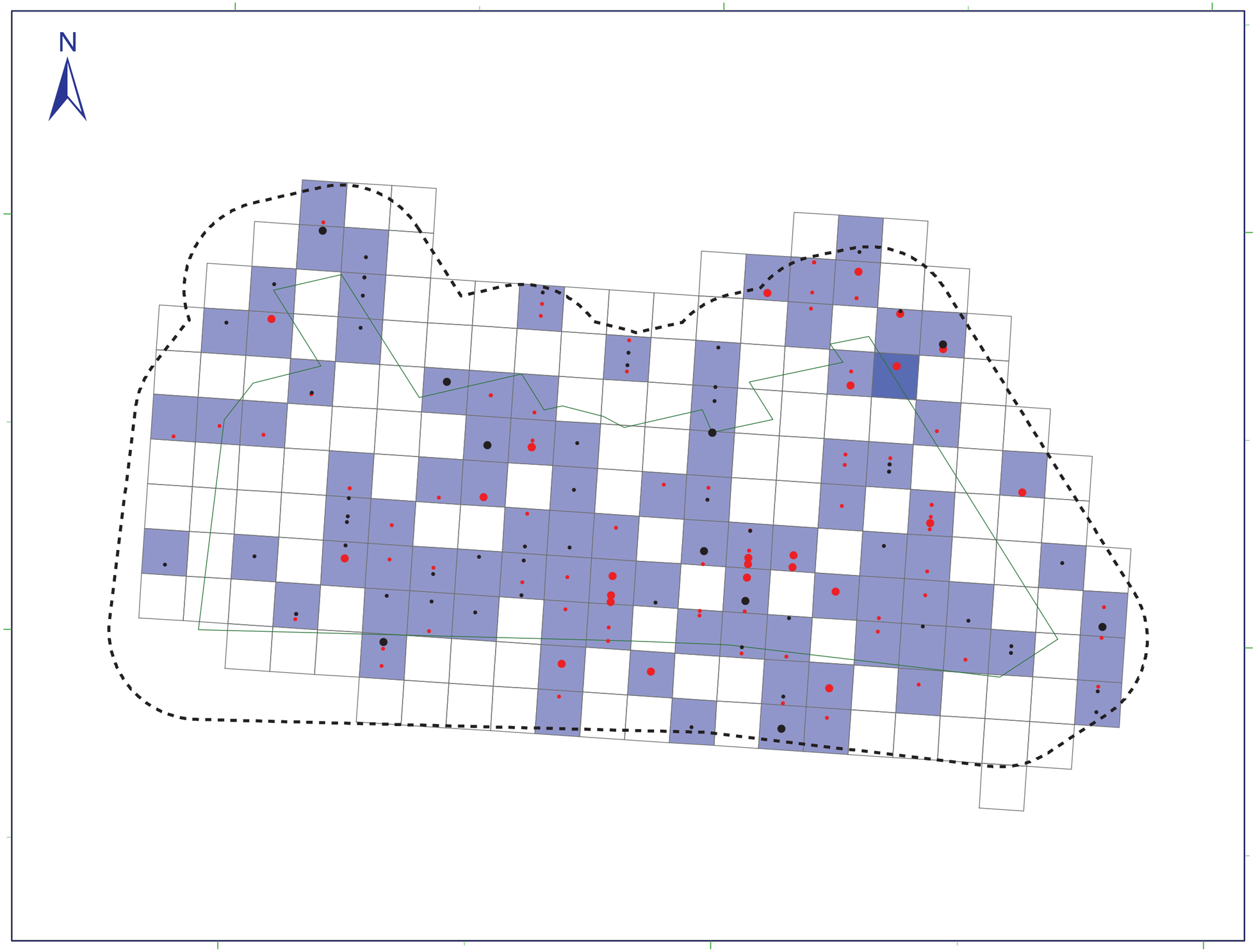
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Northern Fulmar Density
(October 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_NorthernFulmarDensityOct11ToMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

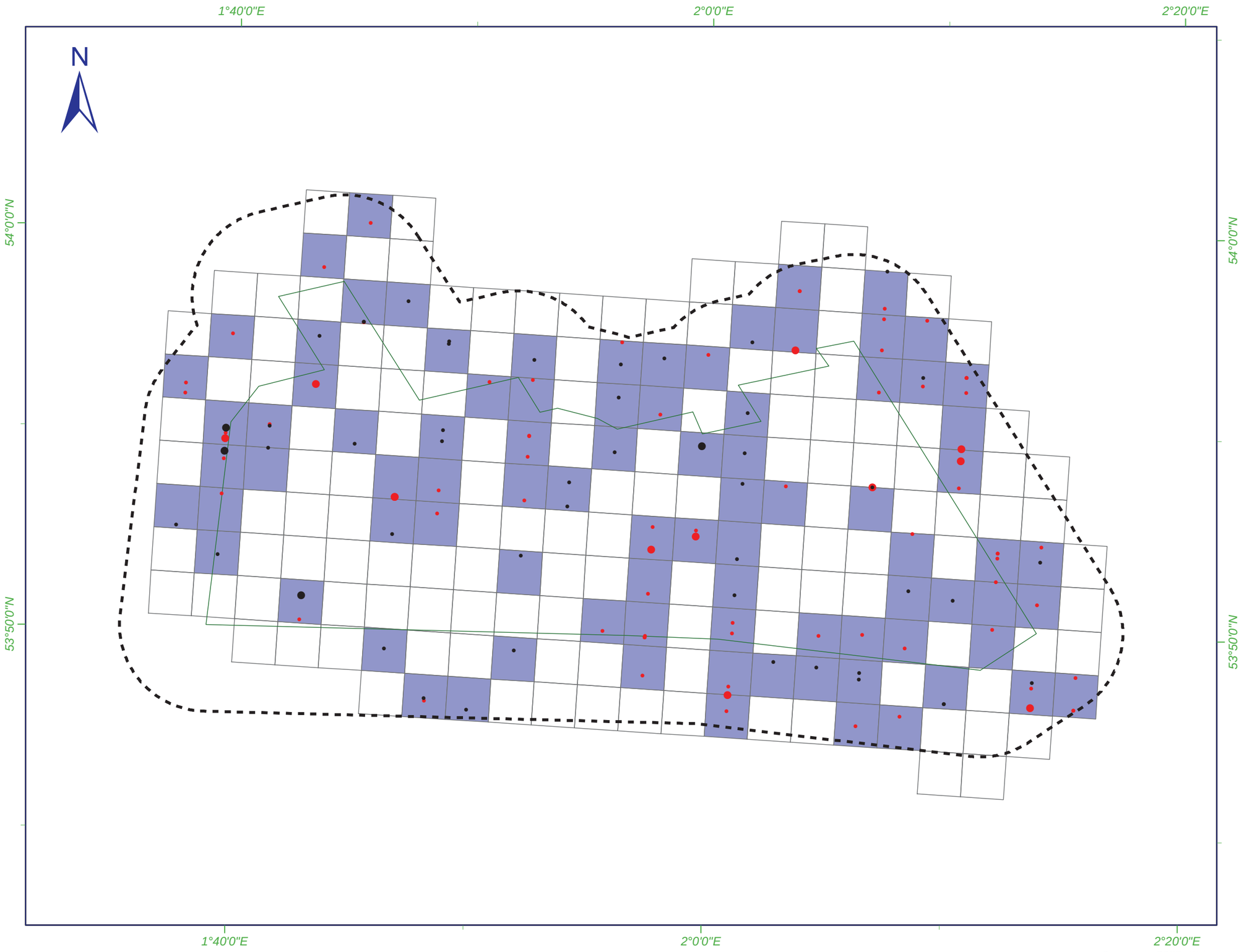
Northern Gannet Density
(April to September 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_NorthernGannetDensityAprilToSept2010_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density (April to September 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_NorthernGannetDensityAprilToSept2011_RJ_121009R0

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

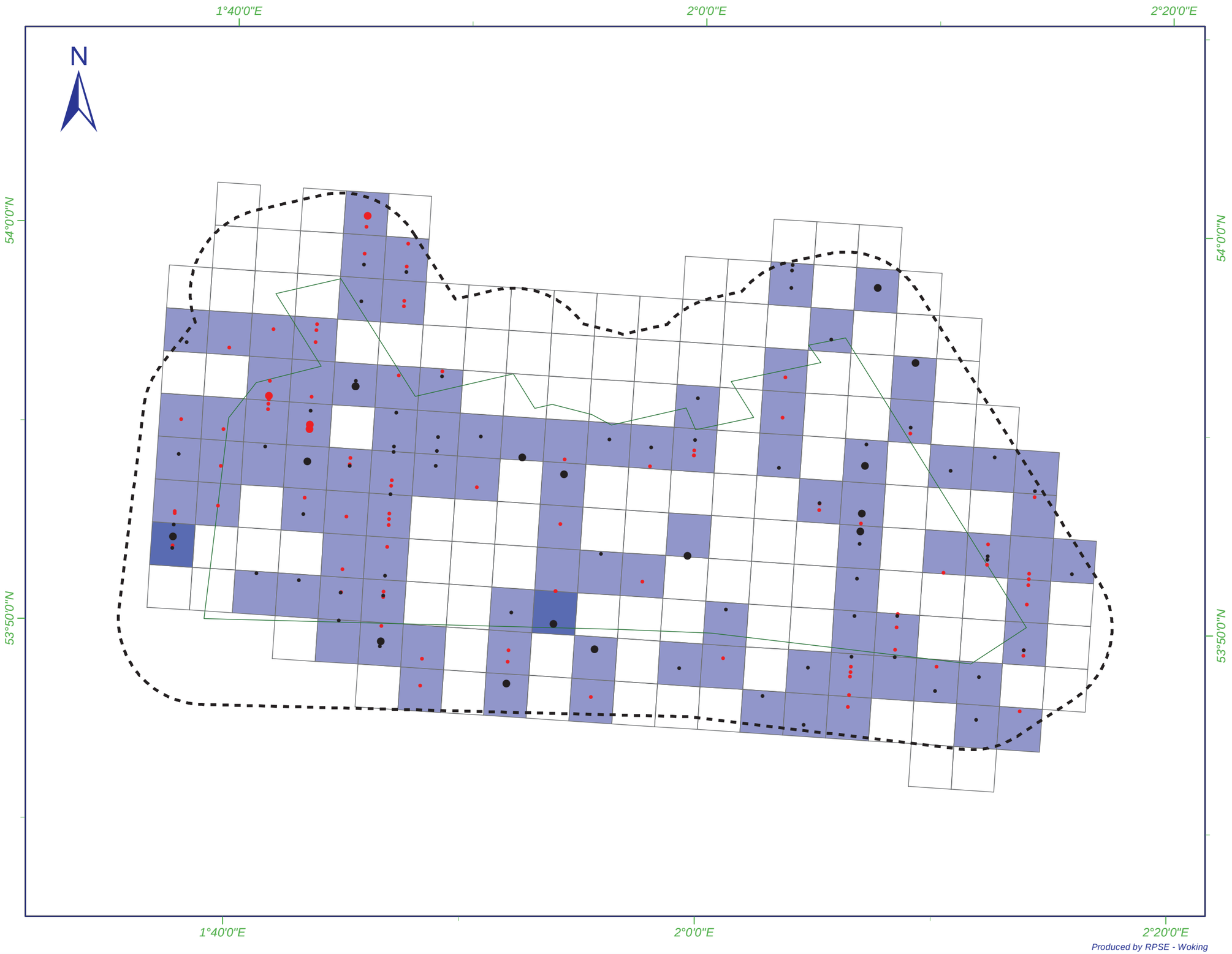
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density
(October 2010 to March 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_NorthernGannetDensityOct10ToMar11_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

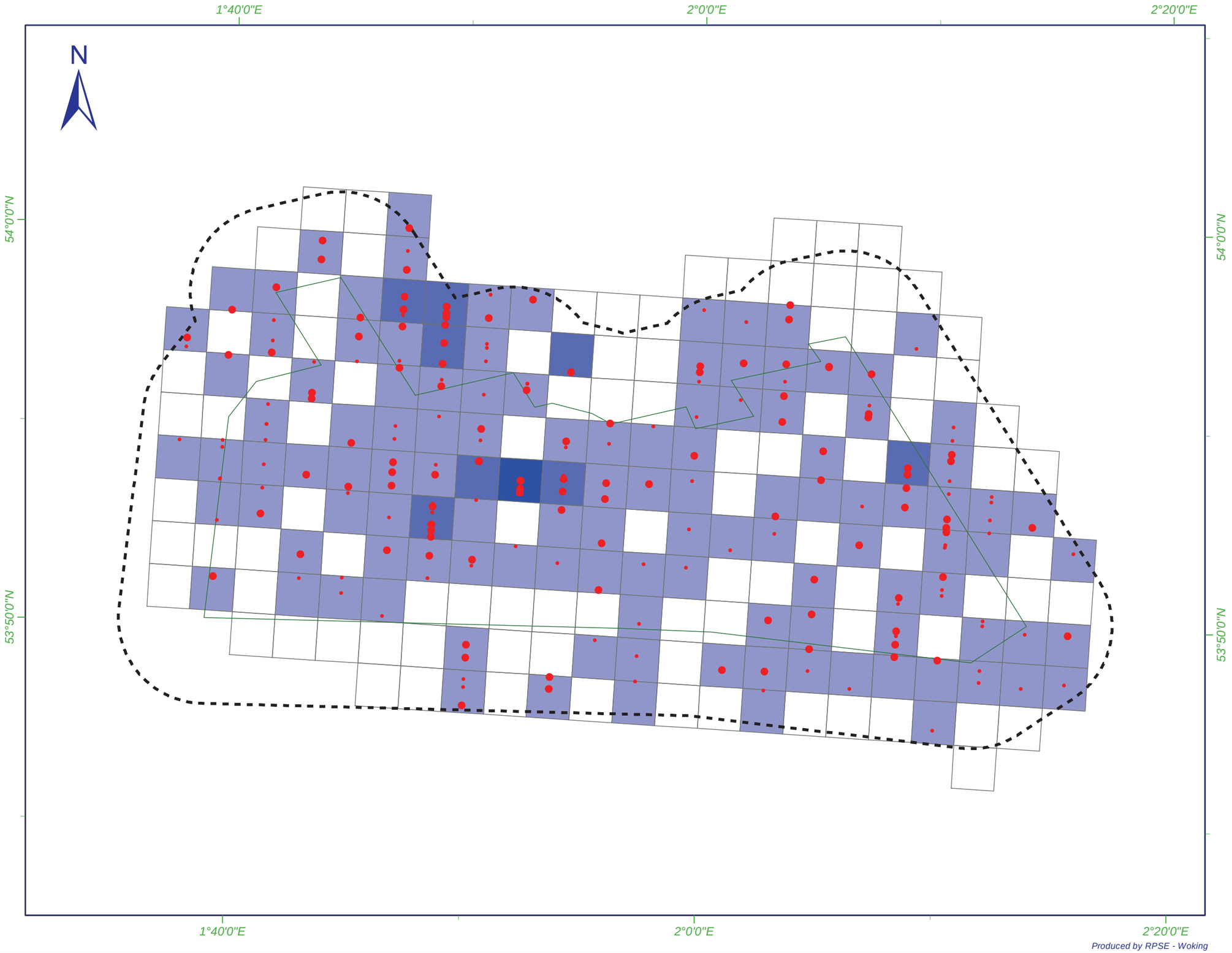
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Northern Gannet Density
(October 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_NorthernGannetDensityOct11ToMar12_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

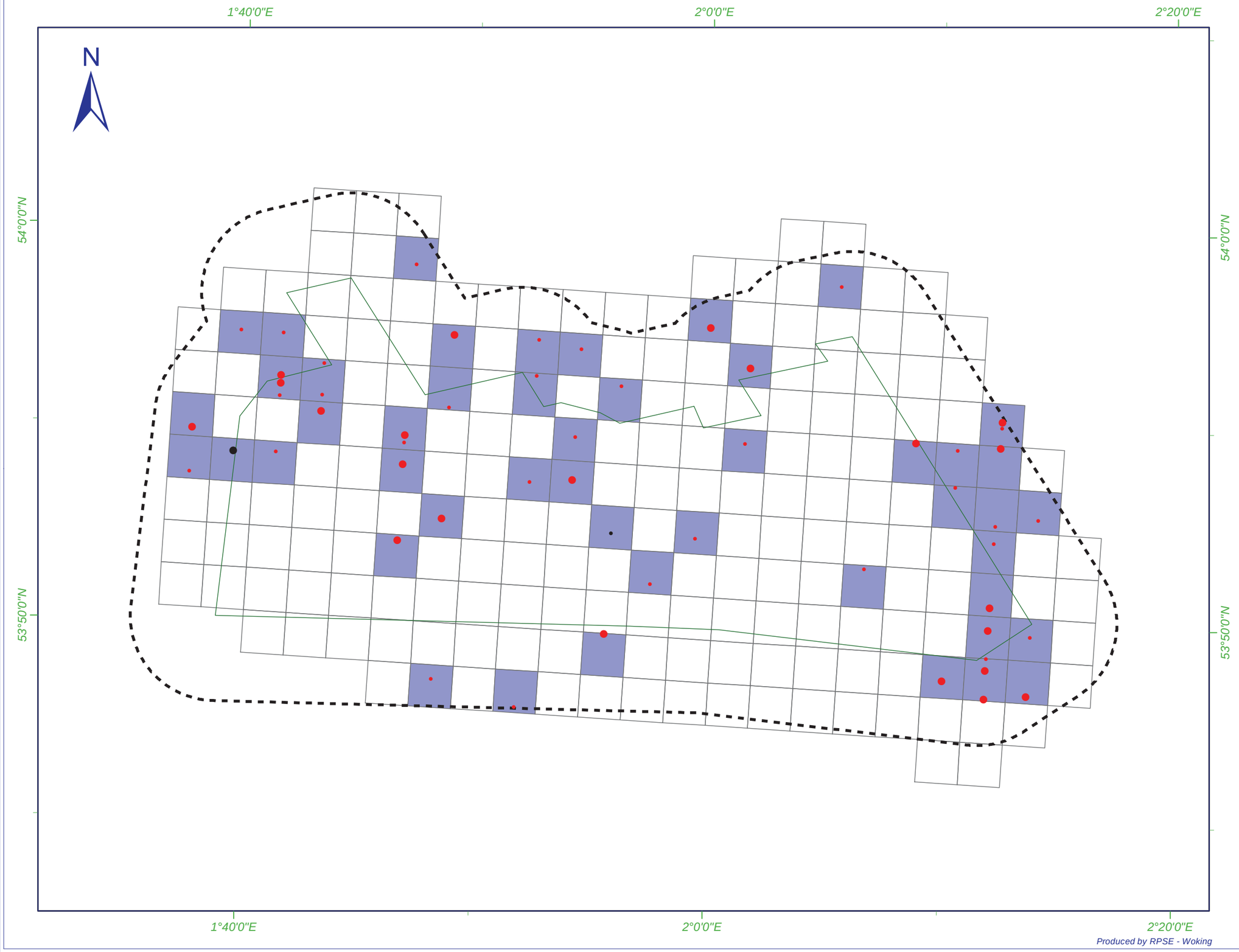
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Puffin Density
(April to July 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_PuffinDensityAprilToJuly2010_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

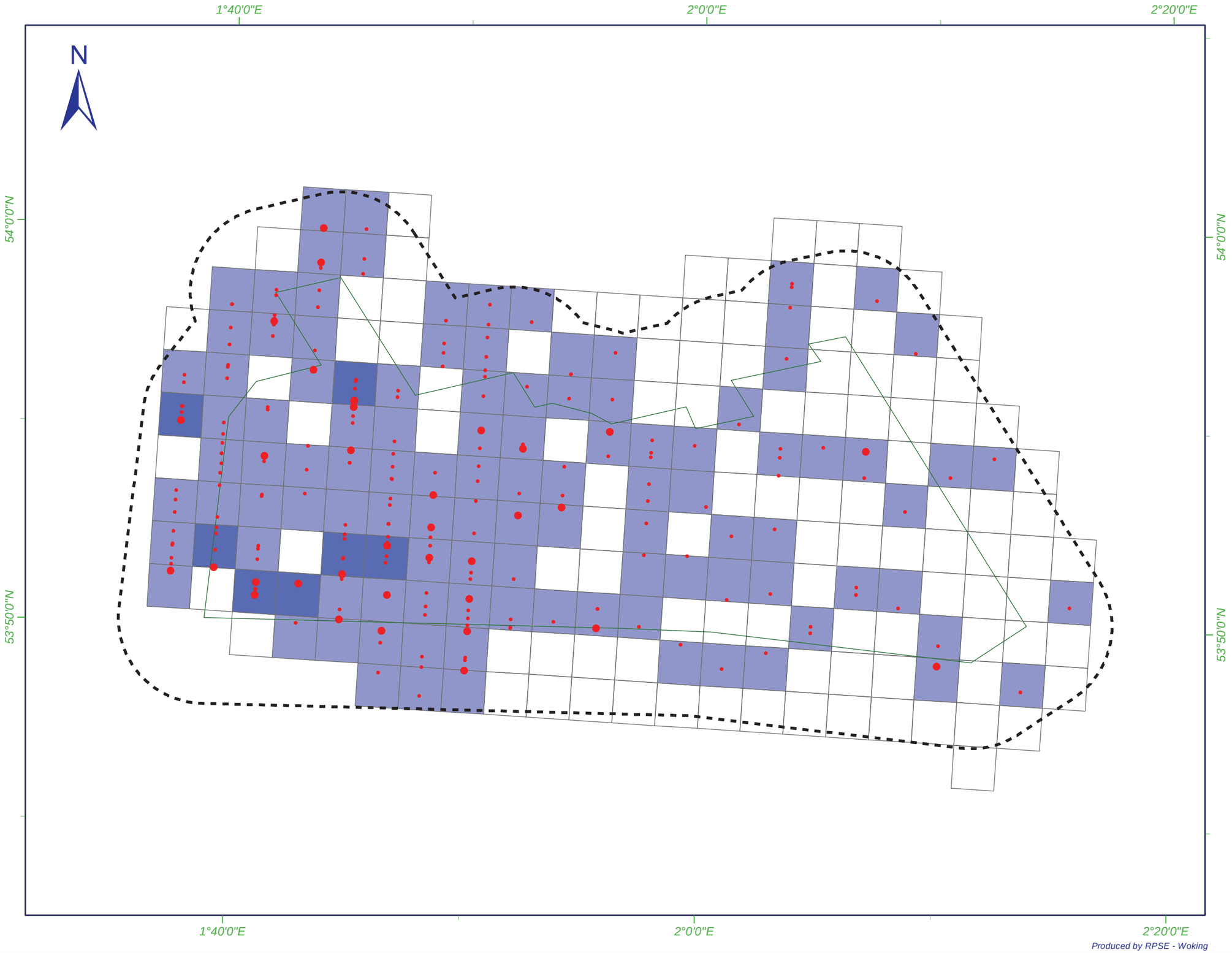
Puffin Density
(April to July 2011)

SMart Wind | RPS

DATE: 11/10/2012 | DRAWN: RJ | CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_PuffinDensityAprilToJuly2011_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

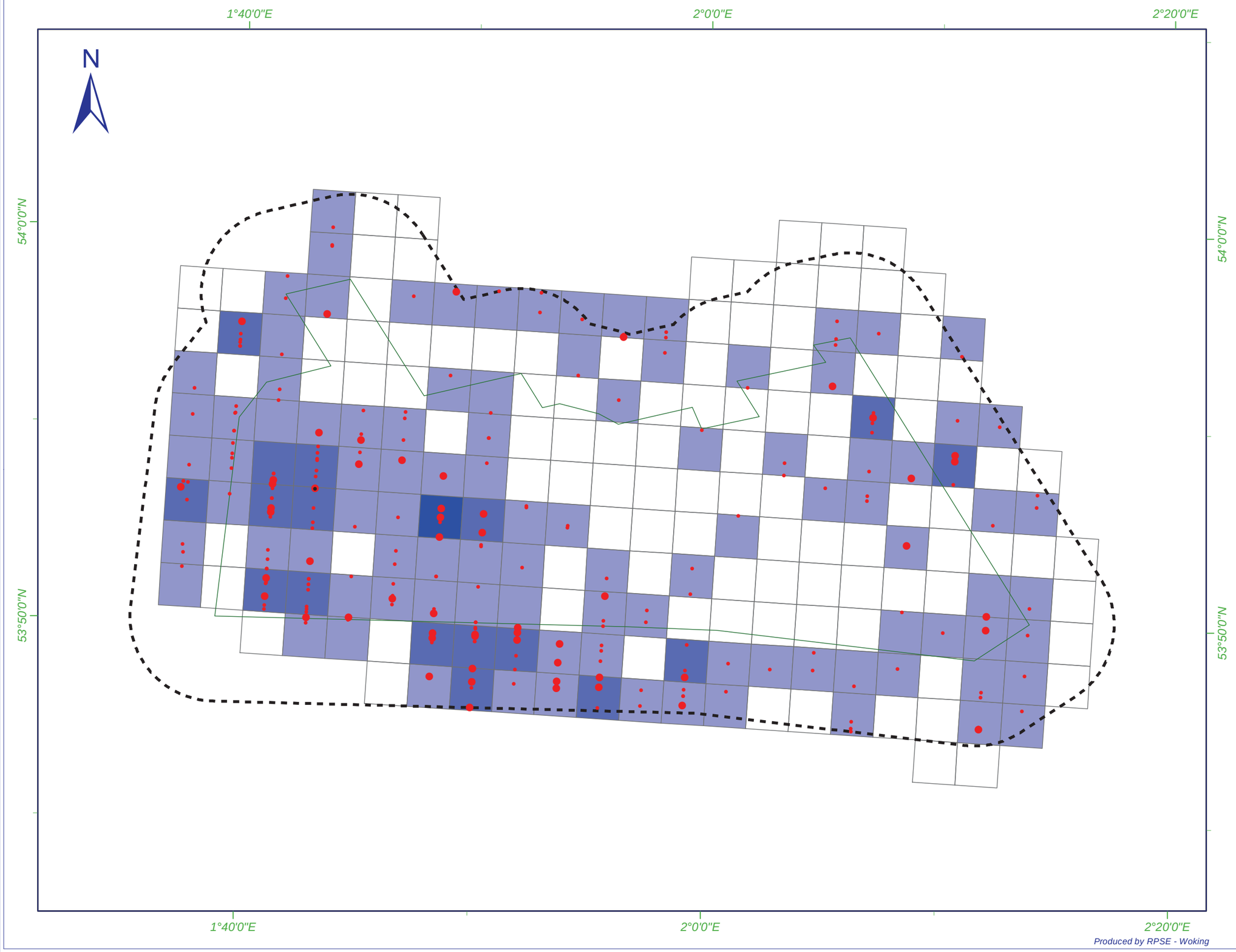
Puffin Density
(August to October 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_PuffinDensityAugustToOctober2010_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

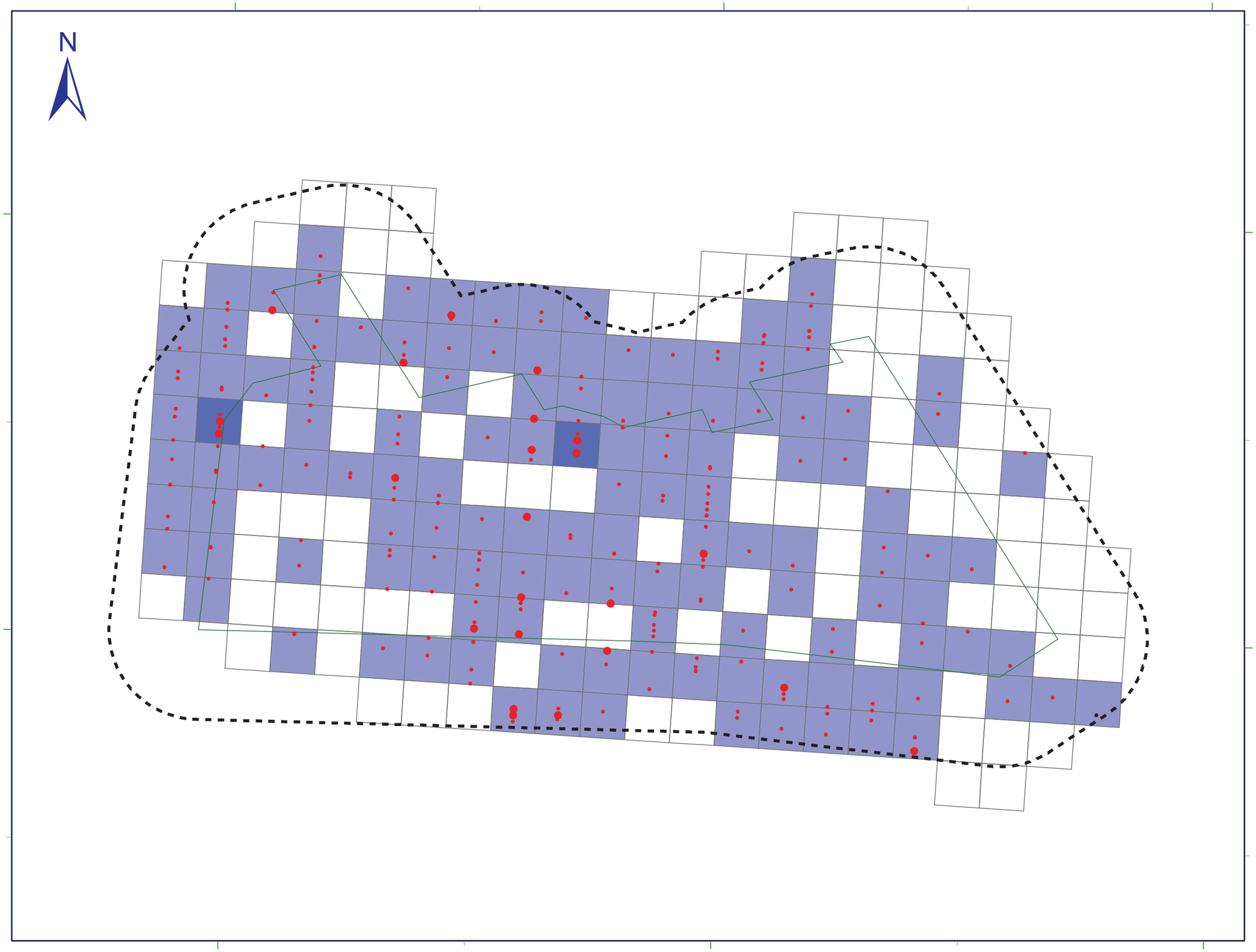
Puffin Density
(August to October 2011)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_PuffinDensityAugustToOctober2011_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Puffin Density
(November 2010 to March 2011)

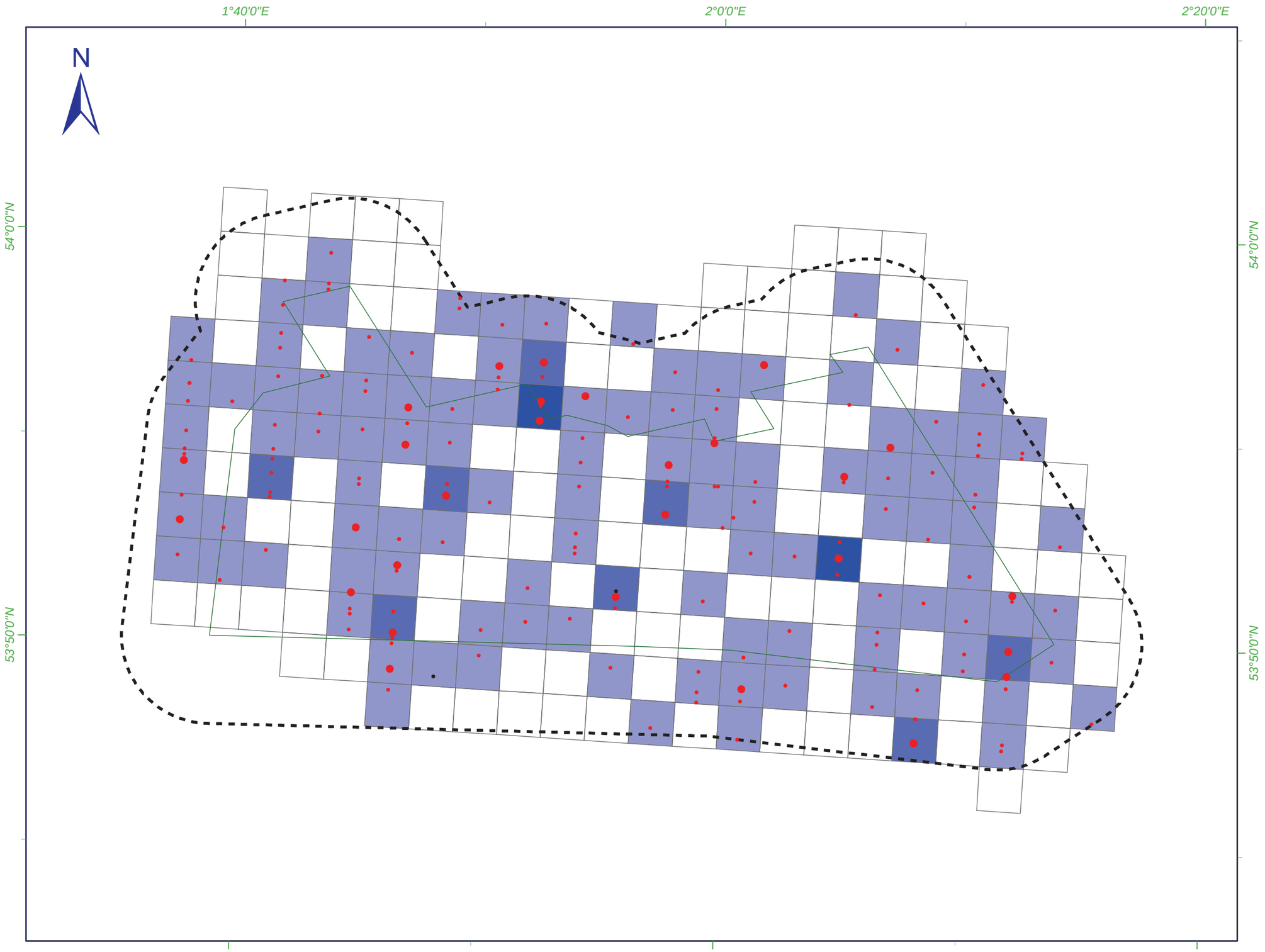
SMart Wind | RPS

DATE: 11/10/2012 | DRAWN: RJ | CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_PuffinDensityNov10ToMar11_RJ_121009R0

Produced by RPSE - Woking



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

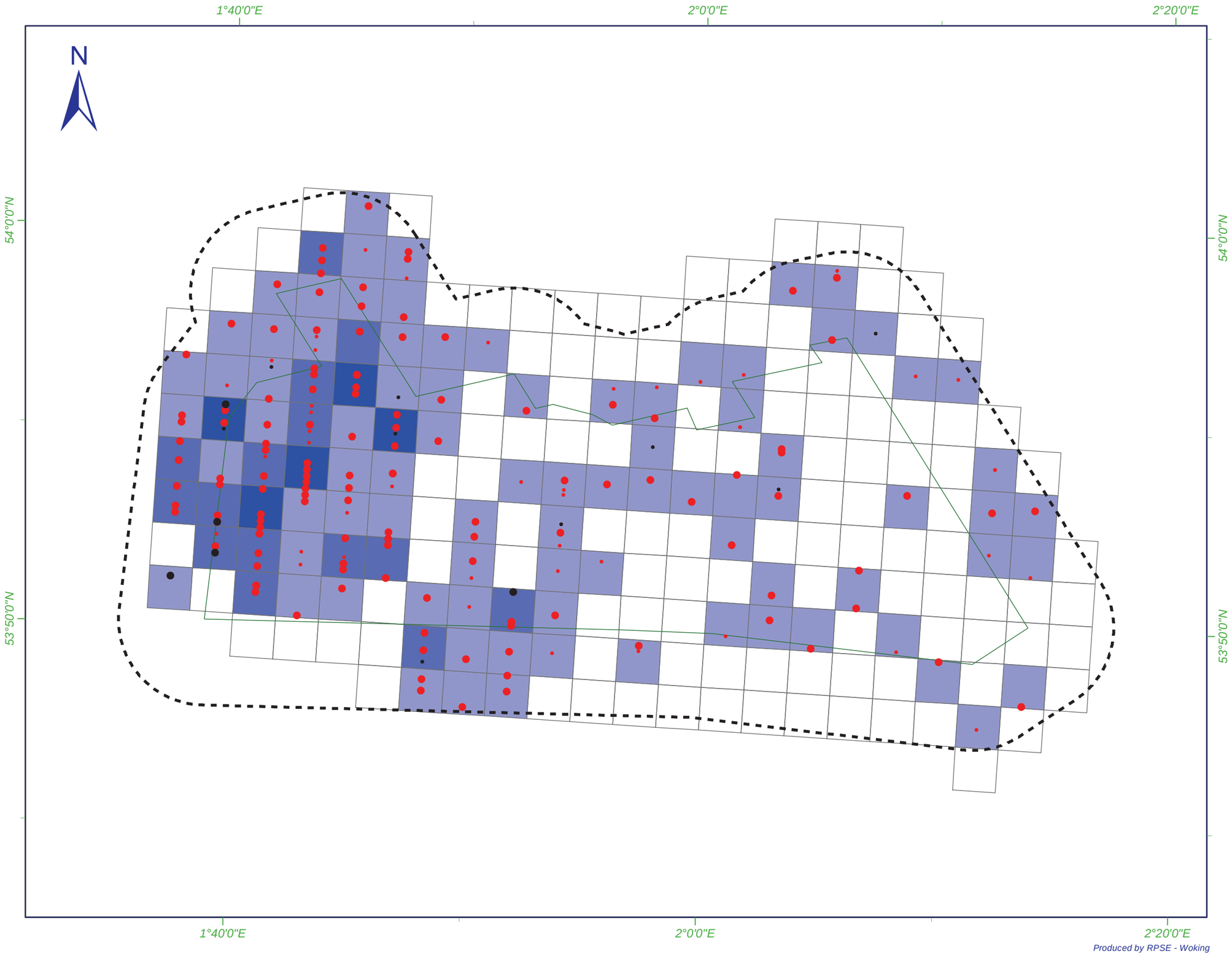
Puffin Density
(November 2011 to March 2012)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_PuffinDensityNov11ToMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

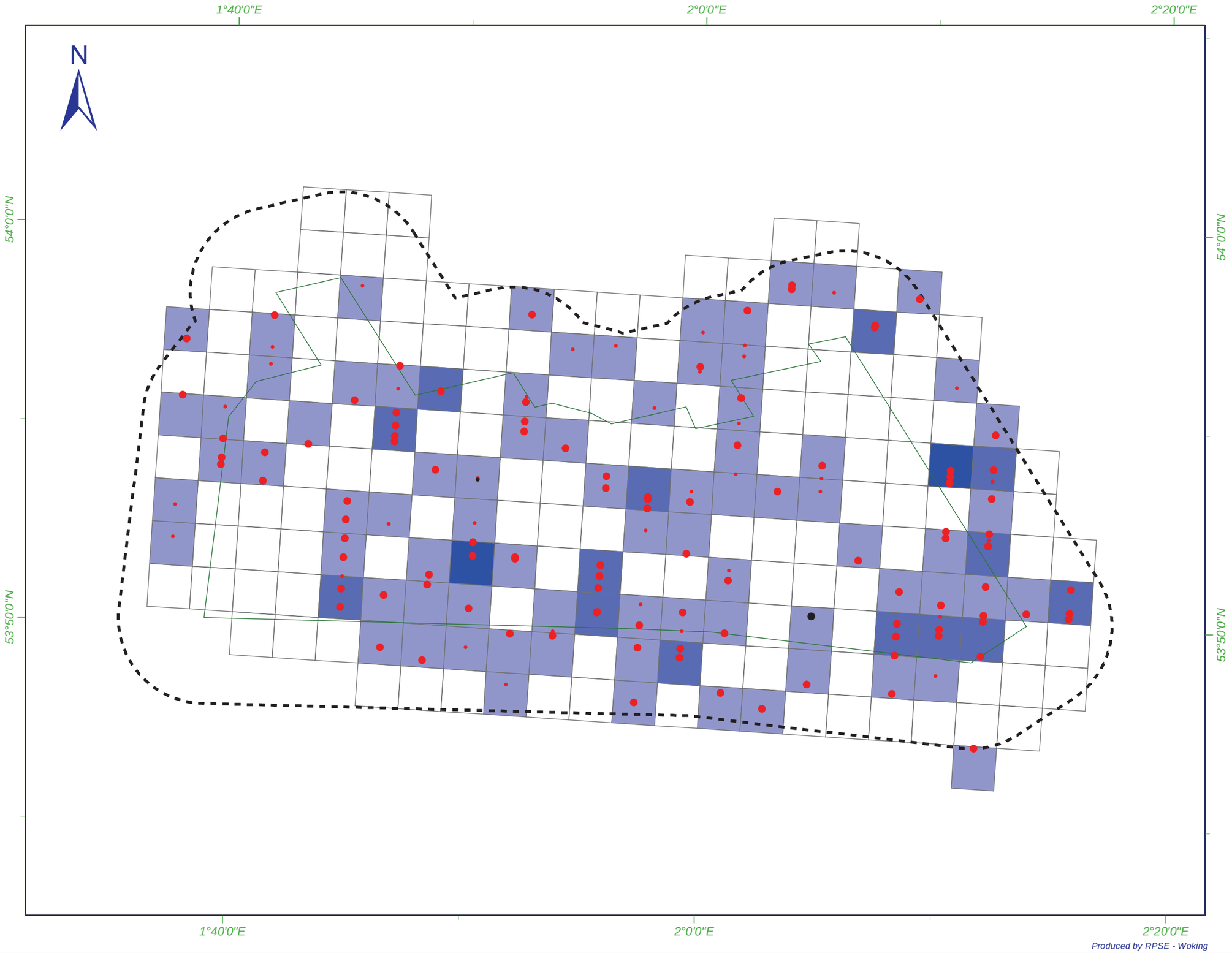
Razorbill Density
(April to June 2010)

SMart Wind | RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_RazorbillDensityAprilToJune2010_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

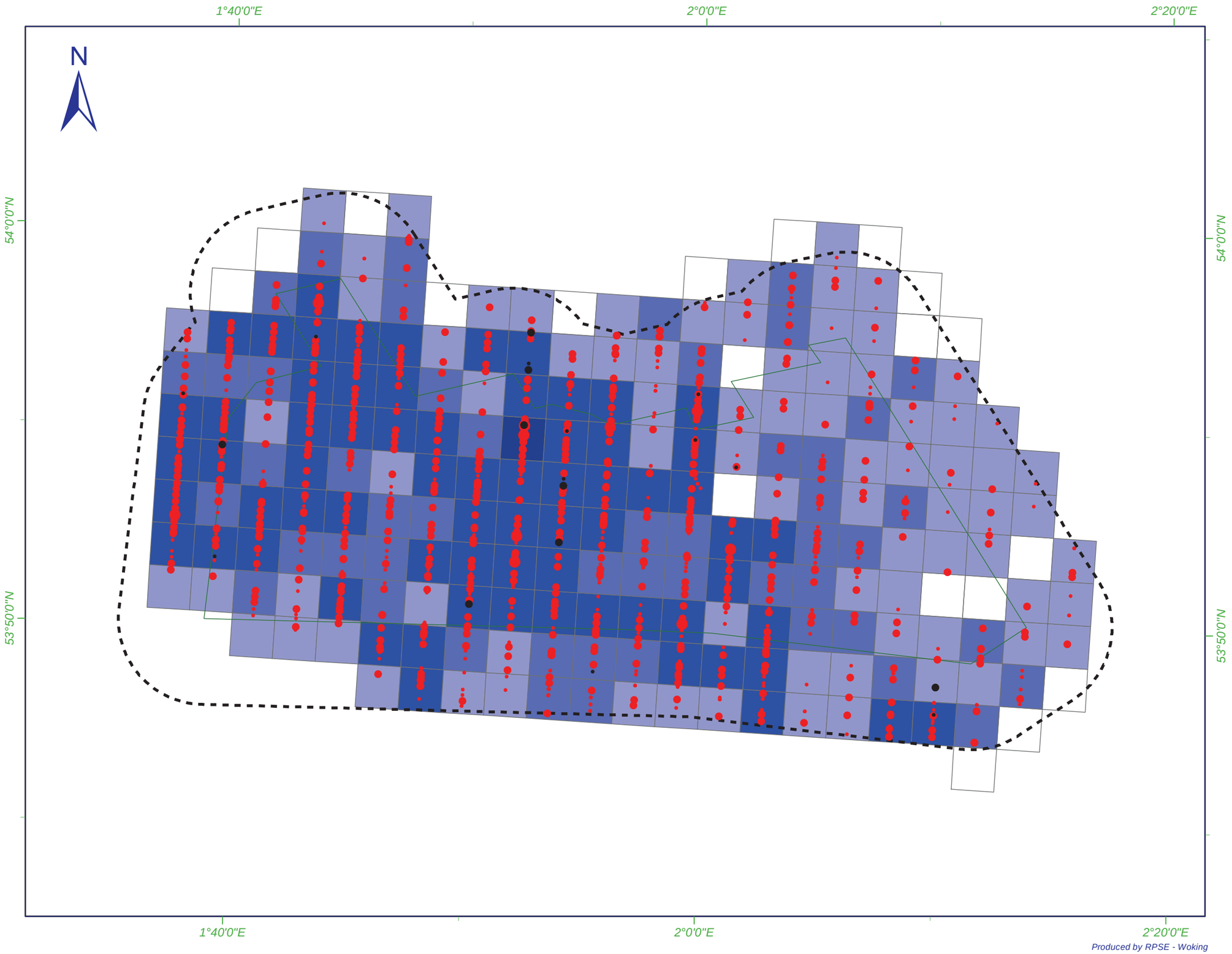
Razorbill Density
(April to June 2011)

SMart Wind | RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_RazorbillDensityAprilToJune2011_RJ_121009R0



Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

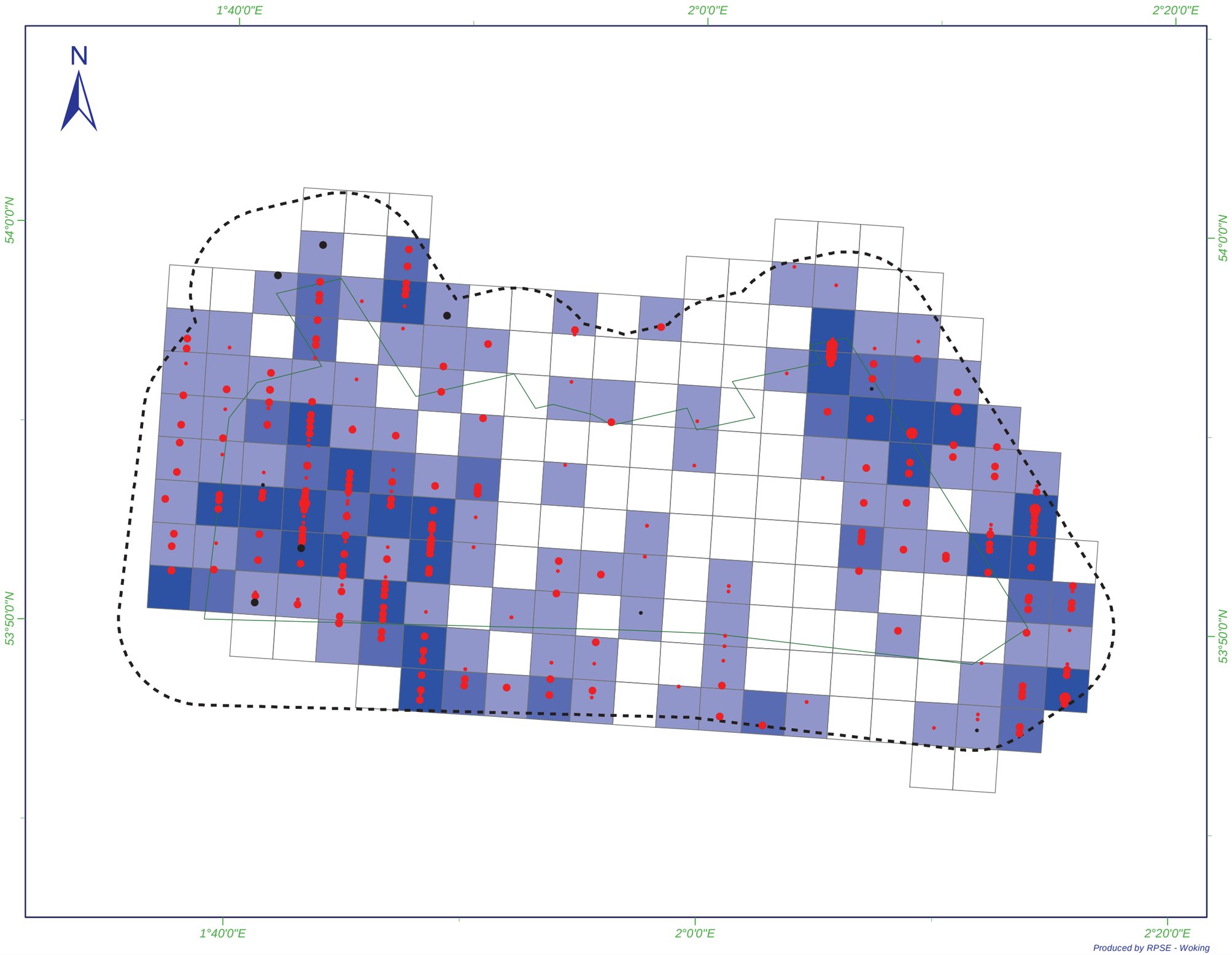
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(July to October 2010)

SMart Wind | RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_RazorbillDensityJulyToOctober2010_RJ_121009R0



Produced by RPSE - Woking

Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

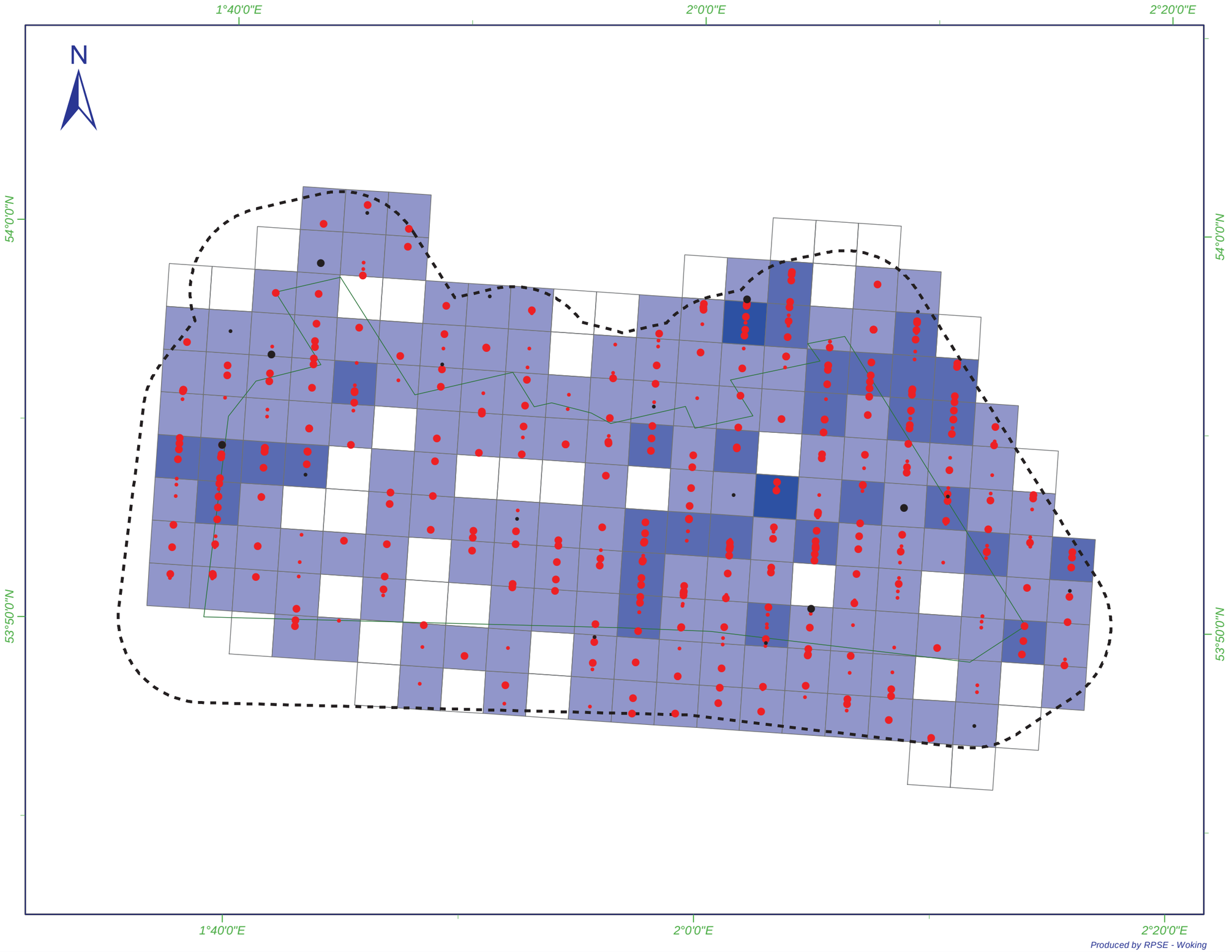
Razorbill Density
(July to October 2011)

SMart Wind | RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_RazorbillDensityJulyToOctober2011_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION

PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Razorbill Density
(November 2010 to March 2011)

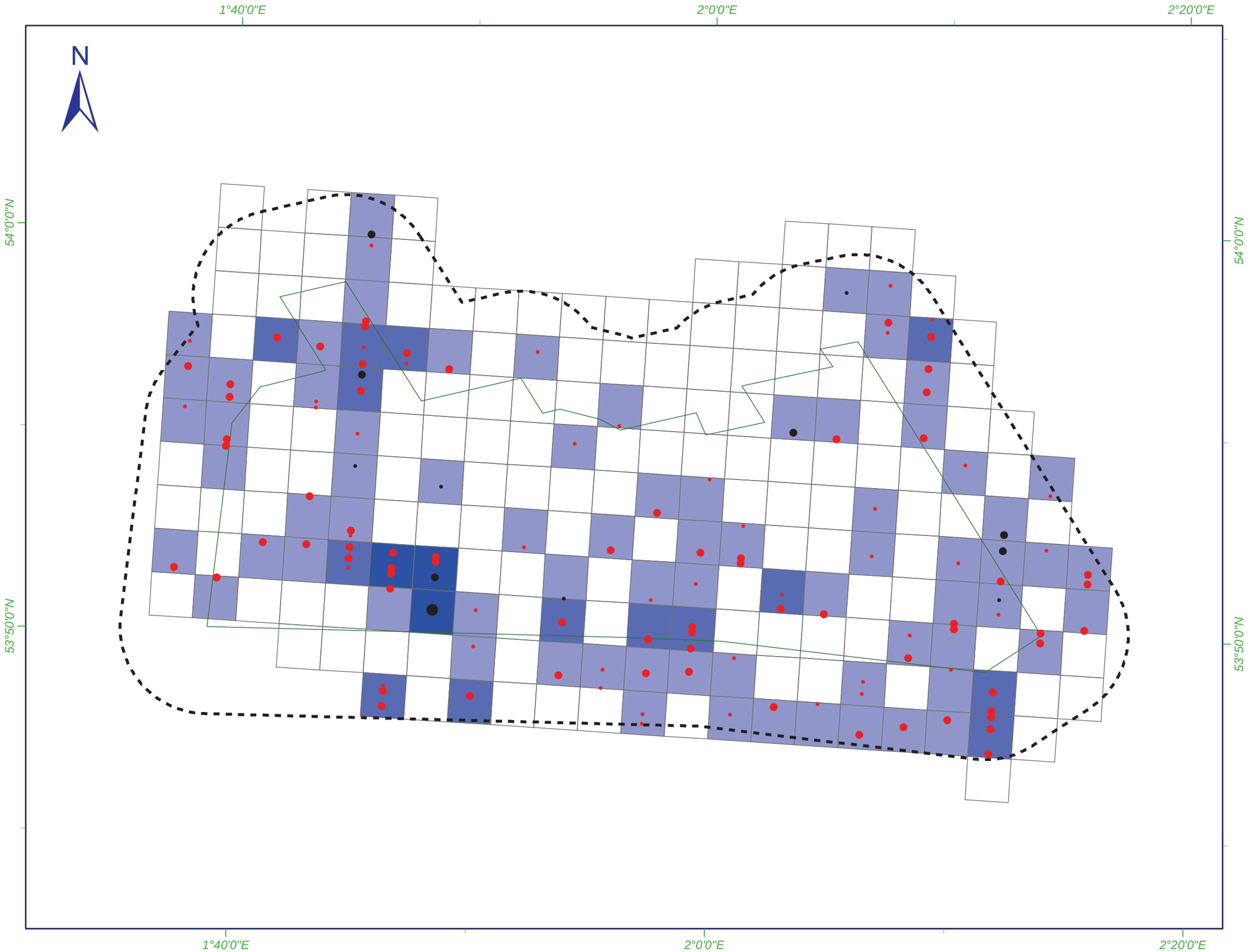
SMart Wind

RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_RazorbillDensityNov10ToMar11_RJ_121009R0



Legend

Subzone 1

Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

SCALE 1:200,000
PAPER SIZE 37 X 23 CM

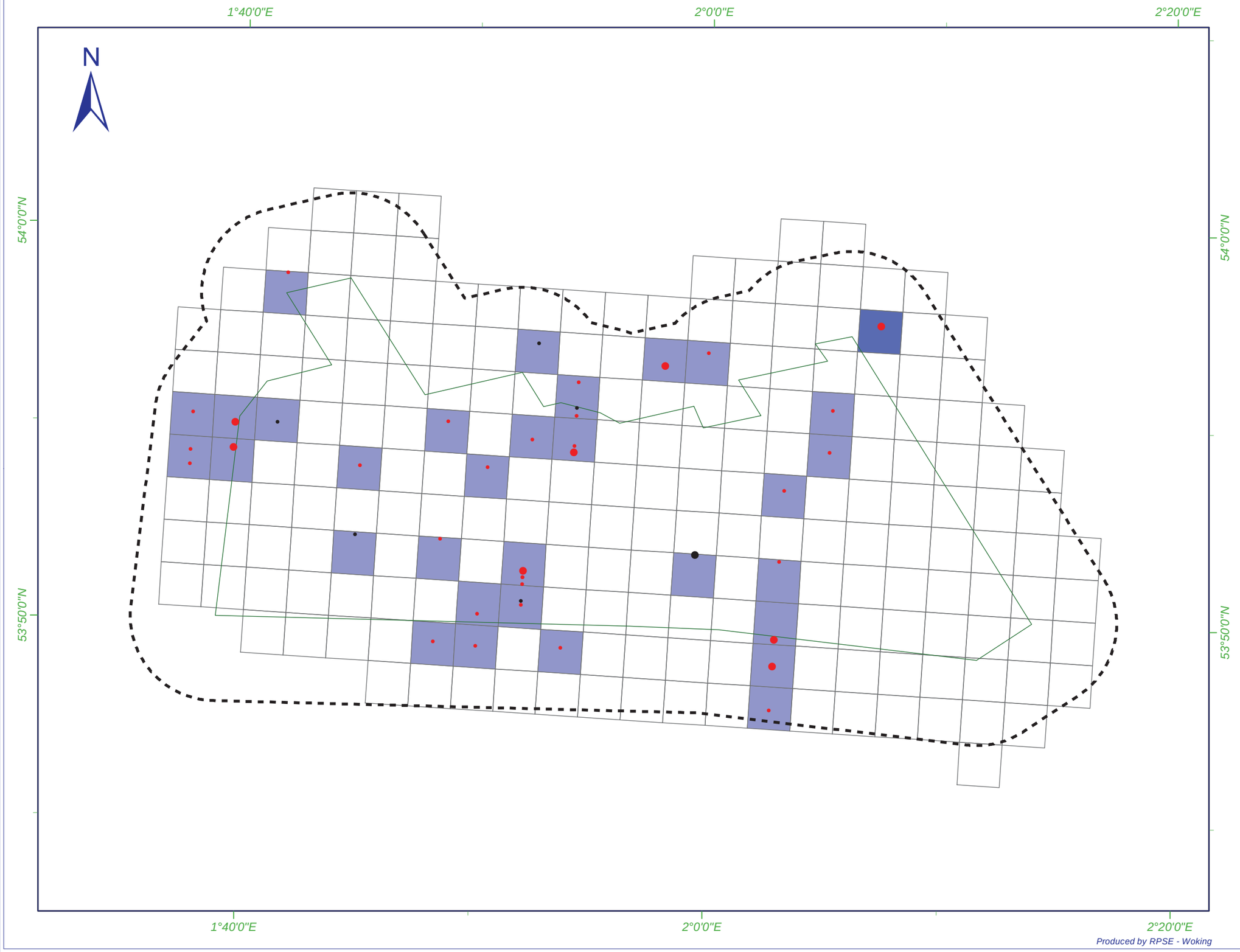
Razorbill Density
(November 2011 to March 2012)

SMart Wind | RPS

DATE: 12/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2

DRAWING: S1_RazorbillDensityNov11ToMar12_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km^2)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 2 4
KILOMETRES

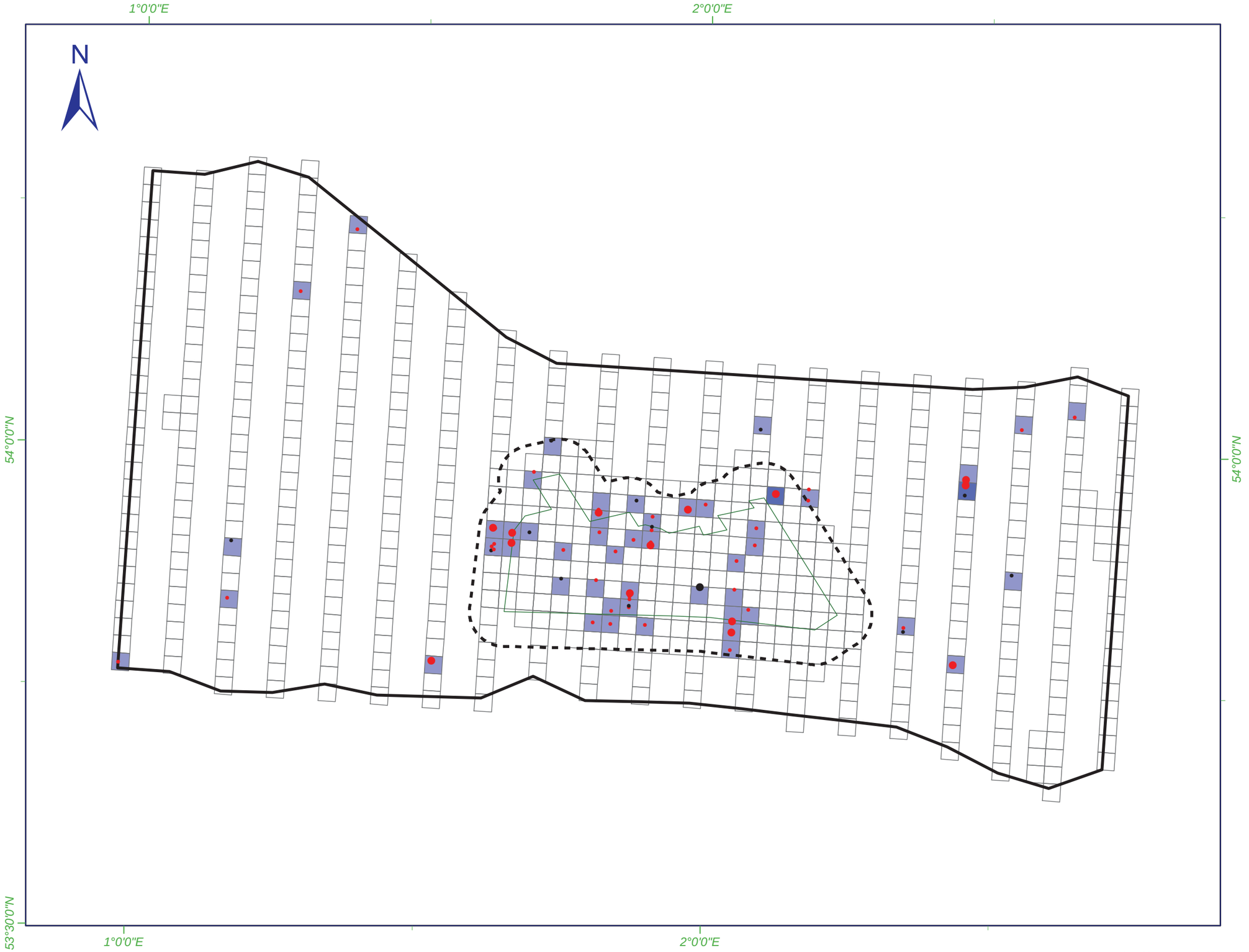
SCALE 1:200,000
PAPER SIZE 37 X 23 CM

Sooty Shearwater Density (September & October 2010)

SMart Wind | RPS

DATE: 11/10/2012	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: S1_SootyShearwaterDensitySep&Oct2010_RJ_121009R0



Produced by RPSE - Woking

Legend

- Subzone 1
- Subzone 1 - 4 km Buffer
- Hornsea Zone - 6 km Buffer

Birds on Water

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Flying Birds

- 1
- 2 - 20
- 21 - 50
- 51 - 100
- 101 - 120

Densities (n/km²)

- 0
- 0 -< 5
- 5 -< 10
- 10 -< 50
- > 50

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

GEODETIC INFORMATION
PROJECTION: UTM31
SPHEROID : WGS 1984
DATUM : WGS 1984

0 5 10
KILOMETRES

SCALE 1:500,000
PAPER SIZE 37 X 23 CM

Sooty Shearwater Density (September & October 2010)

SMart Wind | RPS

DATE: 17/05/2013	DRAWN: RJ	CHECKED: RB

PROJECT REF : EOR0609_SMARTWIND_HORNSEA_P2
DRAWING: SootyShearwaterDensitySep&Oct2010_RJ_130517R1

APPENDIX C - POPULATION, DENSITY AND COLLISION RATE ESTIMATES OF SEABIRDS AT HORNSEA

Distance analysis of ship-based survey data and collision rate modelling using the SOSS Band model

Martin J.M. Poot

Mark P. Collier

Ruben C. Fijn

Robert Jan Jonkvorst

Maarten Japink

Bureau Waardenburg bv
Consultants for environment & ecology
P.O. Box 365, 4100 AJ Culemborg The Netherlands
Tel. +31 345 51 27 10, Fax +31 345 51 98 49
E-mail wbb@buwa.nl Website: www.buwa.nl

Commissioned by: Mainstream Renewable Power

25 June 2013
Report nr 13-113

Status:	final report
Report nr.:	13-113
Date of publication:	25 June 2013
Title:	Population, density and collision rate estimates of seabirds at Hornsea
Subtitle:	Distance analysis of ship-based survey data and collision rate modelling using the SOSS Band model.
Authors:	M.J.M. Poot MSc. M.P. Collier MSc. R.C. Fijn MSc. R-J. Jonkvorst MSc. M. Japink Ing.
Number of pages incl.:	119

Project nr:	11-561
Project manager:	M.J.M. Poot
Name & address client:	Mainstream Renewable Power Zoë Crutchfield Offshore Environment Manager 11th Floor 140 London Wall, London EC2Y 5DN United Kingdom
Reference client:	Consulting Services Agreement Activity No. CTR001
Signed for publication:	Adjunct-director Bureau Waardenburg bv drs. S. Dirksen
Initials:	[redacted]

Bureau Waardenburg bv is not liable for any resulting damage, nor for damage which results from applying results of work or other data obtained from Bureau Waardenburg bv; client indemnifies Bureau Waardenburg bv against third-party liability in relation to these applications.

© Bureau Waardenburg bv / Mainstream Renewable Power

This report is produced at the request of the client mentioned above and is his property. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, transmitted and/or publicized in any form or by any means, electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without prior written permission of the client mentioned above and Bureau Waardenburg bv, nor may it without such a permission be used for any other purpose than for which it has been produced.

The Quality Management System of Bureau Waardenburg bv has been certified by CERTIKED according to ISO 9001:2008.

Preface

In 2010-2012 ship-based surveys following the European Seabirds at Sea (ESAS) methodology were carried out as part of the baseline study for wind farm initiatives at Hornsea off the east coast of England.

Mainstream has commissioned Bureau Waardenburg to calculate population estimates and bird densities based on the data collected during the above-mentioned surveys. In addition, collision rate modelling was carried out based on the densities of flying birds recorded during the surveys. This report presents the analysis and results of the population, density and collision rate estimates for birds at Hornsea Round 3 area, including various sub-zones therein.

The project team of Bureau Waardenburg consisted of and was responsible for:

M.J.M. Poot	project management, distance analysis, collision rate modelling, report
M.P. Collier	collision rate modelling, report
R.C. Fijn	distance analysis, report
R-J. Jonkvorst	distance analysis, report
M. Japink	database management

Cork Ecology, Colin Barton and Claire Pollock, have been particularly helpful with providing their databases and answering questions. In the final stage Rhys Bullman, Rafe Dewar and Matt Wilson of RPS indicated last directions for the final report. This project was commissioned by Mainstream Renewable Energy - Zoe Crutchfield and coordinated by SmartWind - Penny Pickett and Gobe - Pete Gaches. Louise Burt and Eric Rexstad from the Centre for Research into Ecological and Environmental Modelling of the University of St. Andrews provided advice and made useful suggestion on the Distance modelling in this project. Theo Boudewijn of Bureau Waardenburg provided comments on previous versions of this report. The authors thank everyone who has contributed during discussions over these analyses for their contribution.

Table of Contents

Introduction 289
Methods 289
Base material 289
Preparation of database (ESAS model) 289
Processing data (trip, environment, bird, base) ready for analysis 289
Distance analysis 293
Choice of models for Distance analysis calculations 293
Size bias regression vs Mean cluster size analysis 294
Collision rate modelling 294
Population estimates and densities at Hornsea - Year 1 295
Introduction 295
Northern Fulmar *Fulmarus glacialis* 296
Sooty Shearwater *Puffinus griseus* 297
Northern Gannet *Morus bassanus* 298
Herring Gull *Larus argentatus* 299
Great Black-backed Gull *Larus marinus* 300
Lesser Black-backed Gull *Larus fuscus* 301
Little Gull *Larus minutus* 302
Kittiwake Rissa tridactyla 303
Small gull species 304
Large gull species 305
All gull species 306
Common Tern *Sterna hirundo* 307
Common/Arctic tern *Sterna hirundo / S. paradisaea* 308
Little Auk *Alle alle* 309
Puffin *Fratercula arctica* 310
Guillemot *Uria aalge* 311
Razorbill *Alca torda* 312
Large auk species 313
All auk species 314
Population estimates and densities at Hornsea - Year 2 315
Introduction 315
Northern Fulmar *Fulmarus glacialis* 317
Sooty Shearwater *Puffinus griseus* 318
Northern Gannet *Morus bassanus* 319
Herring Gull *Larus argentatus* 320
Great Black-backed Gull *Larus marinus* 321
Lesser Black-backed Gull *Larus fuscus* 322
Little Gull *Larus minutus* 323
Kittiwake *Rissa tridactyla* 324
Small gull species 325
Large gull species 326
All gull species 327
Common Tern *Sterna hirundo* 328
Common/Arctic tern *Sterna hirundo / S. paradisaea* 329
Little Auk *Alle alle* 330
Puffin *Fratercula arctica* 331
Guillemot *Uria aalge* 332
Razorbill *Alca torda* 333
Large auk species 335
All auk species 336
Numbers of birds in sub-zone 1 at Hornsea with a distinction between the Development Area and surrounding buffer area 337
Introduction and methods 337
Northern Fulmar *Fulmarus glacialis* 338
Sooty Shearwater *Puffinus griseus* 339
Northern Gannet *Morus bassanus* 340
Herring Gull *Larus argentatus* 341
Great Black-backed Gull *Larus marinus* 342
Lesser Black-backed Gull *Larus fuscus* 343
Little Gull *Larus minutus* 345
Kittiwake *Rissa tridactyla* 346
Small gull species 347
Large gull species 348
All gull species 349
Common Tern *Sterna hirundo* 350
Common/Arctic tern *Sterna hirundo / S. paradisaea* 351
Little Auk *Alle alle* 352

Puffin *Fratercula arctica* 353
Guillemot *Uria aalge* 354
Razorbill *Alca torda* 355
Large auk species 356
All auk species 357
Collision rate modelling using the SOSS Band (2012) basic model option 1 358
Introduction 358
Results Year 1 sub-zone 1 360
Results Year 1 sub-zone 2 367
Results Year 2 sub-zone 1 374
Results Year 2 sub-zone 2 381
Results Years 1 and 2 sub-zone 1 388
Results Years 1 and 2 sub-zone 2 395
Collision rate modelling using the SOSS Band (2012) extended model option 4 402
Introduction 402
Results Years 1 and 2 sub-zone 1 402
Results Years 1 and 2 sub-zone 2 403
Discussion 404
Collision rate modelling using the basic model 404
Collision rate modelling using the extended model 405
Collision rate estimates 405
References 406

Introduction

C.1. In 2010-2012 ship-based surveys following the European Seabirds at Sea (ESAS) methodology were carried out as part of the baseline study for wind farm initiatives at Hornsea off the east coast of England.

C.2. In this report the analysis and results of the population, density and collision rate estimates for birds at Hornsea are presented. This report should be regarded as background document to support the understanding of the population, density and collision rate estimates for Hornsea. The main goal of this report is to provide an overview of the analyses carried out and present the results in a comprehensive and accessible form.

C.3. This report is based on two years data for Hornsea collected during March 2010 to February 2012.

Methods

Base material

C.4. In this section we describe the procedures carried out during the handling of ESAS data collected at Hornsea. The data analysed in this report were collected according to ESAS ship-based survey methodology (Tasker et al. 1984; Camphuysen et al. 2004). Monthly surveys at Hornsea were carried out from March 2010 until February 2012.

Preparation of database (ESAS model)

C.5. The physical data model was built on a PostgreSQL database server and was based on the SAST Coding Manual (JNCC, 2006) along with some additions (see figure C.1). All coding lists were imported in tables and survey data from Hornsea were imported to the database. Geometric fields for spatial querying of the data are non-projected in WGS84.

C.6. During the uploading of the data some fundamental checks were carried out using a Microsoft (MS) Access database as a front-end to the PostgreSQL database. Therefore, all PostgreSQL tables are ODBC-linked in MS Access and the data table-structures for trips, environment, bird and base data are hard copied.

Processing data (trip, environment, bird, base) ready for analysis

C.7. The different steps of how the base data were processed are described below. The different steps indicated are presented schematically in figure C.2.

C.8. Formatting paradox export files

Paradox exports are required to be in text format. In this case files where delivered in csv format, therefore, the following steps were undertaken:

- replacing spaces with underscores in column names in the csv files; and
- replacing all ',' with ';' as field delimiter.

C.9. Read into MS Access front-end

- All formatted files were read in hard copied MS Access native tables prior to adding to PostgreSQL; and
- A record count was made to ensure all data were successfully imported.

C.10. Check against coding lists

- Each field was checked against its coding list to find missing values *etc*.

C.11. Upload in database

During the import some fields were recalculated.

- Latitude and longitude minutes were changed back to '.' separated values.

C.12. Corrections

The only corrections made to the data were in the field ‘distance’.

- a new field ‘flight_altitude’ was populated with the numeric information from the ‘distance’ field; and
- all ‘distance’ fields with numeric data were replaced with 'F' to indicate flying birds.

C.13. Additions

The ESAS database structure has been extended with some extra fields and an extra table.

- a geometry field in the base table was updated with point locations based on the coordinates in latitude and longitude;
- an 'in_out' field in the base table was updated with a ‘study area’ number, see figure C.3 and C.4 for a visible representation of the study areas and buffers used;
- an extra survey table was populated with lines calculated from base points with the following criteria ‘count_type’ =1 AND key fields from the Hornsea survey data AND ‘in_out’ is not null’;
- line lengths were calculated in UTM 31N projection; and
- *N.B.* For Distance analyses, line lengths were halved as Distance software assumes that observations along transects are made on two sides.

C.14. SELECT and analyse

Following loading and checking the data were ready for use in analysis.

- selection of major sea state, wind direction and observer for each survey for each transect;
- selection of flying or ‘distance birds’; and
- export of required data for Distance and density calculations.

Data used in the collision rate modelling were based on:

- flying birds in transect (in the ‘snapshot’ count);
- birds not associated with the observer base or similar vessels; and
- only birds within the area of interest, *i.e.* the relevant Hornsea development areas.

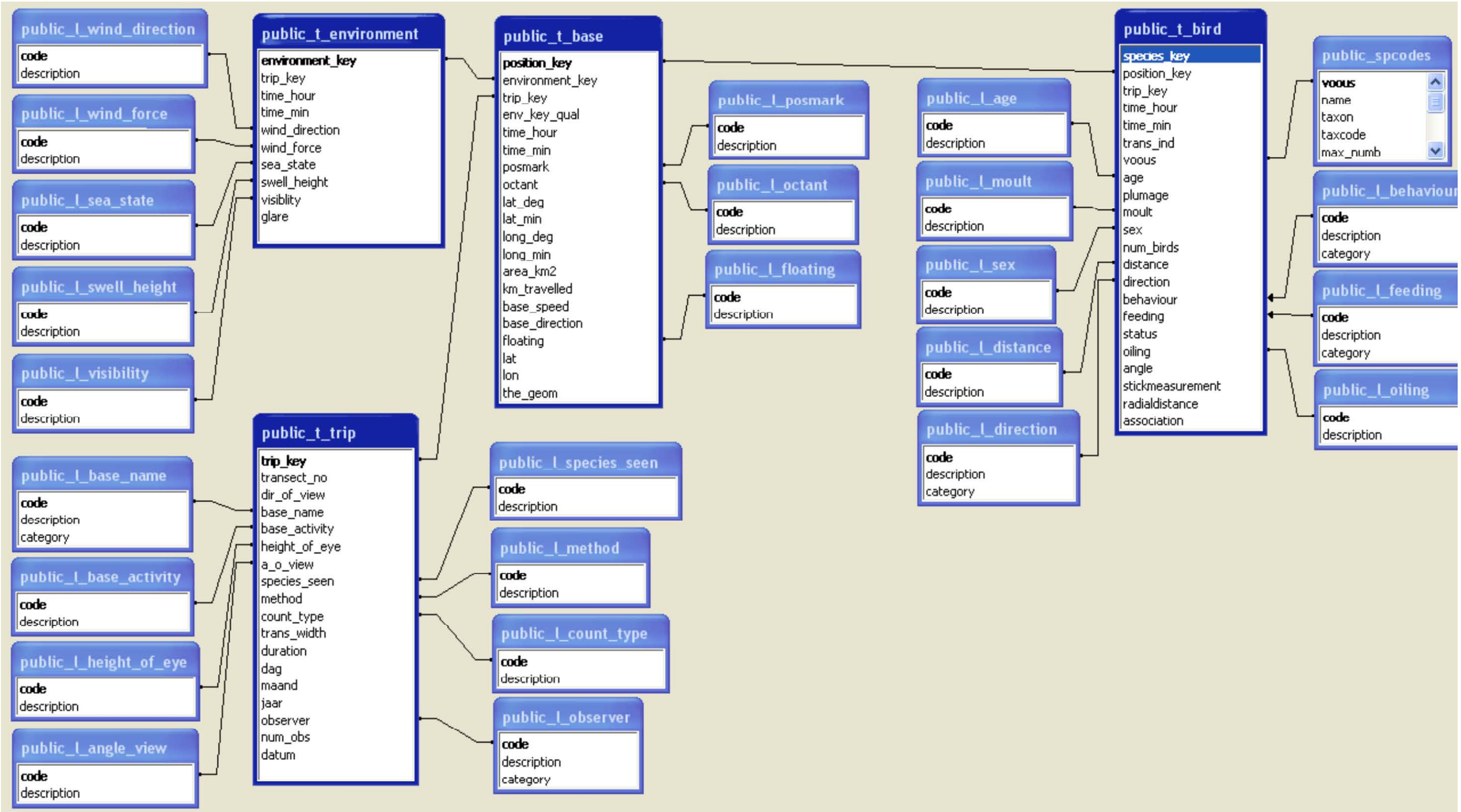


Figure C.1 Overview of the database according the ESAS data model.

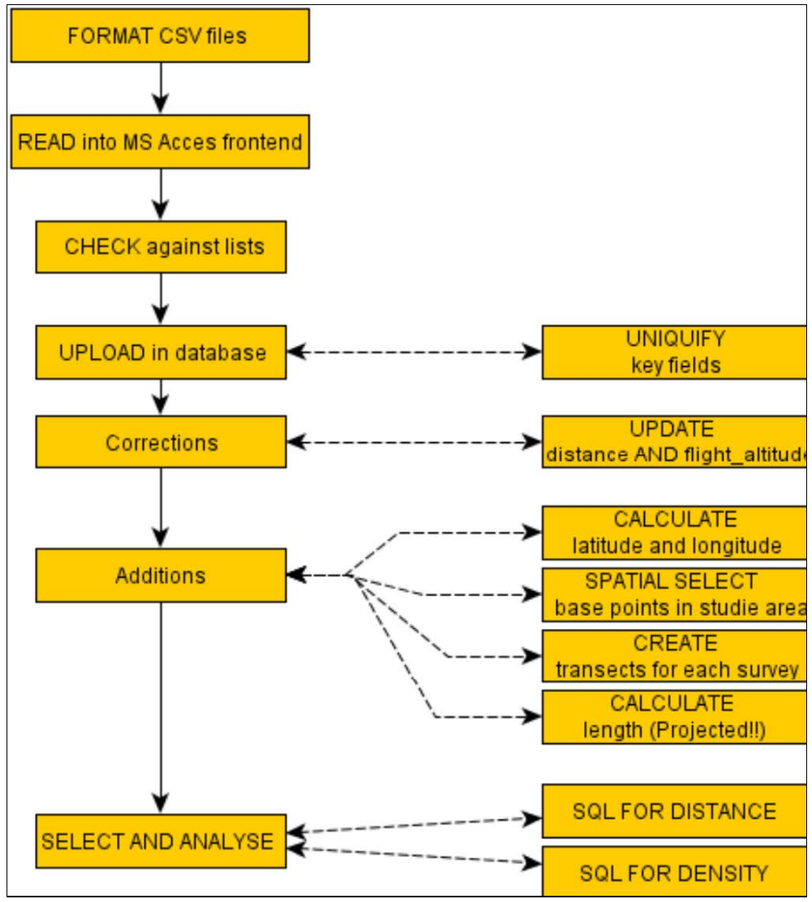


Figure C.2 Overview of the processing steps to make the data ready for analysis.

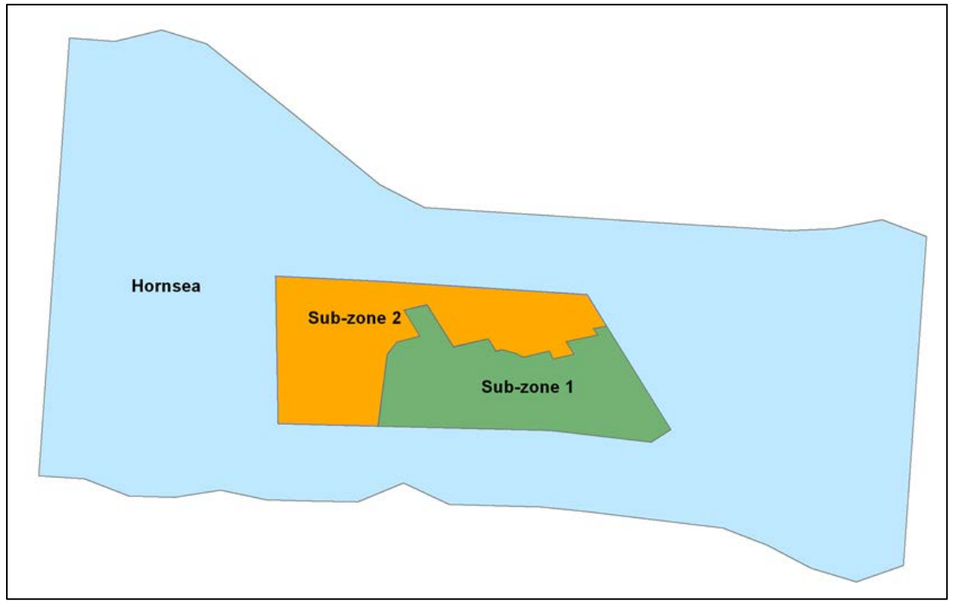


Figure C.3 General overview of the Hornsea area and the two sub-zones.

Figure C.4 For the Distance analysis only observations within the delimited study area of Hornsea area and sub-zone 1, and the relevant 1-4km buffers (as shown above), were included. The transect lengths were amended accordingly.

Distance analysis

C.15. The data collected during the ship-based surveys at Hornsea formed the basis for estimating population sizes and densities of seabirds in the area (see 2.1 for an explanation of data collection and handling). Birds were recorded while steaming along pre-defined transects within the Hornsea and Hornsea development area sub-zone 1 study areas using the ESAS methodology (Camphuysen *et al.* 2004). The detection probability of birds decreases with increasing distance from the transect line. Reliable estimates of the densities and population sizes of birds can be estimated with the application of the Distance Sampling Technique (Buckland *et al.* 1993, 2001, 2004). Distance 6.0 software, developed by the Centre for Research into Ecological and Environmental Modelling at the University of St. Andrews (CREEM), uses this technique to fit a species-specific detection curve through the data collected to determine the width of the strip in which species were effectively recorded (Thomas *et al.* 2010). Subsequently, the densities of birds in the study area can be calculated based on those within the area covered (transect line multiplied with the effective strip width).

C.16. A key assumption of this technique is that all birds along the transect line (g(0) = 1) are detected. This assumption is not always valid due to disturbance of the survey ship causing birds to either dive, swim or fly away from the transect line to more distant transect bands. It is considered that the potential for any error is minimised through the way in which the data is handled in the Distance analysis, notwithstanding this, any potential for residual bias is considered to remain a minor factor. Furthermore, the calculated densities for species that regularly undertake long dives must be regarded as a lower limit as the proportion under the water remains unknown. During ship-based surveys, the species with potentially lower detection rates (g(0) ≠ 1) are likely to include auks, and in particular the smaller species. Because a ship moves relatively slowly and also disturbs birds under water, the problem of missing birds because there are under water is relatively small compared to aerial surveys. If not all individuals of a certain species are detected (g(0) ≠ 1), several analytical techniques can be used to correct for this imperfect detection.

C.17. The distance analysis included all observations of birds that were not in flight (either swimming or sitting on floating objects) and within transect (up to 300 m) and categorised in one of four observation bands (0-50 m, 50-100 m, 100-200 m and 200-300 m). These four observation bands give average perpendicular distances (used by the Distance 6.0 software) of 25, 75, 150 and 250 m. So, automatically a 'right truncation' of the data was performed at the outer boundary of band D (300 m).

C.18. In this report unidentified birds have been analysed in Distance together with the identified individuals of similar species. This is because a bird being unidentified is often related to the detection distance. Assigning before hand proportions of identified species to the unidentified individuals might give a bias when fitting detection functions. In case of e.g. auks, Guillemots are easier to detect than Puffins and Little Auks. This yields smaller Effective Strip Widths in the latter two species compared to Guillemots. However, we assume that detection functions based on identified birds per species are likely more accurate than when pooling all observed birds, including unidentified birds. As our aim was to calculate total population estimates we also wanted to use the unidentified birds in order to see whether more reliable population estimates could be produced (because of more data). Therefore in this report we also have chosen to create unidentified groups of birds of similar species (e.g. auks, large gulls, small gulls etc.), including now the unidentified birds. Then a 'mixed' detection function is fitted and population estimates were generated of a mixed species group. These population estimates can be compared with the sum of the population estimates of the different underlying species.

C.19. As a general rule at least 60 positive observations are needed in order to be able to fit a reliable detection function. In order to correct for loss of detection due to factors such as sea state *etc.* the number of observations needed increases with a multiple of the number explanatory parameters, including covariates in Distance analysis models. Therefore, in order to determine the most reliable detection function especially applicable for the scarce species, all available data were used to estimate the detection functions. For Hornsea survey data for a two years period was available and were used to determine a global detection function (March 2010 - February 2012). Data on encounter rate and cluster sizes were always analysed on survey level (month as stratum) as both parameters relate to general occurrence of a bird species which varies in the course of a year. For the total Hornsea area the effort after August 2011 declined, due to bad weather. The sub-zone 1 area was fully surveyed in the two years. In Year 2 for sub-zone 2 data (see figure C.3) are also available and were used in a separate Distance Analysis to calculate population estimates, based on a global approach combined with the sub-zone 1 data. Like sub-zone 1 this area was also surveyed with a 2 km transect grid. In the chapter on the population estimates and densities at Hornsea - Year 2 for the period with poor coverage of the Hornsea study area (September 2011 – February 2012) for the sub-zones 1 & 2 together population estimates are presented as minimum figures for the Hornsea area.

Choice of models for Distance analysis calculations

C.20. Model selection was mainly based on the Akaike Information Criteria (AIC), with lower AIC values resembling models with a better fit (Buckland *et al.* 1993, 2001, 2004). In each species account in this report, our assessment of distance curves is explained.

C.21. In the species accounts in the chapter on Population estimates and densities at Hornsea - Year 1 the rationale is given for every species why a certain model was chosen. The main issues for improving models concerned the type of detection

function, the inclusion or not of covariates (either as a variate or factor), the application of size bias regression or mean size in the cluster size analysis. This latter issue turned out to lead potentially to relatively large differences in final population estimates, the reason this aspect is discussed in more detail below.

C.22. Detection of seabirds on the water surface is influenced by observation conditions due to weather and sea state. The Distance 6.0 software allows the analysis of sea state data as covariates during the modelling process. By applying the AIC criterion, better models could be used to correct population estimates for the effect of sea state, resulting in better estimates with smaller confidence intervals.

C.23. Generally, the data of the Hornsea surveys were such that a variety of competing models could be fitted that produced similar results. Thus, fitting a variety of models and using AIC to objectively choose between models seemed in principle a sensible approach for most species. However, as reported in several individual species accounts, selecting the model with the lowest AIC was not always applied to all species. Most of the exclusions have been made on the basis of the knowledge of birds and survey experience. Especially in case the detection function overestimated the density on the track line or the shape of the detection functions was not fluently decreasing (see further Buckland *et al.* 2001), we have chosen an alternative model. Most of the time this was in situations that birds were being detected disproportionately in the second band (due to birds diving under water or birds flying up in the A band and pop up in the second band unnoticed). As a robust, conservative approach, hazard-rate detection curves can then be chosen. Alternatively pooling the two bands also can reveal a smooth distance detection curve.

C.24. Only sea state has been included in some species models as a covariate in some detection functions when on the basis of AIC it would be included. Mostly sea state was included as a non-factor variable as it used fewer parameters and enforced a monotonic relationship between detectability and sea state. The Distance analysis program uses a size bias regression for each survey to obtain estimates of cluster size. For some species the numbers of sightings in a survey were small and so in these cases the size bias regression failed to come up with reliable estimates of expected cluster size, however, applying a mean cluster size instead could reveal far too high population estimates.

Size bias regression vs Mean cluster size analysis

C.25. In some cases during the population size modelling in Distance, the created models encounter problems with the clustered distribution of certain species. Distance uses size-bias regression models to calculate population estimates based on the assumption that larger groups are more easily observed further away from the transect line than individual birds at a similar distance. With the size-bias regression, the assumption is made that all cluster sizes are observed on, or close to, the track line. So, in case more large clusters are observed close to the line than one would expect the size-bias estimate is larger than the mean estimate. The question is why the observed groups on the track line can consist of more large groups than expected? Often this is the case when numbers per survey are low and thus the potential influence of a large group near the transect line is large. In certain species, like gulls and Northern Fulmar, this phenomena can occur due to groups of birds related to fishery activities, that are still present long after fishing activity was undertaken at that location. Also clustered presence of foraging Little Gulls along lines or fronts at sea might give problems.

C.26. This size-bias regression gives problems when the expected cluster size (E(s) as determined by Distance) is larger than the mean cluster size. This problem mainly occurs when population estimates are given per survey and thus based on a cluster size per survey as well (in Distance terms: “Cluster Size per ‘stratum’ instead of ‘global’). In this report, size-bias regression has been chosen as the preferred method for estimating populations based on several reasons. Problems with the size-biased regression do not occur frequently and in most cases E(s) only slightly larger than the mean cluster size. Also the surveys with these problems are almost exclusively surveys with low numbers of the particular species so the overall influence on population estimates is small.

Collision rate modelling

C.27. For various bird species, the level of collision-related mortality was estimated by collision rate modelling. The model used was that published by the Crown Estate Strategic Ornithological Support Services group in July 2012 (Band 2012; available from http://www.bto.org/science/wetland-and-marine/soss/projects). This model, based on the onshore SNH/Band collision risk model (Band *et al.* 2007; available from http://www.snh.gov.uk/planning-and-development/renewable-energy/onshore-wind/assessing-bird-collision-risks/), has been extended to allow the direct input of density data and to allow the comparison of various avoidance rates on the estimated collision rates.

C.28. Based on the physical characteristics of both the turbine and species of bird, a turbine/species-specific probability of collision for a single bird crossing the rotor-swept area can be calculated. This probability is then applied to the number of birds crossing the rotor-swept area of an entire wind farm, which is estimated based on the density of flying birds over a particular timeframe and the size and number of turbines. Finally, an avoidance factor is applied that accounts for birds avoiding turbines, were they present. This forms the basic collision risk model as used in options 1. The model also allows a correction factor for large arrays, which assumes a decreasing density of birds across the wind farm that is relative to numbers of birds that have been assumed to collide. For the current wind farm scenarios, this

correction factor has the effect of reducing the estimates of the numbers of collisions by a fraction of a percent and has therefore not been applied.

C.29. The collision risk model makes a number of assumptions and is further sensitive to changes in avoidance rates (Chamberlain *et al.* 2006), which urge caution when interpreting the results. Here, four different avoidance rates have been applied: 95%, 98%, 99% and 99.5%.

C.30. Data for the various wind farm variants and turbine-specific data are given in tables C.133 and C.134. Data for species-specific parameters, such as length, wingspan and flight speed, were obtained from literature and are presented in table C.135. Not all data were available for all wind farm scenarios or for all species modelled. Missing data were estimated based on similar turbines or on similar species.

C.31. The proportions of each species flying at rotor height were calculated from site-specific data recorded during the ship-based surveys. The heights of flying birds were recorded in 5m categories. For each turbine variant, the proportions of birds recorded in the height categories of the rotor tip at its lowest point to the rotor tip at its highest point were taken as the proportion flying at rotor height.

C.32. Only flying birds recorded as 'in transect', thus within the snapshot count (Camphuysen *et al.* 2004), were included in when calculating species-specific densities. Monthly densities, and therefore monthly collision rates, were calculated, which were summed to provide annual collision rates. In cases of missing data annual collision rates were derived from the monthly rates averaged across that year. This approach was only adopted after reviewing the cases of missing data in relation to the densities in similar months and across the year. In no cases did it seem that this approach would result in considerably fewer estimated collisions than a seasonal mean.

C.33. In addition to the basic collision risk model (here, option 1), an extended model (option 4) was used for four of the species assessed. This extended model incorporates detailed information on the altitudinal distribution of flying birds in relation to the encounter rate and collision probability with the rotors. The flight height distributions of these four species were taken from data collected at the site over the two years. The flight heights of birds were recorded in five-metre categories. To provide height distributions at the one-metre interval the birds were divided evenly within each category. Due to the absence of suitable tidal information the tidal correction component of the model was not included.

Population estimates and densities at Hornsea - Year 1

Introduction

C.34. In the species accounts below we present the population estimates and densities at Hornsea on a monthly basis for Year 1 of the study period, March 2010 - February 2011.

C.35. Figures presented are for birds sitting on the water and are based on calculations with the Distance Analysis software (CREEM). Detection functions were built for species or species-groups with at least 60 different sightings (Buckland *et al.* 1993). In every species account rationale is given for the model chosen for use in Distance. Data from Year 2 of study were also already incorporated in the analyses to strengthen the detection functions.

C.36. Estimates of population sizes of birds sitting on the water are accompanied by confidence intervals. The average density of flying birds as determined by the snapshot method is also presented along with a population estimate based on this density and the total surface cover of the study area. The two population estimates together provide the estimated total population for the area.

Table C.1 Survey effort of the Hornsea area with a 6 km transect grid (n = 20) in Year 1, March 2010 - February 2011.

Survey (yyyymm)	effort (n transects covered)	% of total transects covered
201003	20	100
201004	20	100
201005	20	100
201006	20	100
201007	20	100
201008	20	100
201009	20	100
201010	20	100
201011	14	70
201012	17	85
201101	12	60
201102	2	10

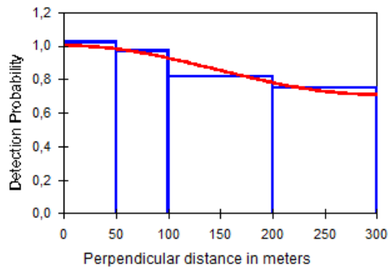
Table C.2 Survey effort of the sub-zone 1 sub-zone area with the 2 km transect grid (n = 22) in Year 1, March 2010 - February 2011.

Survey (yyyymm)	effort (n transects covered)	% of total transects covered
201003	22	100
201004	22	100
201005	22	100
201006	22	100
201007	22	100
201008	22	100
201009	22	100
201010	22	100
201011	22	100
201012	22	100
201101	22	100
201102	22	100

Northern Fulmar *Fulmarus glacialis*

C.37. Population estimates and densities were determined on 1,787 observations of Northern Fulmar in the Hornsea and sub-zone 1 ship-based surveys in Year 1 and Year 2. In the first study year at Hornsea 1,468 individual Northern Fulmars were recorded in 1,063 sightings. Fulmars were seen throughout the year with lowest numbers present in late winter. Most sightings of Northern Fulmar were recorded in spring and late summer/autumn.

Model selection:



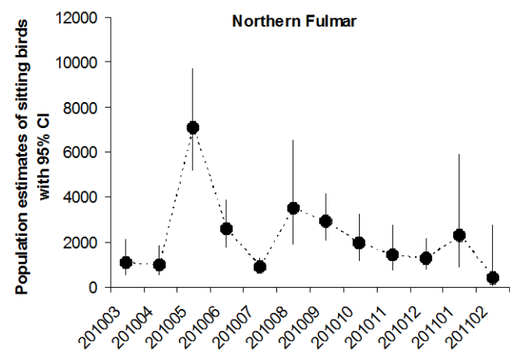
Effective strip width (± SE): 256.31 ± 7.565 CI: 241.90 <> 271.59

Model function: Uniform with 1 cosine adjustment
Covariates: n.a.

Remarks: A uniform detection probability was chosen based on the lowest AIC criterium and the most decreasing fluent shape of the detection function, in contrast to the half-normal and hazard rate options.

Table C.3 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.090	463	0.202	1044	527	2068
201004	0.134	693	0.190	981	533	1806
201005	0.596	3073	1.373	7084	5192	9665
201006	0.228	1175	0.501	2583	1748	3817
201007	0.142	731	0.171	883	613	1273
201008	0.296	1527	0.675	3483	1876	6467
201009	0.203	1049	0.565	2915	2067	4113
201010	0.156	804	0.371	1912	1142	3202
201011	0.166	856	0.270	1391	709	2728
201012	0.179	921	0.245	1265	757	2112
201101	0.238	1226	0.444	2291	893	5877
201102	0.110	565	0.077	397	58	2729



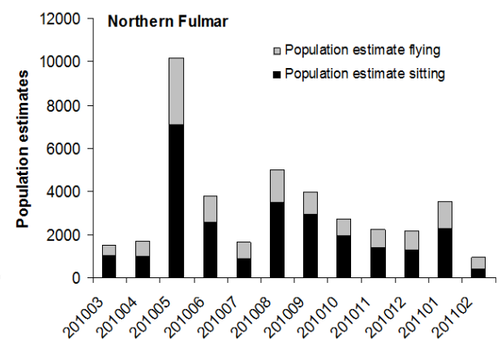
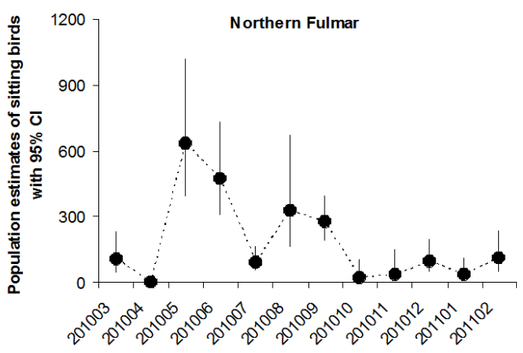
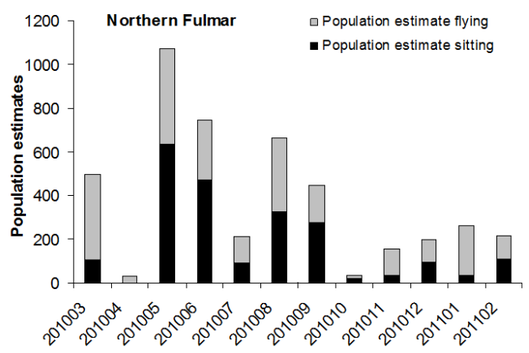


Table C.4 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.45	392	0.12	103	47	226
201004	0.03	30	0.00	0	0	0
201005	0.50	436	0.72	632	393	1016
201006	0.31	269	0.54	473	307	728
201007	0.14	119	0.10	92	53	160
201008	0.38	336	0.37	325	159	666
201009	0.20	175	0.31	274	192	393
201010	0.02	15	0.02	18	3	98
201011	0.14	120	0.04	35	8	148
201012	0.11	97	0.11	97	49	192
201101	0.26	225	0.04	35	11	107
201102	0.12	104	0.12	109	51	231

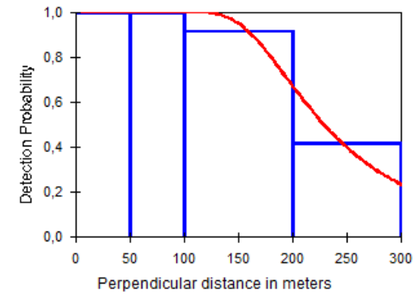




Sooty Shearwater *Puffinus griseus*

C.38. Population estimates and densities were determined on 56 observations of Sooty Shearwaters in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 82 individual Sooty Shearwaters were recorded in 55 sightings. Shearwaters were largely absent in the area and only present during autumn migration.

Model selection:



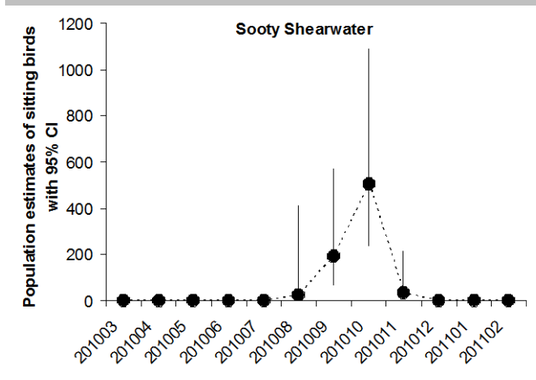
Effective strip width (± SE): 233.33 ± 36.004 CI: 171.56 <> 317.35

Model function: Hazard Rate
Covariates: -

Remarks: A half normal detection probability would yield the lowest AIC, however the detection function suggest a substantial overestimation of birds in band A. This is unrealistic in this medium-sized seabird which is a very active flyer, therefore a hazard rate function was chosen.

Table C.5 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.000	0	0	0
201004	0.000	0	0.000	0	0	0
201005	0.000	0	0.000	0	0	0
201006	0.000	0	0.000	0	0	0
201007	0.000	0	0.000	0	0	0
201008	0.000	0	0.005	25	409	142
201009	0.007	38	0.037	193	66	565
201010	0.019	96	0.097	502	233	1083
201011	0.005	27	0.007	34	60	213
201012	0.000	0	0.000	0	0	0
201101	0.000	0	0.000	0	0	0
201102	0.000	0	0.000	0	0	0



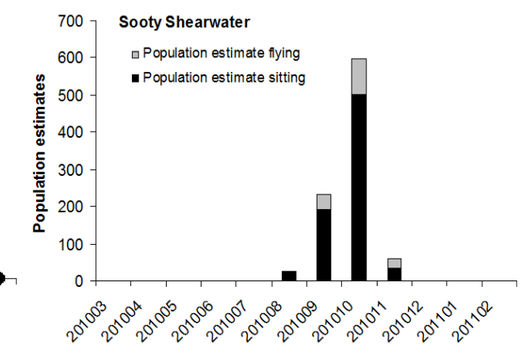
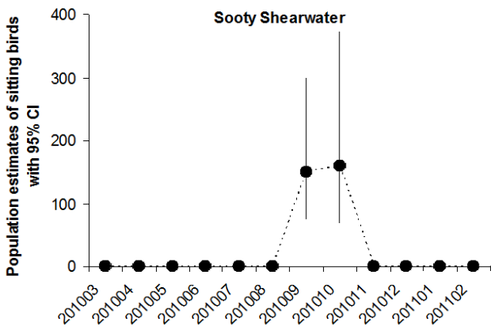
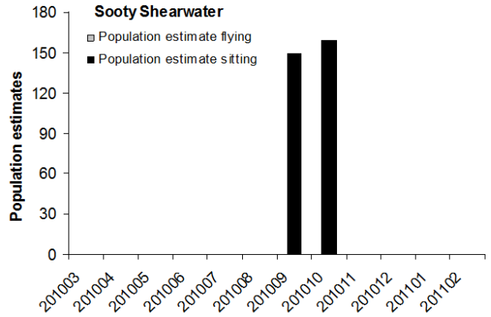


Table C.6 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.00	0	0.00	0	0	0
201005	0.00	0	0.00	0	0	0
201006	0.00	0	0.00	0	0	0
201007	0.00	0	0.00	0	0	0
201008	0.00	0	0.00	0	0	0
201009	0.00	0	0.17	149	74	297
201010	0.00	0	0.18	159	68	370
201011	0.00	0	0.00	0	0	0
201012	0.00	0	0.00	0	0	0
201101	0.00	0	0.00	0	0	0
201102	0.00	0	0.00	0	0	0

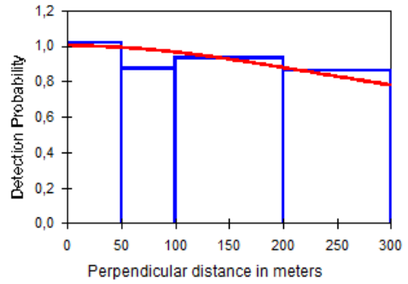




Northern Gannet *Morus bassanus*

C.39. Population estimates and densities were determined on 980 observations of Northern Gannet in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 1,007 individual Northern Gannets were recorded in 731 sightings. Gannets were present year-round but most sightings of Northern Gannets were recorded in late summer and autumn.

Model selection:



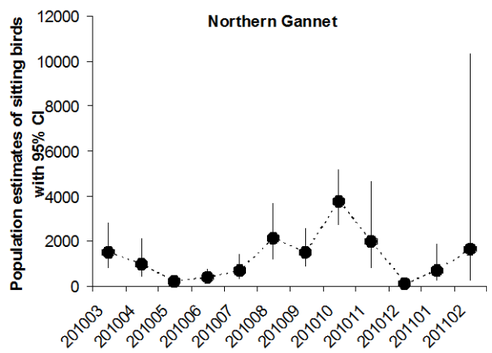
Effective strip width (± SE): 278.04 ± 2.724 CI: 272.75 <> 283.44

Model function: Half Normal
Covariates: Seastate (variate)

Remarks: A plain half normal detection probability was chosen based on the shape of the detection function and lowest AIC criterium. Seastate was included as covariate in the analysis.

Table C.7 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.344	1774	0.293	1511	816	2798
201004	0.201	1039	0.184	949	440	2046
201005	0.060	307	0.042	214	108	426
201006	0.034	173	0.077	397	221	712
201007	0.067	346	0.135	695	341	1415
201008	0.381	1967	0.407	2098	1208	3643
201009	0.166	859	0.288	1487	875	2525
201010	0.571	2947	0.725	3738	2714	5149
201011	0.280	1445	0.378	1947	819	4629
201012	0.050	260	0.020	102	32	320
201101	0.077	398	0.128	658	240	1805
201102	0.526	2713	0.313	1612	253	10289



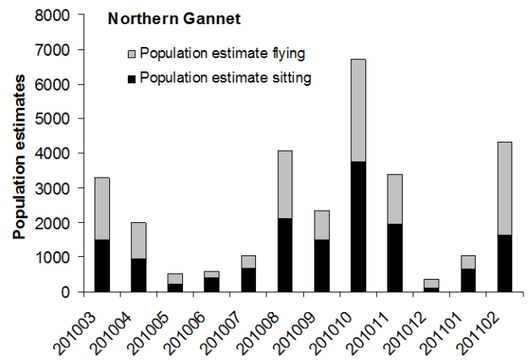
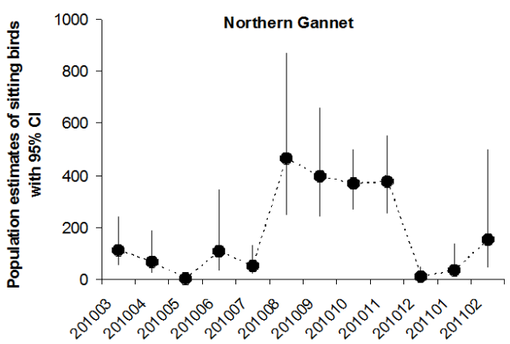
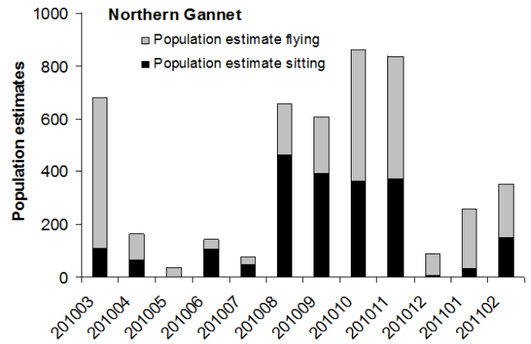


Table C.8 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.65	573	0.12	109	51	234
201004	0.11	98	0.07	65	23	181
201005	0.04	38	0.00	0	0	0
201006	0.04	37	0.12	105	32	343
201007	0.03	30	0.06	48	19	125
201008	0.22	194	0.53	462	246	865
201009	0.24	212	0.45	394	238	653
201010	0.57	495	0.42	366	269	497
201011	0.53	465	0.42	372	253	547
201012	0.09	82	0.01	8	1	45
201101	0.26	225	0.04	32	8	136
201102	0.23	201	0.17	150	45	497

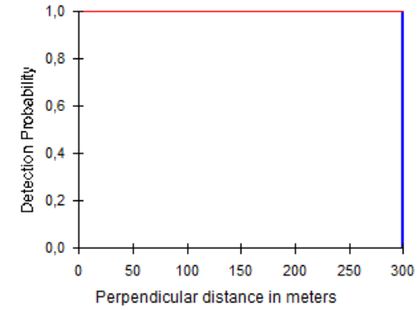




Herring Gull *Larus argentatus*

C.40. Population estimates and densities were determined on 77 observations of Herring Gulls in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 57 individual Herring Gulls were recorded in 40 sightings. Most Herring Gulls were present in winter.

Model selection:



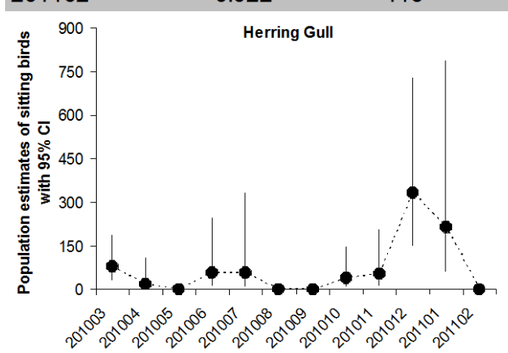
Effective strip width (± SE): Uniform function with no cosine adjustments in a strip-transect with 300 m width.

Model function: Uniform no cosine adjustments
Covariates: n.a.

Remarks: All curves yield a flat "uniform" detection function; low sample sizes might play a role here. A uniform detection function was selected based on the lowest AIC criterium.

Table C.9 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.026	135	0.015	77	32	185
201004	0.000	0	0.004	19	3	108
201005	0.004	19	0.000	0	0	0
201006	0.011	58	0.011	58	14	243
201007	0.026	135	0.011	58	10	329
201008	0.000	0	0.000	0	0	0
201009	0.000	0	0.000	0	0	0
201010	0.011	57	0.007	38	10	142
201011	0.057	294	0.010	54	14	202
201012	0.137	709	0.064	331	151	724
201101	0.059	306	0.042	215	59	785
201102	0.022	113	0.000	0	0	0



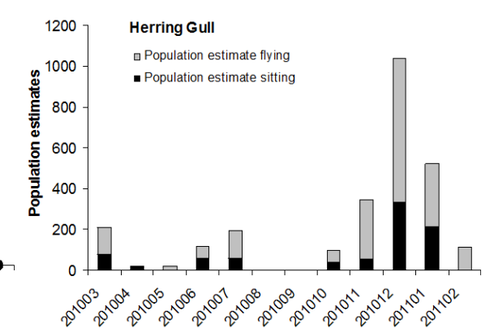
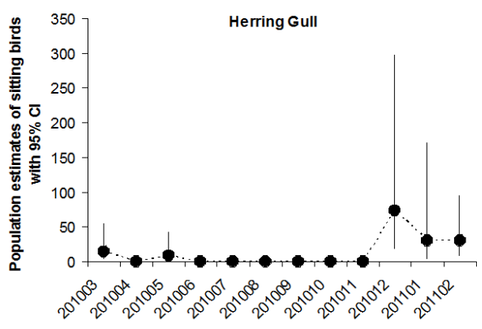
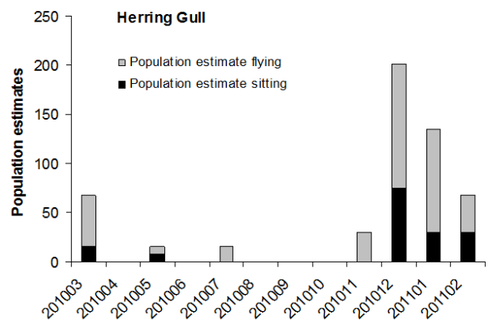


Table C.10 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.06	53	0.02	15	4	54
201004	0.00	0	0.00	0	0	0
201005	0.01	8	0.01	8	1	42
201006	0.00	0	0.00	0	0	0
201007	0.02	15	0.00	0	0	0
201008	0.00	0	0.00	0	0	0
201009	0.00	0	0.00	0	0	0
201010	0.00	0	0.00	0	0	0
201011	0.03	30	0.00	0	0	0
201012	0.14	127	0.09	74	19	296
201101	0.12	105	0.03	30	5	170
201102	0.04	37	0.03	30	9	94

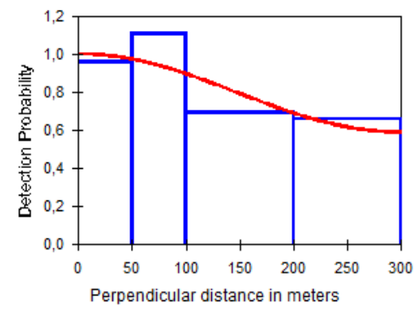




Great Black-backed Gull ***Larus marinus***

C.41. Population estimates and densities were determined on 462 observations of Great Black-backed Gulls in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 449 individual Great Black-backed Gulls were recorded in 290 sightings. Most Great Black-backed Gulls were present in winter.

Model selection:



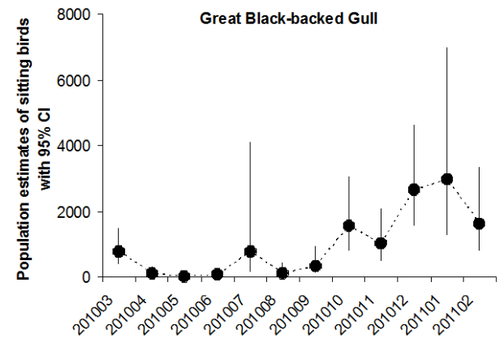
Effective strip width (± SE): 238.43 ± 12.714 CI: 214.73 <> 264.75

Model function: Uniform with 1 cosine adjustment
Covariates: n.a.

Remarks: A uniform detection function was selected based on the lowest AIC criterium.

Table C.11 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.183	945	0.147	757	392	1464
201004	0.078	404	0.019	97	32	292
201005	0.015	77	0.000	0	0	0
201006	0.011	58	0.009	48	13	180
201007	0.007	38	0.147	760	142	4075
201008	0.111	573	0.019	96	22	413
201009	0.252	1297	0.063	327	115	927
201010	0.234	1206	0.302	1558	800	3033
201011	0.135	696	0.193	994	482	2047
201012	0.188	969	0.516	2659	1540	4593
201101	0.208	1073	0.573	2953	1251	6974
201102	0.132	678	0.313	1616	789	3308



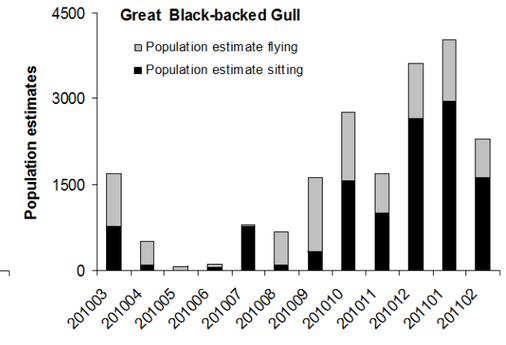
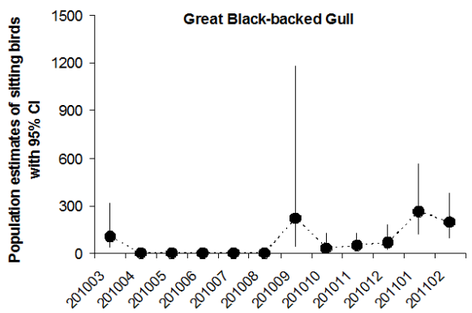
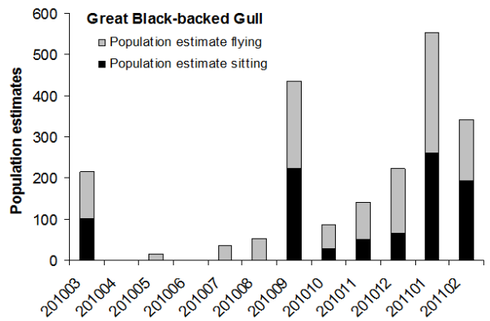


Table C.12 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.13	113	0.12	102	34	308
201004	0.00	0	0.00	0	0	0
201005	0.02	15	0.00	0	0	0
201006	0.00	0	0.00	0	0	0
201007	0.04	37	0.00	0	0	0
201008	0.06	52	0.00	0	0	0
201009	0.24	212	0.25	222	42	1178
201010	0.07	60	0.03	28	7	120
201011	0.10	90	0.06	50	20	124
201012	0.18	156	0.07	66	24	177
201101	0.33	292	0.30	261	121	563
201102	0.17	149	0.22	193	99	376

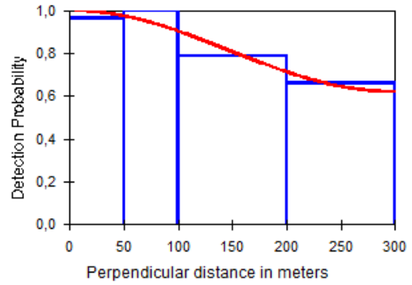




Lesser Black-backed Gull ***Larus fuscus***

C.42. Population estimates and densities were determined on 151 observations of Lesser Black-backed Gulls in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 159 individual Lesser Black-backed Gulls were recorded in 67 sightings. Most sightings of Lesser Black-backed Gulls were recorded in spring and summer.

Model selection:



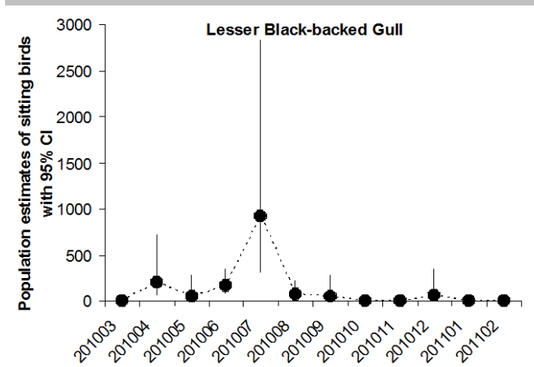
Effective strip width (± SE): 243.12 ± 23.217 CI: 201.40 <> 293.48

Model function: Uniform with 1 cosine adjustment
Covariates: n.a.

Remarks: Remarks: A uniform detection function was selected based on the lowest AIC criterium.

Table C.13 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.030	154	0.00	0	0	0
201004	0.108	558	0.04	202	58	700
201005	0.041	211	0.01	47	8	267
201006	0.108	559	0.03	169	85	338
201007	0.052	269	0.18	921	300	2823
201008	0.152	783	0.01	71	24	208
201009	0.007	38	0.01	47	8	270
201010	0.000	0	0.00	0	0	0
201011	0.000	0	0.00	0	0	0
201012	0.000	0	0.01	58	10	340
201101	0.000	0	0.00	0	0	0
201102	0.000	0	0.00	0	0	0



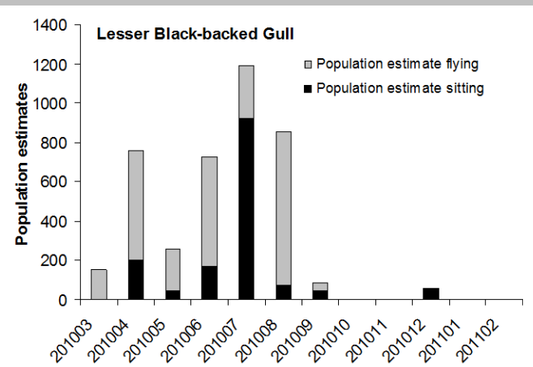
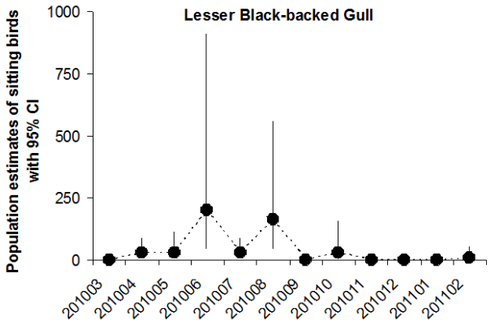
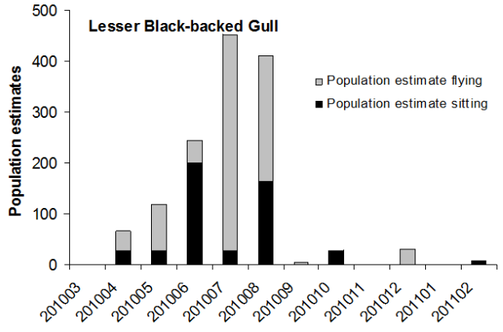


Table C.14 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.04	38	0.03	28	10	82
201005	0.10	90	0.03	28	7	109
201006	0.05	45	0.23	200	44	906
201007	0.48	424	0.03	28	9	82
201008	0.28	246	0.19	164	48	558
201009	0.00	4	0.00	0	0	0
201010	0.00	0	0.03	28	5	155
201011	0.00	0	0.00	0	0	0
201012	0.03	30	0.00	0	0	0
201101	0.00	0	0.00	0	0	0
201102	0.00	0	0.01	9	2	51

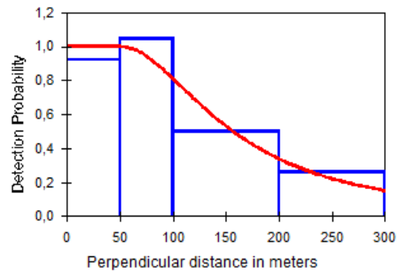




Little Gull *Larus minutus*

C.43. Population estimates and densities were determined on 337 observations of Little Gulls in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 1,299 individual Little Gulls were recorded in 333 sightings. Most sightings of Little Gulls were recorded in October and the presence of this species is largely confined to the autumn migration.

Model selection:



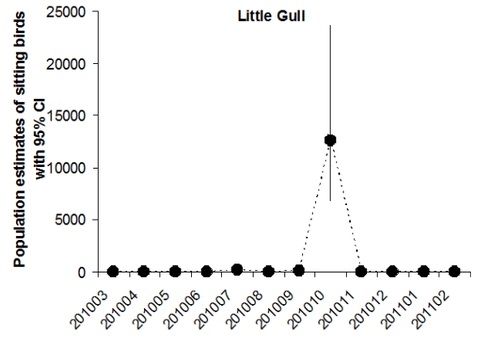
Effective strip width (± SE): 174.38 ± 6.599 CI: 161.88 <> 187.85

Model function: Hazard Rate
Covariates: Sea state (factor)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as factor as it improved the plain model. In higher sea states this small species is more difficult to detect.

Table C.15 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.000	0	0	0
201004	0.000	0	0.000	0	0	0
201005	0.000	0	0.000	0	0	0
201006	0.000	0	0.000	0	0	0
201007	0.019	96	0.033	168	42	678
201008	0.004	19	0.000	0	0	0
201009	0.000	0	0.019	98	18	552
201010	1.113	5742	2.448	12626	6778	23520
201011	0.000	0	0.000	0	0	0
201012	0.000	0	0.008	41	7	231
201101	0.000	0	0.000	0	0	0
201102	0.000	0	0.000	0	0	0



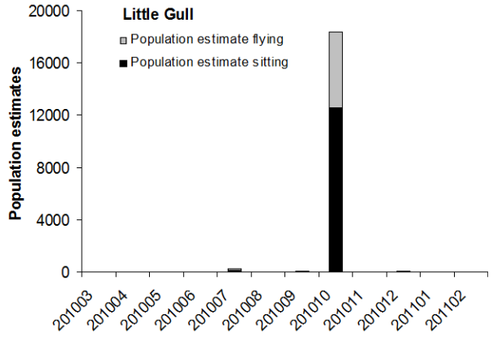
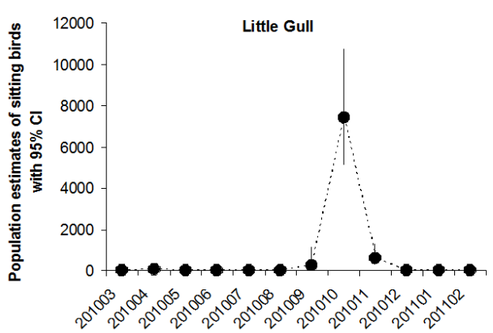
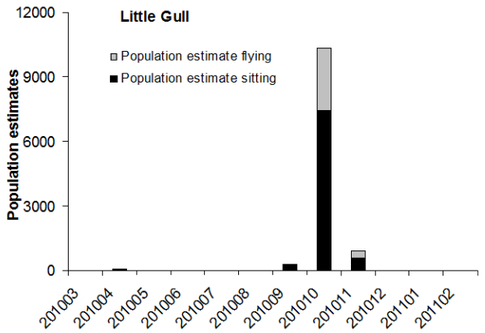


Table C.16 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.00	0	0.06	52	9	292
201005	0.00	0	0.00	0	0	0
201006	0.00	0	0.00	0	0	0
201007	0.00	0	0.00	0	0	0
201008	0.00	0	0.00	0	0	0
201009	0.06	48	0.29	257	61	1083
201010	3.33	2915	8.48	7415	5127	10724
201011	0.38	330	0.67	584	273	1250
201012	0.00	0	0.00	0	0	0
201101	0.00	0	0.00	0	0	0
201102	0.00	0	0.00	0	0	0

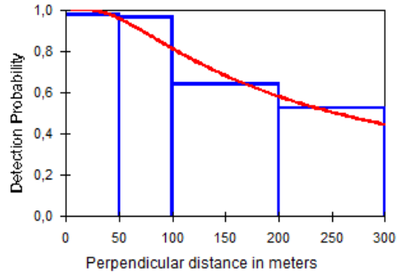




Kittiwake Rissa tridactyla

C.44. Population estimates and densities were determined on 2,418 observations of Kittiwakes in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 7,808 individual Kittiwakes were recorded in 1,399 sightings. Kittiwakes were present year-round and the highest numbers were found in summer.

Model selection:



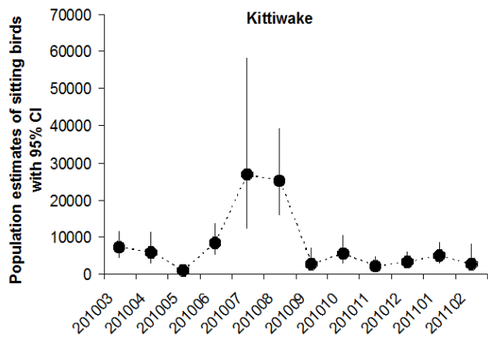
Effective strip width (± SE): 214.40 ± 2.374 CI: 209.80 <> 219.11

Model function: Hazard Rate
Covariates: Sea state (variate)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as factor covariate as it improved the plain model. In higher sea states this small species is more difficult to detect.

Table C.17 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.295	1523	1.362	7024	4344	11357
201004	0.317	1636	1.096	5651	2876	11106
201005	0.074	384	0.168	868	415	1815
201006	0.415	2139	1.627	8391	5257	13394
201007	1.205	6215	5.177	26700	12310	57912
201008	1.151	5938	4.835	24939	15991	38895
201009	0.311	1603	0.476	2453	880	6843
201010	0.642	3311	1.022	5271	2736	10155
201011	0.654	3371	0.384	1979	838	4676
201012	0.339	1748	0.610	3149	1752	5657
201101	0.202	1042	0.938	4836	2789	8385
201102	0.614	3165	0.521	2686	897	8042



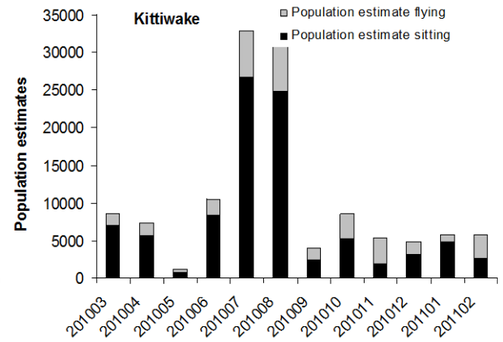
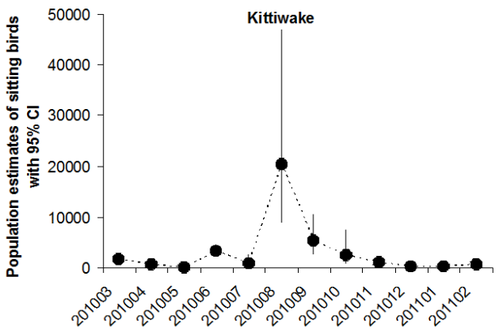
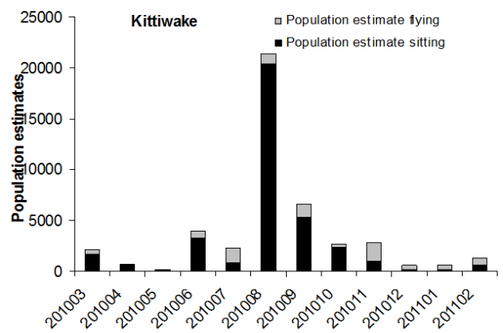


Table C.18 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.63	550	1.89	1653	1094	2499
201004	0.16	143	0.67	589	329	1054
201005	0.16	143	0.07	63	19	208
201006	0.70	612	3.75	3279	2438	4410
201007	1.56	1361	1.00	871	314	2420
201008	1.13	985	23.35	20422	8938	46662
201009	1.42	1245	6.07	5307	2703	10419
201010	0.36	315	2.71	2371	765	7342
201011	2.18	1904	1.08	944	646	1378
201012	0.50	439	0.20	179	98	325
201101	0.37	322	0.26	231	113	472
201102	0.72	627	0.71	625	348	1122

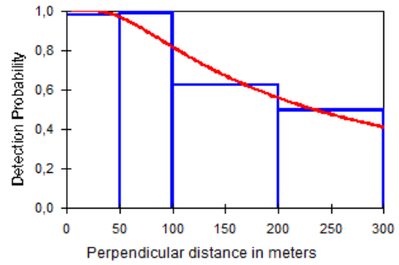




Small gull species

C.45. Population estimates and densities were determined on 2,799 observations of small gull species in the Hornsea and sub-zone 1 ship-based surveys. This group comprises all smaller gull species (Kittiwake, Black-headed, Common, Sabine's and Little Gull) as well as unidentified gulls (small gull spec.). Most sightings of identified small gulls are Kittiwakes and the highest numbers were recorded in summer and autumn.

Model selection:



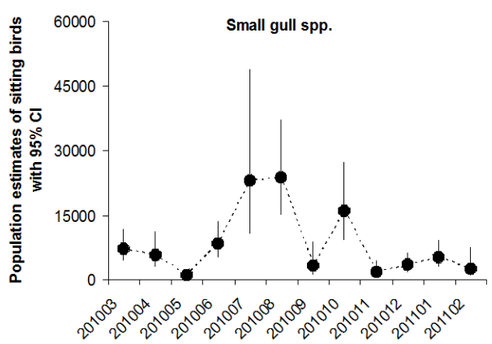
Effective strip width (± SE): 208.80 ± 9.837 CI: 190.38 <> 228.99

Model function: Half Normal with 3 cosine adjustments
Covariates:

Remarks: A Half Normal detection with 3 cosine adjustments yields the lowest AIC and best detection function with the smallest confidence intervals

Table C.19 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.318	1639	1.381	7123	4402	11525
201004	0.328	1694	1.082	5580	2816	11057
201005	0.074	384	0.167	859	408	1808
201006	0.415	2139	1.617	8340	5189	13404
201007	1.231	6350	4.449	22945	10842	48560
201008	1.177	6072	4.586	23653	15223	36751
201009	0.333	1717	0.612	3155	1158	8592
201010	1.796	9263	3.067	15818	9267	26997
201011	0.674	3478	0.337	1738	748	4041
201012	0.362	1866	0.643	3314	1814	6055
201101	0.232	1195	1.002	5169	2979	8968
201102	0.658	3391	0.490	2525	865	7372



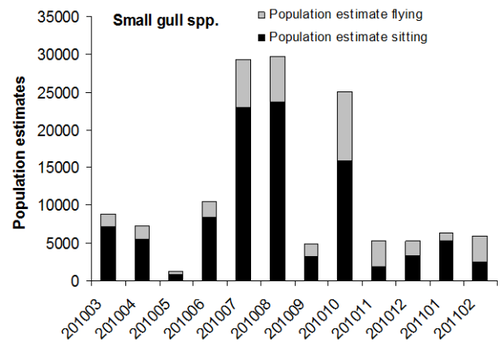
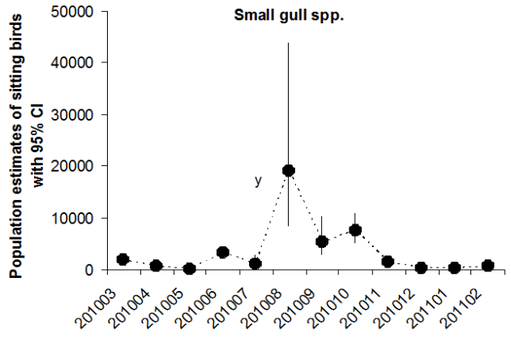
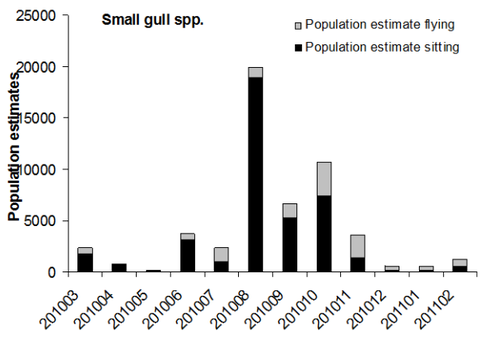


Table C.20 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.63	550	2.01	1757	1152	2679
201004	0.17	151	0.75	655	363	1181
201005	0.16	143	0.07	64	19	211
201006	0.71	619	3.60	3151	2316	4287
201007	1.56	1368	1.11	969	356	2632
201008	1.13	985	21.65	18934	8218	43625
201009	1.50	1308	6.07	5311	2806	10053
201010	3.69	3229	8.48	7417	5081	10826
201011	2.55	2233	1.62	1418	984	2043
201012	0.51	447	0.21	180	102	315
201101	0.38	330	0.26	227	108	478
201102	0.72	634	0.71	623	345	1126

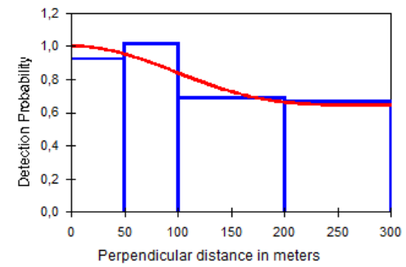




Large gull species

C.46. Population estimates and densities were determined on 710 observations of large gull species in the Hornsea and sub-zone 1 ship-based surveys. This group comprises all larger gull species (Great Black-backed, Lesser Black-backed, Herring Gull and *Larus argentatus argentatus* (Scandinavian Herring Gull) as well as unidentified gulls (Black-backed Gull spec and large gull spec.). Most large gulls were seen in winter and a small summer peak with mainly Lesser Black-backed Gulls.

Model selection:



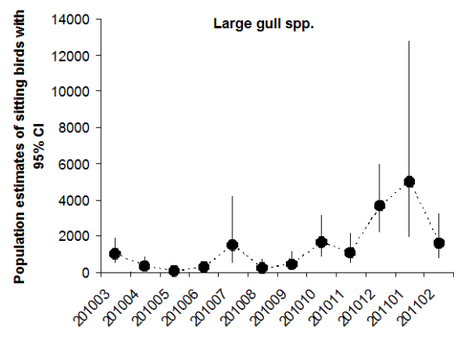
Model function: Uniform with 2 cosine adjustments
Covariates: -

Remarks: Uniform with 2 cosine adjustments yields the lowest AIC.

Effective strip width (± SE): 226.12 ± 15.220 CI: 198.16 <> 258.03

Table C.21 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.247	1273	0.194	1000	538	1859
201004	0.187	962	0.064	329	138	783
201005	0.060	307	0.010	50	9	279
201006	0.131	674	0.053	271	150	491
201007	0.086	443	0.288	1485	530	4162
201008	0.263	1356	0.043	219	69	701
201009	0.259	1336	0.078	400	141	1137
201010	0.245	1263	0.317	1635	853	3135
201011	0.208	1070	0.207	1067	543	2098
201012	0.330	1701	0.707	3648	2249	5918
201101	0.279	1440	0.971	5009	1973	12717
201102	0.153	791	0.304	1566	769	3188



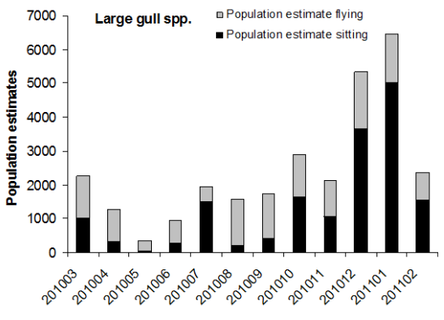
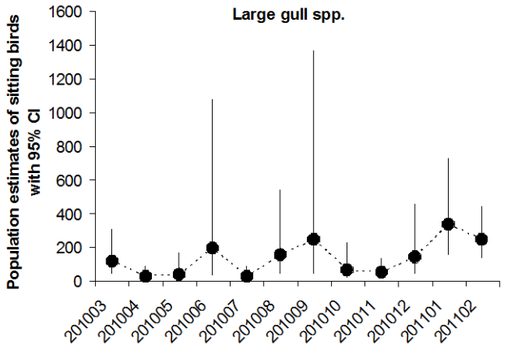
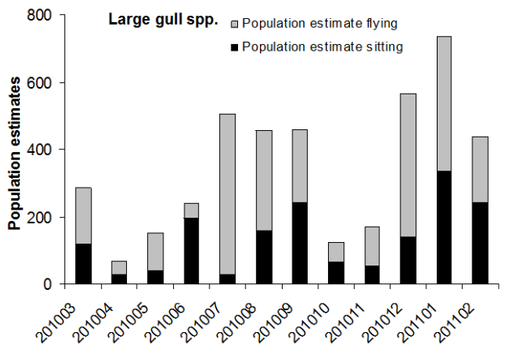


Table C.22 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.19	166	0.13	118	46	305
201004	0.04	38	0.03	29	10	85
201005	0.13	113	0.04	39	9	163
201006	0.05	45	0.22	194	35	1069
201007	0.54	476	0.03	29	10	85
201008	0.34	298	0.18	158	47	536
201009	0.25	216	0.28	243	43	1360
201010	0.07	60	0.07	64	18	224
201011	0.14	120	0.06	52	21	132
201012	0.49	424	0.16	139	43	449
201101	0.45	397	0.38	336	155	725
201102	0.22	194	0.28	243	135	439

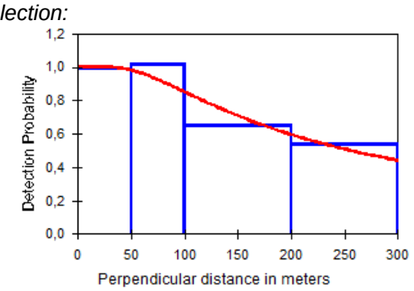




All gull species

C.47. Population estimates and densities were determined on 3,509 observations of gulls in the Hornsea and sub-zone 1 ship-based surveys. This group comprises all gull species (Kittiwake, Black-headed, Common, Sabine's, Little, Great Black-backed, Lesser Black-backed, Herring Gull and *Larus argentatus argentatus* (Scandinavian Herring Gull) as well as unidentified gulls (Black-backed Gull spec., small gull spec. and large gull spec.). Gulls were recorded throughout the year but peaked in summer.

Model selection:



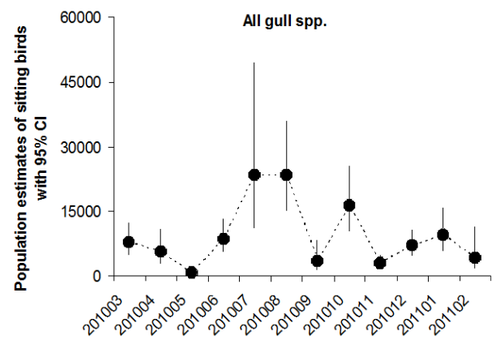
Effective strip width (± SE): 218.95 ± 1.973 CI: 215.12 <> 222.85

Model function: Hazard Rate
Covariates: Sea state (Factor)

Remarks: A Hazard Rate detection probability combined with Seastate as factor, yields the lowest AIC and best detection function with the smallest confidence intervals.

Table C.23 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.565	2912	1.491	7691	4853	12188
201004	0.515	2656	1.087	5606	2969	10584
201005	0.134	691	0.164	848	422	1706
201006	0.545	2813	1.647	8496	5536	13040
201007	1.317	6792	4.532	23377	11079	49329
201008	1.440	7427	4.498	23199	15108	35623
201009	0.592	3053	0.681	3511	1536	8026
201010	2.041	10526	3.157	16284	10472	25321
201011	0.882	4549	0.551	2843	1740	4646
201012	0.692	3567	1.355	6989	4638	10533
201101	0.511	2636	1.850	9541	5862	15527
201102	0.811	4183	0.823	4245	1623	11104



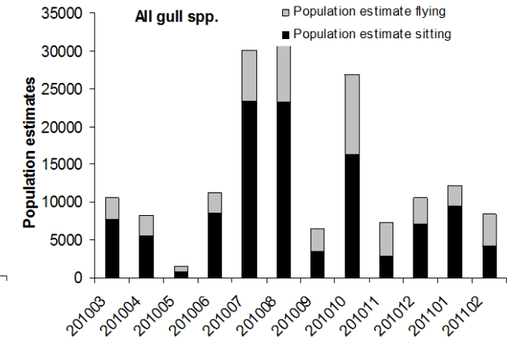
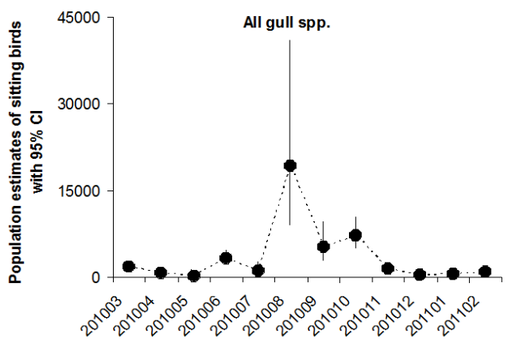
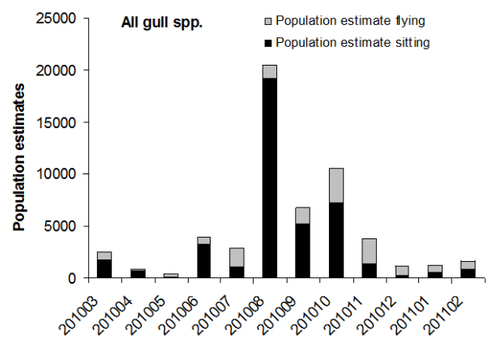


Table C.24 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.82	716	2.01	1756	1217	2535
201004	0.22	189	0.75	660	374	1166
201005	0.29	256	0.11	98	39	246
201006	0.76	664	3.79	3319	2469	4460
201007	2.11	1844	1.17	1024	426	2462
201008	1.47	1283	21.95	19198	9005	40928
201009	1.74	1524	5.93	5188	2845	9459
201010	3.76	3289	8.26	7227	5074	10294
201011	2.69	2353	1.57	1371	977	1923
201012	1.00	871	0.34	299	153	582
201101	0.83	727	0.64	560	316	994
201102	0.95	828	0.97	847	529	1355

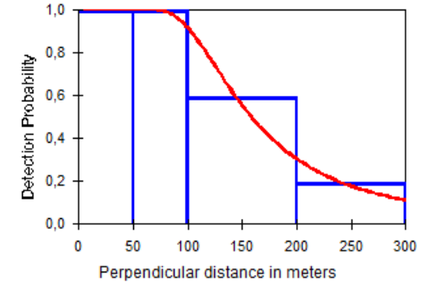




Common Tern *Sterna hirundo*

C.48. Population estimates and densities were determined on 57 observations of Common Terns in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 229 individual Common Terns were recorded in 37 sightings. Common Terns were confined to the autumn migration period (September). The majority of these terns are not resting on the water but mainly foraging birds, which hit the water during their foraging dives and are thus recorded in transect. This has implications for the determination of the detection function as shown below.

Model selection:



Model function: Hazard Rate
Covariates: -

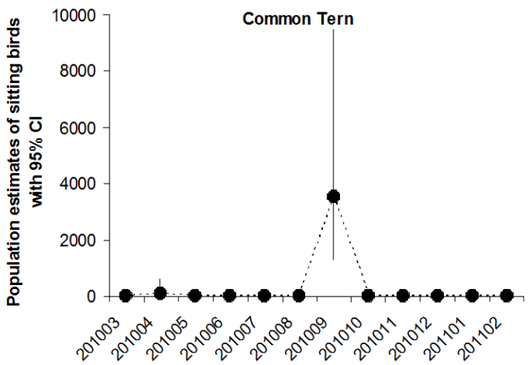
Remarks: A uniform detection function with 1 cosine adjustment yielded the lowest AIC value, but overestimated the number of birds in band A. The equal numbers in band A and B are more likely the result of inaccuracy by the observers to assign the birds to the correct category. Therefore a Hazard rate function has been selected as this shows a better detection function.

Effective strip width (± SE): 175.80 ± 24.020 CI: 133.86 <> 230.88

When including sea state the AIC decreases, but as we deal here with flying birds and the irregular patterns of detection due to relatively low number of birds, we choose not to incorporate this covariate in the model. As Common terns are missed due to limitations in identification (birds are recorded as Comic terns), the detection function is biased, with probably more birds unidentified at larger distances. Therefore the Common terns are included in the group Comic terns to determine a global 'small tern' detection function. This detection function should be used in the distance analysis for this species.

Table C.25 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.000	0	0	0
201004	0.000	0	0.019	99	17	569
201005	0.000	0	0.000	0	0	0
201006	0.019	96	0.000	0	0	0
201007	0.000	0	0.000	0	0	0
201008	0.078	401	0.000	0	0	0
201009	0.740	3816	0.682	3516	1313	9418
201010	0.004	19	0.000	0	0	0
201011	0.000	0	0.000	0	0	0
201012	0.000	0	0.000	0	0	0
201101	0.000	0	0.000	0	0	0
201102	0.000	0	0.000	0	0	0



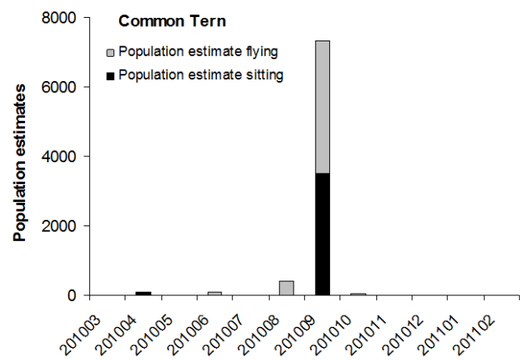
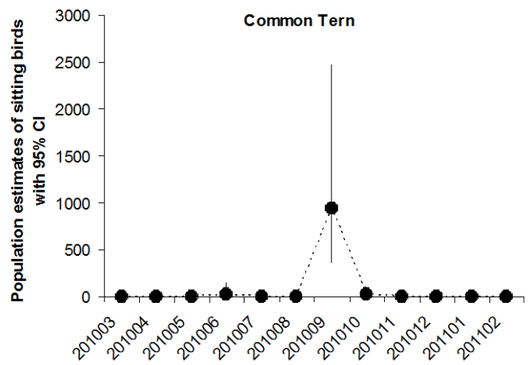
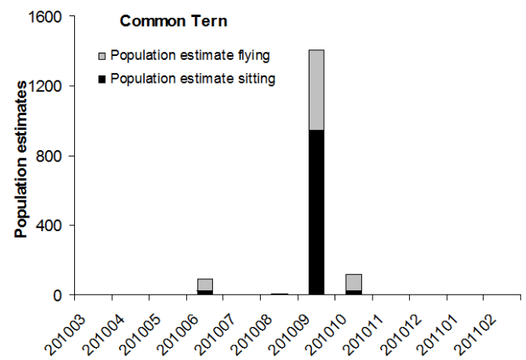


Table C.26 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.00	0	0.00	0	0	0
201005	0.00	0	0.00	0	0	0
201006	0.08	67	0.03	25	4	145
201007	0.00	0	0.00	0	0	0
201008	0.01	7	0.00	0	0	0
201009	0.52	458	1.08	945	363	2464
201010	0.10	90	0.03	26	7	94
201011	0.00	0	0.00	0	0	0
201012	0.00	0	0.00	0	0	0
201101	0.00	0	0.00	0	0	0
201102	0.00	0	0.00	0	0	0

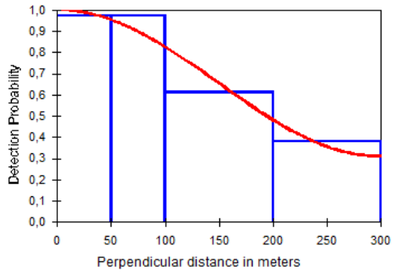




Common/Arctic tern *Sterna hirundo / S. paradisaea*

C.49. Population estimates and densities were determined on 93 observations of 'Commic tern' species in the Hornsea and sub-zone 1 ship-based surveys. This group comprises Common Terns and Arctic Terns as well as unidentified small terns of either species, hence the name 'Commic'. Commic terns were confined to late summer, early autumn with peak numbers in September. The majority of these terns are not resting on the water but mainly foraging birds, which hit the water during their foraging dives and are thus recorded in transect as if sitting on the water.

Model selection:



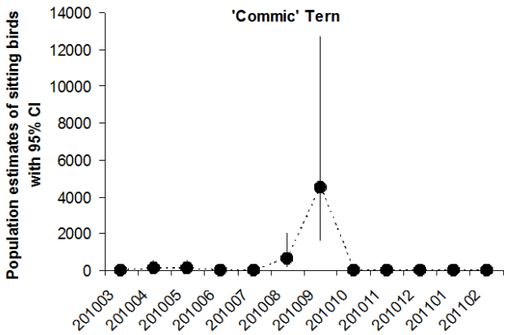
Model function: Uniform with 1 cosine adjustment
Covariates: -

Remarks: A Uniform detection function with 1 cosine adjustment yielded the lowest AIC value.

Effective strip width (± SE): 196.53 ± 17.768 CI: 164.29 <> 235.10

Table C.27 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.000	0	0	0
201004	0.000	0	0.017	88	15	507
201005	0.004	19	0.017	88	15	507
201006	0.019	96	0.000	0	0	0
201007	0.000	0	0.000	0	0	0
201008	0.200	1031	0.120	621	197	1959
201009	0.991	5114	0.871	4490	1591	12675
201010	0.004	19	0.000	0	0	0
201011	0.000	0	0.000	0	0	0
201012	0.000	0	0.000	0	0	0
201101	0.000	0	0.000	0	0	0
201102	0.000	0	0.000	0	0	0



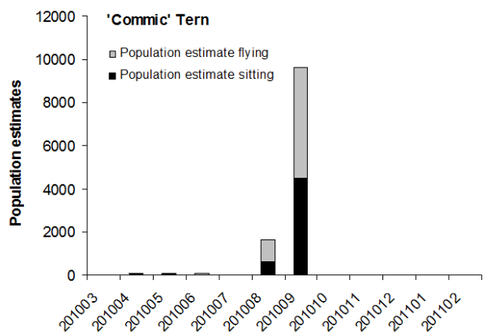
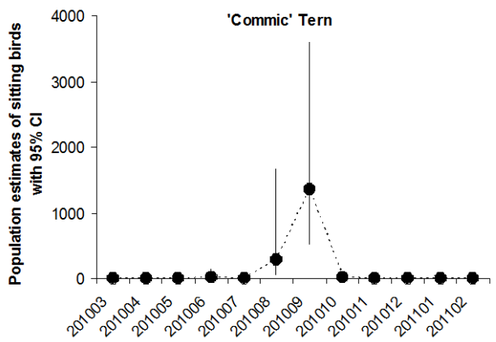
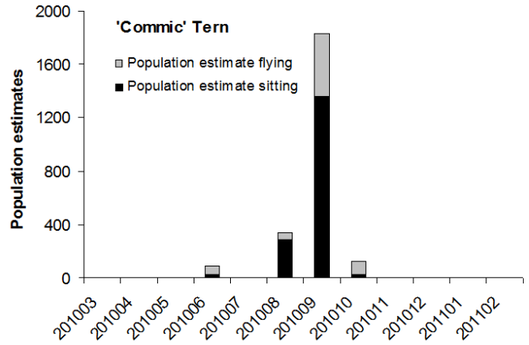


Table C.28 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.00	0	0.00	0	0	0
201005	0.00	0	0.00	0	0	0
201006	0.08	67	0.03	23	4	129
201007	0.00	0	0.00	0	0	0
201008	0.07	60	0.33	285	49	1649
201009	0.55	477	1.55	1355	512	3586
201010	0.11	97	0.03	23	6	83
201011	0.00	0	0.00	0	0	0
201012	0.00	0	0.00	0	0	0
201101	0.00	0	0.00	0	0	0
201102	0.00	0	0.00	0	0	0

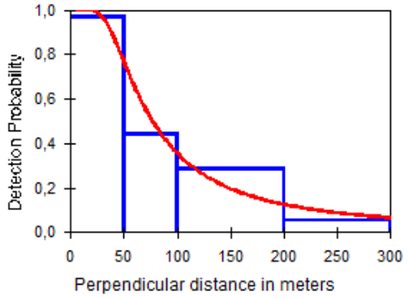




Little Auk *Alle alle*

C.50. Population estimates and densities were determined on 209 observations of Little Auk in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 283 individual Little Auk were recorded in 207 sightings. Little Auks were only seen in the end of autumn and winter (November onwards).

Model selection:



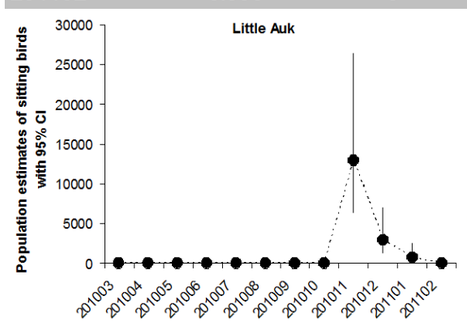
Model function: Hazard rate
Covariates: -

Remarks: A half normal function yields the lowest AIC. However, the detection function shows an unrealistic 'hump'. This is not the case with a Hazard rate model and this model was chosen based on detection function.

Effective strip width (± SE): 104.44 ± 12.254 CI: 82.94 <> 131.52

Table C.29 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.000	0	0	0
201004	0.000	0	0.000	0	0	0
201005	0.000	0	0.000	0	0	0
201006	0.000	0	0.000	0	0	0
201007	0.000	0	0.000	0	0	0
201008	0.000	0	0.000	0	0	0
201009	0.000	0	0.000	0	0	0
201010	0.000	0	0.000	0	0	0
201011	0.161	829	2.506	12923	6345	26319
201012	0.005	24	0.563	2904	1219	6921
201101	0.006	31	0.154	792	258	2437
201102	0.000	0	0.000	0	0	0



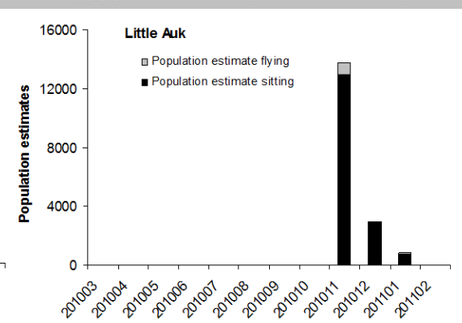
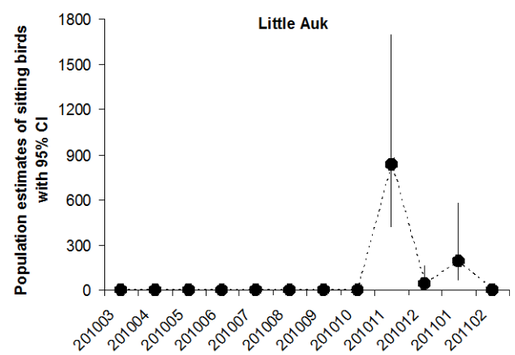
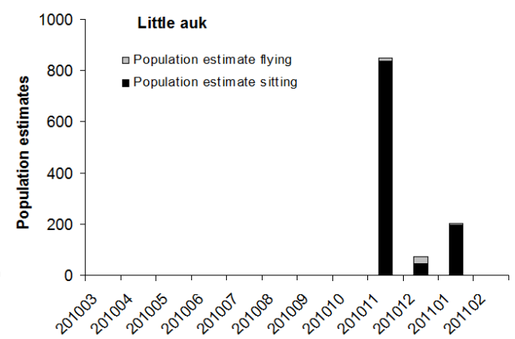


Table C.30 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.00	0	0.00	0	0	0
201004	0.00	0	0.00	0	0	0
201005	0.00	0	0.00	0	0	0
201006	0.00	0	0.00	0	0	0
201007	0.00	0	0.00	0	0	0
201008	0.00	0	0.00	0	0	0
201009	0.00	0	0.00	0	0	0
201010	0.00	0	0.00	0	0	0
201011	0.02	15	0.96	836	414	1685
201012	0.03	30	0.05	43	12	157
201101	0.01	7	0.22	194	66	573
201102	0.00	0	0.00	0	0	0

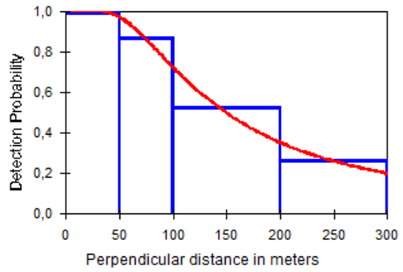




Puffin *Fratercula arctica*

C.51. Population estimates and densities were determined on 2,577 observations of Puffin in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 2,199 individual Puffin were recorded in 1,699 sightings. Puffins were seen throughout the year but the lowest numbers in summer.

Model selection:



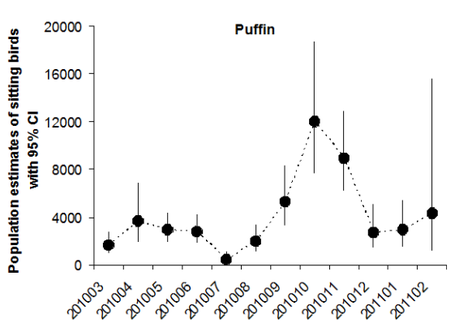
Effective strip width (± SE): 175.80 ± 2.286 CI: 171.37 <> 180.34

Model function: Half normal
Covariates: Sea state (variate)

Remarks: A Halfnormal detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as covariate as it improved the plain model. In higher sea states this small species is more difficult to detect.

Table C.31 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.000	0	0.310	1601	952	2692
201004	0.000	0	0.710	3664	1976	6792
201005	0.000	0	0.557	2875	1940	4259
201006	0.004	19	0.538	2775	1876	4104
201007	0.000	0	0.084	435	180	1053
201008	0.004	19	0.370	1911	1106	3300
201009	0.000	0	1.013	5223	3301	8265
201010	0.026	134	2.326	11995	7726	18622
201011	0.005	27	1.726	8900	6209	12757
201012	0.000	0	0.526	2712	1454	5056
201101	0.000	0	0.561	2894	1561	5363
201102	0.022	113	0.835	4306	1195	15514



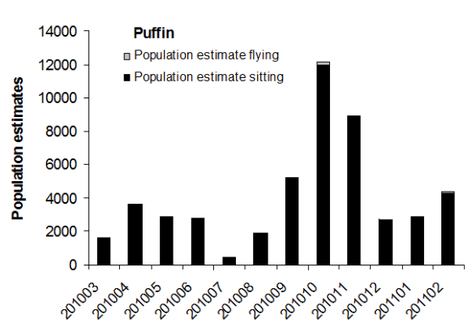
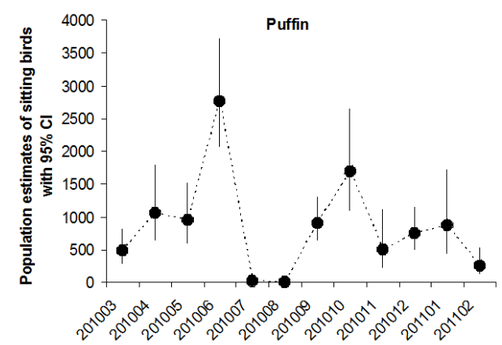
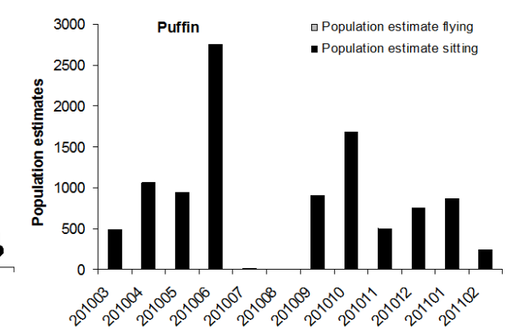


Table C.32 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.02	15	0.54	476	279	813
201004	0.00	0	1.21	1062	630	1789
201005	0.00	0	1.08	941	591	1498
201006	0.00	0	3.16	2762	2063	3698
201007	0.00	0	0.01	13	2	71
201008	0.00	0	0.00	0	0	0
201009	0.00	0	1.03	901	631	1288
201010	0.00	0	1.93	1689	1083	2632
201011	0.01	7	0.57	497	223	1106
201012	0.00	0	0.86	751	500	1130
201101	0.00	0	0.98	861	436	1698
201102	0.00	0	0.29	250	124	507

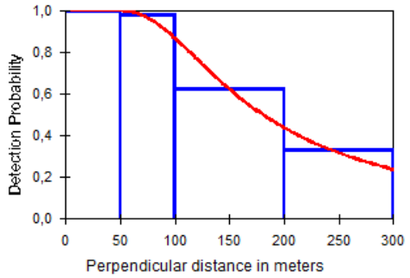




Guillemot *Uria aalge*

C.52. Population estimates and densities were determined on 24,016 observations of Guilemot in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 38,200 individual Guillemot were recorded in 15,955 sightings. Guillemots were present year-round with the highest numbers in the end of summer.

Model selection:



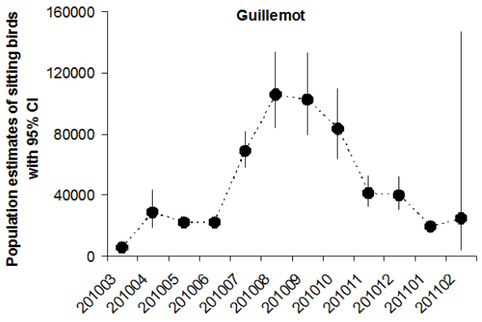
Effective strip width (± SE): 193.79 ± 0.752 CI: 192.32 <> 195.27

Model function: Hazard Rate
Covariates: Sea state (factor)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as covariate as it improved the plain model. In higher sea states this small species is more difficult to detect.

Table C.33 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.120	617	1.056	5449	3226	9202
201004	0.022	115	5.475	28241	18701	42647
201005	0.034	173	4.200	21660	18291	25650
201006	0.049	251	4.202	21676	18101	25956
201007	0.142	731	13.234	68258	57660	80803
201008	0.000	0	20.403	105240	83404	132780
201009	0.004	19	19.800	102120	78862	132250
201010	0.167	861	16.133	83212	63353	109300
201011	0.581	2997	7.918	40841	32099	51964
201012	0.316	1630	7.692	39675	30532	51556
201101	0.321	1655	3.647	18808	15261	23180
201102	0.175	904	4.703	24259	4024	146260



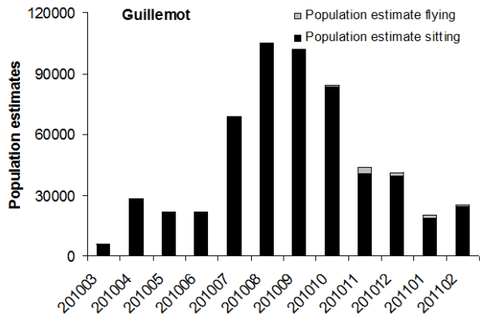
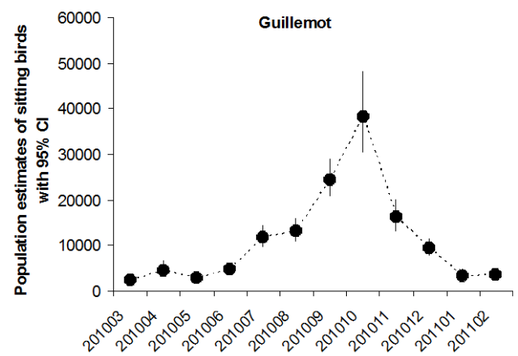
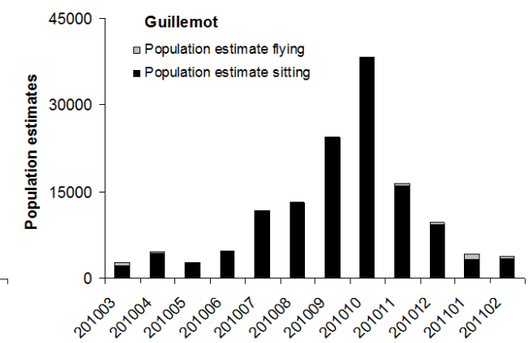


Table C.34 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.47	414	2.55	2228	1615	3073
201004	0.18	158	5.07	4436	3013	6532
201005	0.03	23	3.13	2740	2172	3457
201006	0.03	30	5.33	4666	3830	5683
201007	0.07	59	13.37	11691	9564	14291
201008	0.03	22	14.94	13067	10798	15813
201009	0.01	11	27.98	24472	20841	28737
201010	0.09	75	43.66	38183	30357	48025
201011	0.26	225	18.40	16095	13074	19814
201012	0.43	372	10.70	9359	7772	11269
201101	0.93	810	3.83	3348	2369	4733
201102	0.43	380	3.89	3402	2481	4665

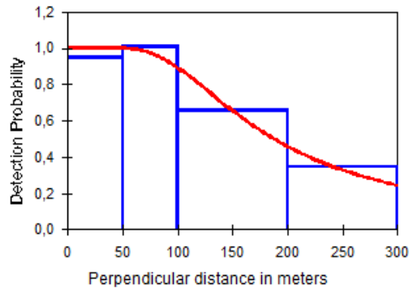




Razorbill *Alca torda*

C.53. Population estimates and densities were determined on 5,565 observations of Razorbill in the Hornsea and sub-zone 1 ship-based surveys. In the first study year at Hornsea 12,825 individual Razorbill were recorded in 4,005 sightings. Razorbills were present year-round with the highest numbers in the end of summer.

Model selection:



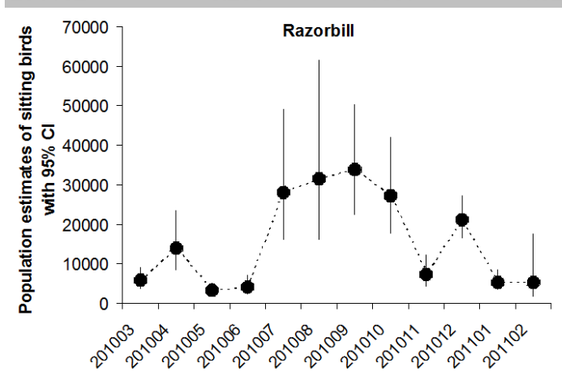
Effective strip width (± SE): 198.45 ± 1.577 CI: 195.38 <> 201.56

Model function: Hazard Rate
Covariates: Sea state (factor)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as covariate as it improved the plain model. In higher sea states this small species is more difficult to detect.

Table C.35 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.079	405	1.136	5861	3872	8873
201004	0.071	366	2.701	13934	8281	23443
201005	0.026	134	0.602	3105	1973	4887
201006	0.034	173	0.791	4081	2445	6811
201007	0.224	1154	5.424	27976	16004	48904
201008	0.000	0	6.113	31532	16232	61255
201009	0.000	0	6.515	33603	22578	50012
201010	0.219	1129	5.271	27185	17660	41848
201011	0.047	241	1.382	7130	4245	11974
201012	0.055	283	4.093	21111	16425	27136
201101	0.030	153	1.031	5317	3435	8231
201102	0.263	1357	1.021	5268	1605	17291



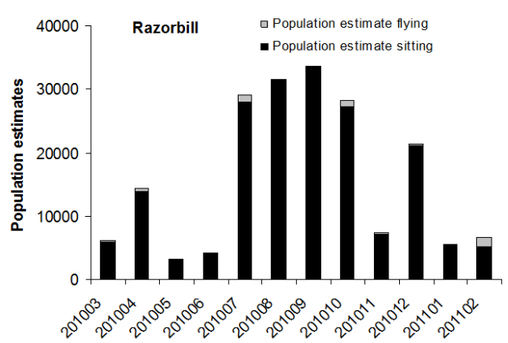
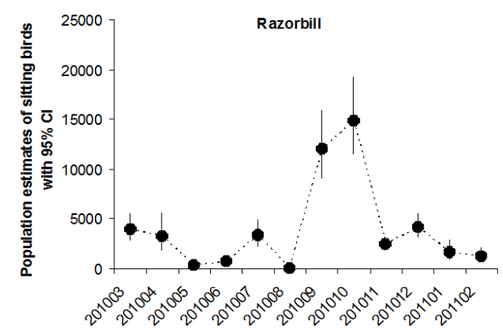
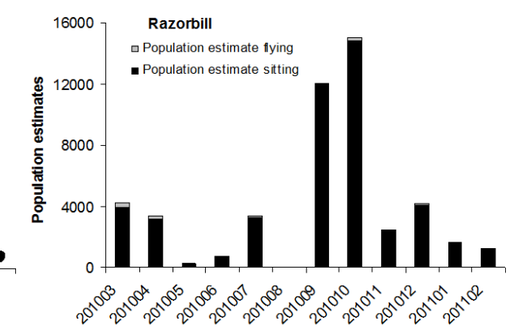


Table C.36 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.33	286	4.48	3920	2812	5465
201004	0.19	166	3.66	3197	1840	5556
201005	0.01	8	0.32	281	143	553
201006	0.03	22	0.81	712	448	1131
201007	0.13	112	3.75	3281	2207	4878
201008	0.00	0	0.00	0	0	0
201009	0.02	15	13.72	11998	9093	15830
201010	0.21	180	16.94	14816	11487	19109
201011	0.05	45	2.76	2416	1840	3173
201012	0.04	37	4.69	4103	3102	5427
201101	0.03	30	1.85	1618	934	2800
201102	0.06	52	1.38	1211	709	2066

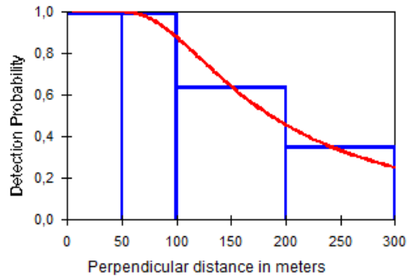




Large auk species

C.54. Population estimates and densities were determined on 30,189 observations of large auks spp. in the Hornsea and sub-zone 1 ship-based surveys. The species group 'large auks' consist of birds recorded as 'guillemot/razorbill', guillemots and razorbills. In the first study year at Hornsea 83,369 large auks were recorded in 57,854 sightings.

Model selection:



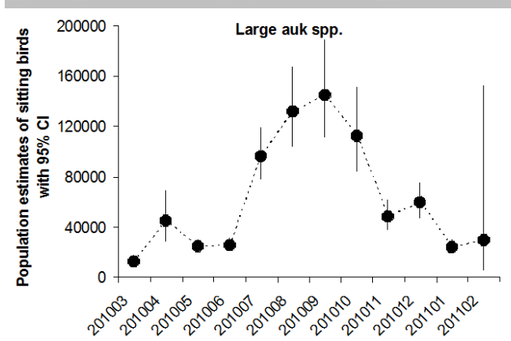
Effective strip width (± SE): 197.27 ± 0.672 CI: 195.85 <> 198.59

Model function: Hazard Rate
Covariates: Sea state (factor)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as covariate as it improved the plain model. In higher sea states these small species are more difficult to detect.

Table C.37 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.213	1099	2.310	11913	8212	17280
201004	0.093	481	8.595	44333	28792	68263
201005	0.063	326	4.728	24384	20295	29298
201006	0.086	443	4.932	25437	20849	31034
201007	0.369	1905	18.669	96291	78252	118490
201008	0.000	0	25.493	131490	103830	166520
201009	0.004	19	28.125	145070	111720	188370
201010	0.393	2029	21.759	112230	83781	150340
201011	0.674	3478	9.267	47801	37510	60915
201012	0.376	1937	11.521	59425	47190	74834
201101	0.357	1839	4.614	23797	19354	29260
201102	0.438	2261	5.665	29220	5622	151860



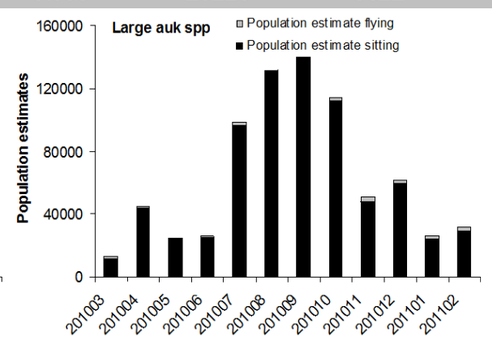
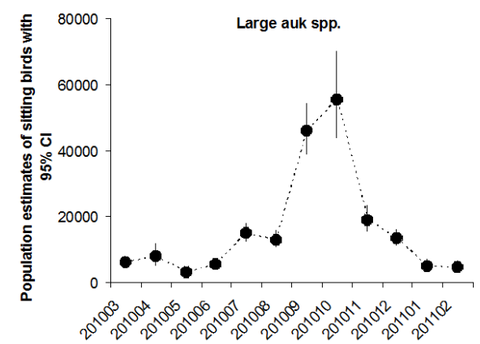
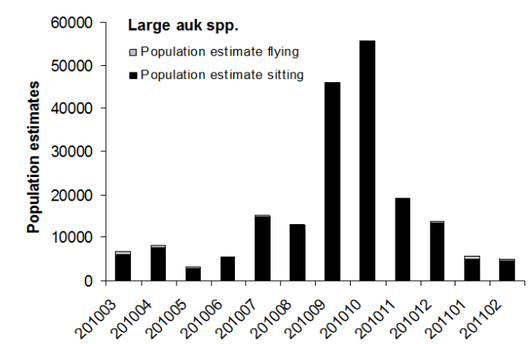


Table C.38 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.88	768	6.93	6058	4635	7917
201004	0.37	324	8.87	7760	5158	11673
201005	0.03	30	3.41	2979	2419	3668
201006	0.06	52	6.31	5520	4606	6615
201007	0.20	171	16.98	14849	12583	17523
201008	0.03	22	14.69	12847	10617	15546
201009	0.04	34	52.59	45997	39047	54184
201010	0.32	277	63.27	55343	43816	69902
201011	0.35	307	21.58	18874	15488	23001
201012	0.48	417	15.29	13377	11300	15836
201101	0.97	847	5.67	4958	3525	6973
201102	0.56	492	5.26	4604	3347	6335

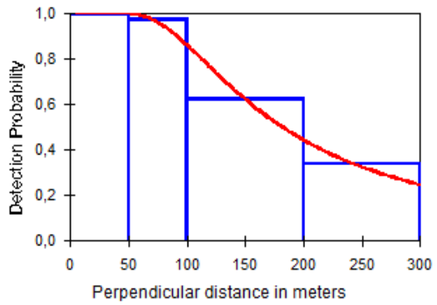




All auk species

C.55. Population estimates and densities were determined on 33,110 observations of all auks spp. in the Hornsea and sub-zone 1 ship-based surveys. The species group 'all auk species' consist of all categories of species mentioned before including a category of 'unidentified auks' (of which observers did not gave an indication that the birds either belonged to the group of small or large auks). In the first study year at Hornsea 60,486 auks were recorded in 22,470 sightings. Highest numbers of auks were present at the end of summer en in autumn.

Model selection:



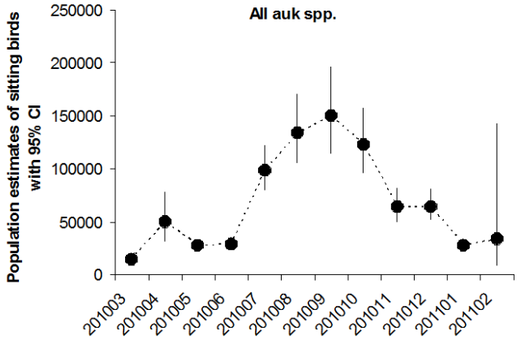
Effective strip width (± SE): 194.08 ± 0.641
CI: 192.82 <> 195.34

Model function: Hazard Rate
Covariates: Sea state (factor)

Remarks: A Hazard Rate detection probability yields the lowest AIC and best detection function with the smallest confidence intervals. Sea state is included as covariate as it improved the plain model. In higher sea states these small species are more difficult to detect.

Table C.39 Density and population estimates of sitting and flying birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.217	1119	2.739	14127	9941	20076
201004	0.093	481	9.533	49168	31463	76836
201005	0.063	326	5.328	27482	23151	32623
201006	0.090	462	5.483	28282	23244	34411
201007	0.369	1905	19.056	98289	79703	121210
201008	0.004	19	25.969	133950	105450	170150
201009	0.004	19	28.951	149330	114420	194890
201010	0.419	2163	23.781	122660	95963	156780
201011	0.840	4335	12.311	63501	49757	81040
201012	0.380	1961	12.446	64195	51781	79586
201101	0.362	1869	5.264	27153	21848	33748
201102	0.460	2374	6.533	33694	8010	141740



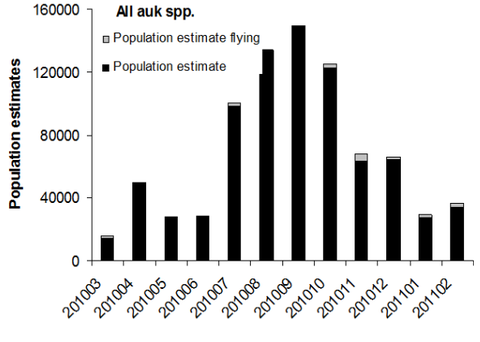
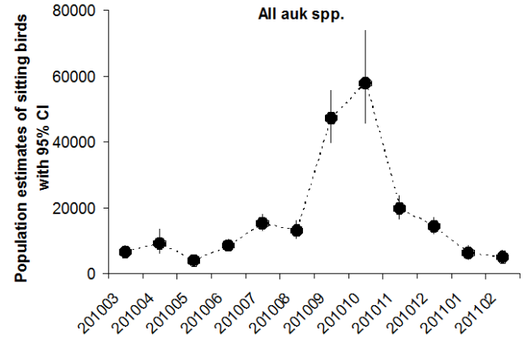
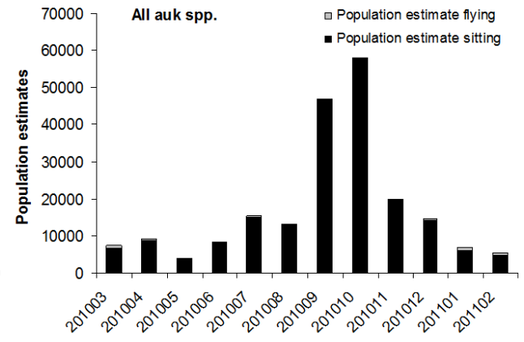


Table C.40 Density and population estimates of sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201003	0.90	784	7.45	6515	5020	8455
201004	0.37	324	10.15	8879	6000	13140
201005	0.03	30	4.46	3905	3161	4823
201006	0.06	52	9.43	8245	7046	9649
201007	0.20	171	17.31	15142	12842	17852
201008	0.03	22	14.90	13035	10772	15773
201009	0.04	34	53.77	47027	39825	55531
201010	0.32	277	66.09	57807	45419	73574
201011	0.38	330	22.56	19731	16573	23491
201012	0.51	447	16.22	14187	12002	16770
201101	0.98	855	6.84	5980	4242	8430
201102	0.56	492	5.61	4904	3583	6713





Population estimates and densities at Hornsea - Year 2

Introduction

C.56. In the species accounts below we present the population estimates and densities at Hornsea on a monthly basis for Year 2 of the study period March 2011 – August 2011. Figures presented are for birds sitting on the water and are based on calculations with the Distance Analysis software (CREEM). Detection functions were determined for species or species-groups with at least 60 different sightings (Buckland *et al.* 1993). Data from Year 1 of study were also incorporated to strengthen the detection functions. In the species accounts in the section before on

the population estimates and densities at Hornsea - Year 1 the rationale is given for the Distance model chosen and detection functions are presented.

C.57. Estimates of population sizes of birds sitting on the water are accompanied by confidence intervals based on the Distance Analysis. The average density of flying birds as determined by the snapshot method is also presented along with a population estimate based on this density and the total surface cover of the study area. The two population estimates together provide the estimated total population for the area.

C.58. Due to bad weather the survey effort of the Hornsea area in the second part of Year 2 was low (table C.41). Sub-zone 1 was well covered during the whole study period (table C.42). In Year 2 data for sub-zone 2 (see figure C.3) are also available. Like sub-zone 1 this area was also surveyed with a 2 km transect grid. In this chapter for the period with bad coverage of the Hornsea study area (September 2011 – February 2012) for the sub-zones 1 & 2 together (see figure C.5, and table C.43 for the effort) population estimates are presented as minimum figures for the Hornsea area.

Table C.41 Survey effort of the Hornsea area with a 6 km transect grid (n = 20) in Year 2, March 2011 - February 2012.

Survey (yyyymm)	effort (n transects covered)	% of total transects covered
201103	20	100
201104	20	100
201105	20	100
201106	20	100
201107	20	100
201108	20	100
201109	0	0
201110	0	0
201111	5	25
201112	0	0
201201	0	0
201202	0	0

Table C.42 Survey effort of the sub-zone 1 sub-zone area with the 2 km transect grid (n = 22) in Year 2, March 2011 - February 2012.

Survey (yyyymm)	effort (n transects covered)	% of total transects covered
201103	22	100
201104	22	100
201105	22	100
201106	22	100
201107	22	100
201108	22	100
201109	22	100
201110	22	100
201111	22	100
201112	5	23
201201	22	100
201202	22	100

Table C.43 Survey effort of the Hornsea sub-zone 1 & 2 with a 2 km transect grid (n = 44) in Year 2, March 2011 - February 2012 (see C.5 for the area studied).

Survey (yyyymm)	effort (n transects covered)	% of total transects covered
201109	29	66
201110	44	100
201111	44	100
201112	5	11
201201	35	80
201202	44	100

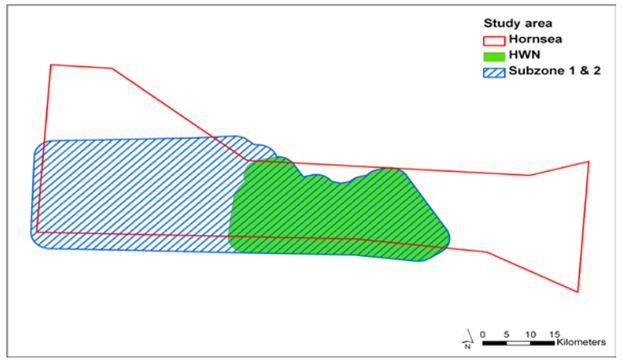
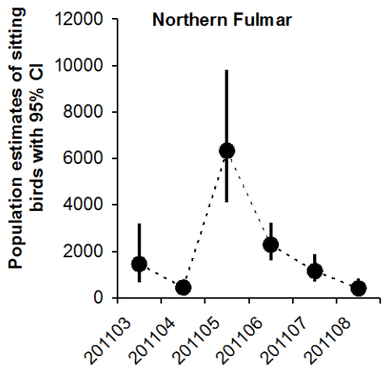


Figure C.5 Overview of the study areas covered in Year 2, respectively Hornsea, sub-zone 1 and sub-zone 1 & 2.

Northern Fulmar *Fulmarus glacialis*

Table C.44 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.189	976	0.282	1452	661	3192
201104	0.026	134	0.086	445	268	736
201105	0.404	2084	1.229	6338	4092	9818
201106	0.324	1669	0.442	2280	1611	3227
201107	0.197	1016	0.224	1154	700	1901
201108	0.078	403	0.078	401	194	831



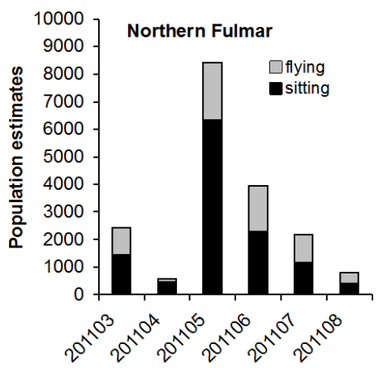
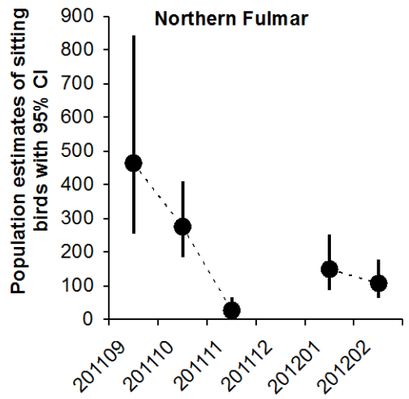


Table C.45 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.069	13	0.339	464	255	844
201110	0.096	29	0.201	275	184	410
201111	0.128	0	0.020	27	11	65
201112						
201201	0.120	29	0.109	149	88	251
201202	0.062	19	0.078	107	64	179



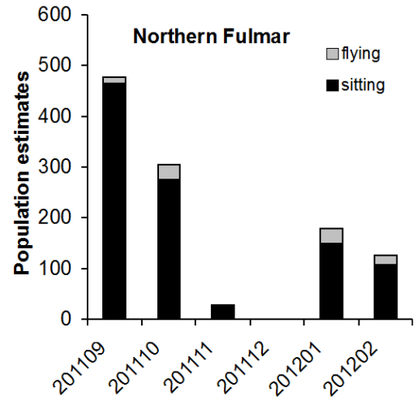
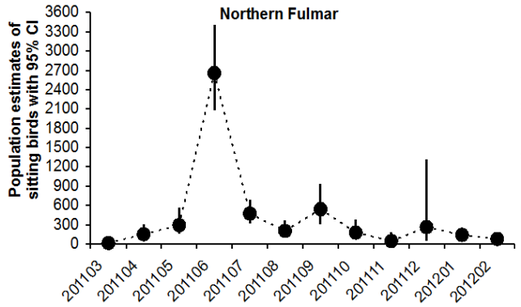
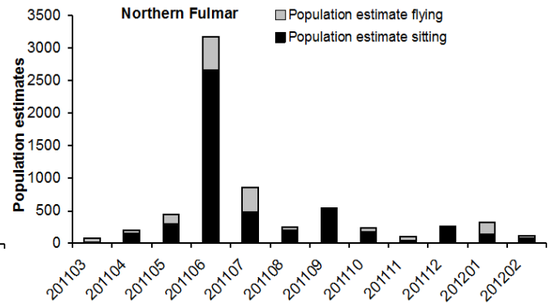


Table C.46 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.07	64	0.02	15	4	55
201104	0.05	44	0.18	154	76	313
201105	0.17	147	0.34	297	156	565
201106	0.58	511	3.04	2660	2077	3407
201107	0.43	380	0.54	476	326	696
201108	0.05	44	0.23	204	113	370
201109	0.00	0	0.62	541	313	937
201110	0.07	59	0.21	181	87	378
201111	0.07	59	0.05	45	11	184
201112	0.00	0	0.30	261	52	1311
201201	0.21	184	0.16	143	79	259
201202	0.05	43	0.09	77	38	158

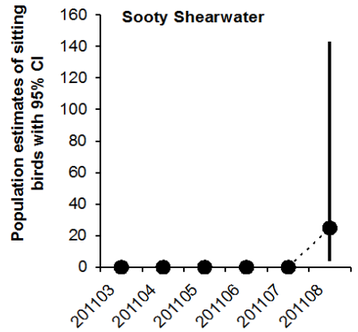




Sooty Shearwater *Puffinus griseus*

Table C.47 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.000	0	0.000	0	0	0
201104	0.000	0	0.000	0	0	0
201105	0.000	0	0.000	0	0	0
201106	0.000	0	0.000	0	0	0
201107	0.000	0	0.000	0	0	0
201108	0.000	0	0.005	25	4	143



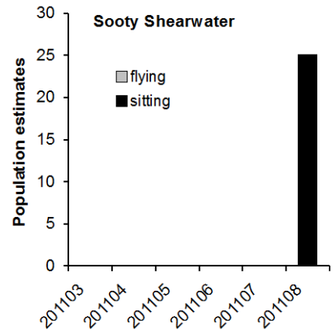


Table C.48 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

No observations were made of this species during the Hornsea sub-zones 1&2 surveys in the period September 2011 – February 2012.

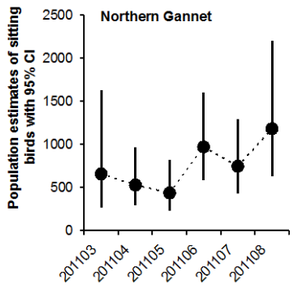
Table C.49 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

No observations of this species during the surveys of this area in Year 2.

Northern Gannet *Morus bassanus*

Table C.50 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.326	1683	0.128	659	267	1627
201104	0.022	115	0.103	530	291	965
201105	0.078	402	0.085	440	235	825
201106	0.123	633	0.188	972	589	1603
201107	0.234	1207	0.145	748	431	1298
201108	0.100	518	0.229	1183	634	2207



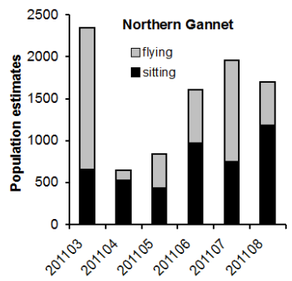
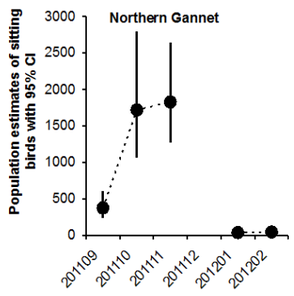


Table C.51 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.169	32	38.870	378	235	607
201110	0.632	192	47.430	1721	1060	2795
201111	0.563	172	51.500	1830	1267	2643
201112						
201201	0.112	27	34.570	37	13	109
201202	0.068	21	48.130	46	19	112



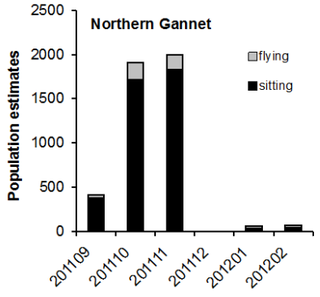
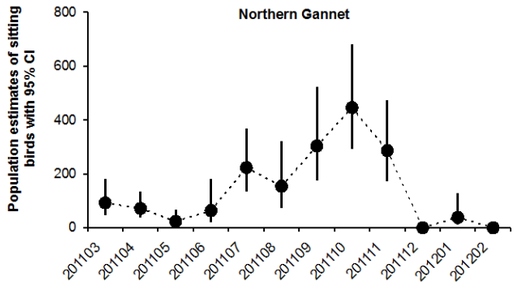
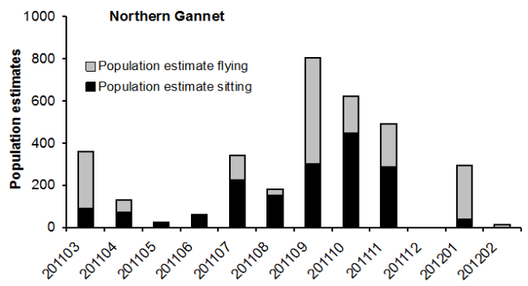


Table C.52 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.31	268	0.10	92	46	182
201104	0.07	59	0.08	72	39	135
201105	0.00	0	0.03	24	8	69
201106	0.00	0	0.07	64	22	182
201107	0.13	117	0.26	224	136	370
201108	0.03	29	0.18	154	74	322
201109	0.57	501	0.35	304	177	523
201110	0.20	178	0.51	446	292	681
201111	0.23	205	0.33	287	173	475
201112	0.00	0	0.00	0	0	0
201201	0.29	254	0.04	39	11	130
201202	0.02	14	0.00	0	0	0

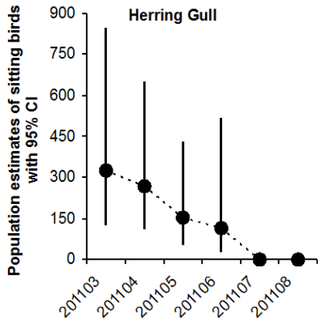




Herring Gull *Larus argentatus*

Table C.53 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.045	230	0.063	325	125	846
201104	0.022	115	0.052	268	110	650
201105	0.026	134	0.030	153	54	430
201106	0.015	77	0.022	115	26	519
201107	0.000	0	0.000	0	0	0
201108	0.000	0	0.000	0	0	0



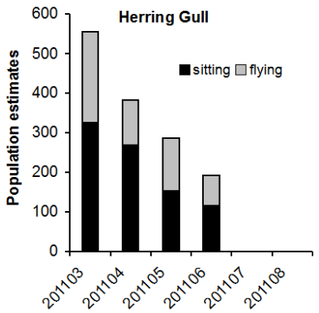
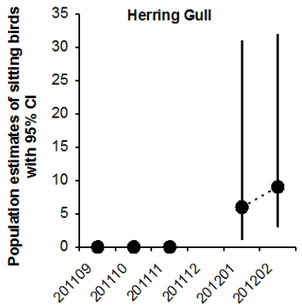


Table C.54 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.000	0	0.000	0	0	0
201110	0.007	2	0.000	0	0	0
201111	0.023	7	0.000	0	0	0
201112						
201201	0.004	1	0.004	6	1	31
201202	0.026	8	0.007	9	3	32



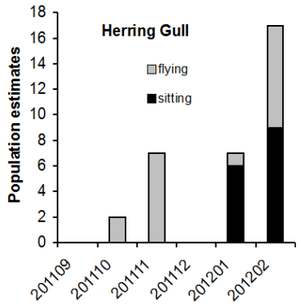
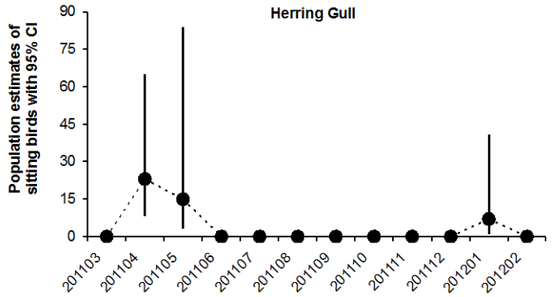
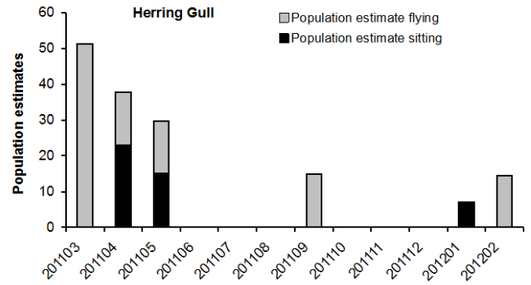


Table C.55 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.06	51	0.00	0	0	0
201104	0.02	15	0.03	23	8	65
201105	0.02	15	0.02	15	3	84
201106	0.00	0	0.00	0	0	0
201107	0.00	0	0.00	0	0	0
201108	0.00	0	0.00	0	0	0
201109	0.02	15	0.00	0	0	0
201110	0.00	0	0.00	0	0	0
201111	0.00	0	0.00	0	0	0
201112	0.00	0	0.00	0	0	0
201201	0.00	0	0.01	7	1	41
201202	0.02	14	0.00	0	0	0

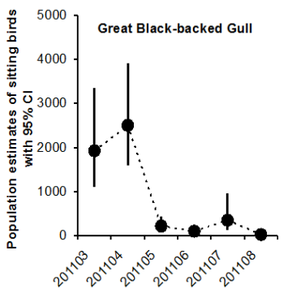




Great Black-backed Gull *Larus marinus*

Table C.56 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.163	842	0.373	1922	1103	3350
201104	0.067	344	0.485	2501	1601	3905
201105	0.059	306	0.042	215	107	430
201106	0.030	153	0.019	96	40	228
201107	0.037	192	0.066	343	123	958
201108	0.019	96	0.005	24	4	138



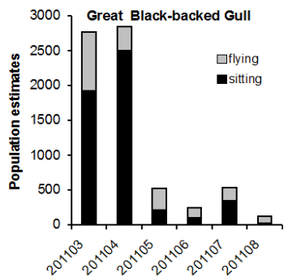
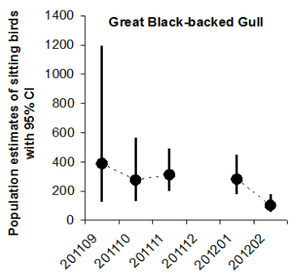


Table C.57 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.249	47	0.285	390	127	1198
201110	0.132	40	0.202	277	135	567
201111	0.236	72	0.229	314	200	491
201112						
201201	0.112	27	0.206	283	177	451
201202	0.124	38	0.075	103	58	180



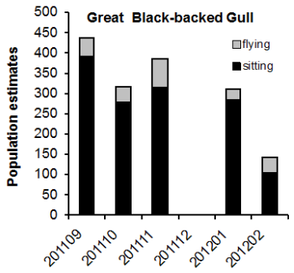
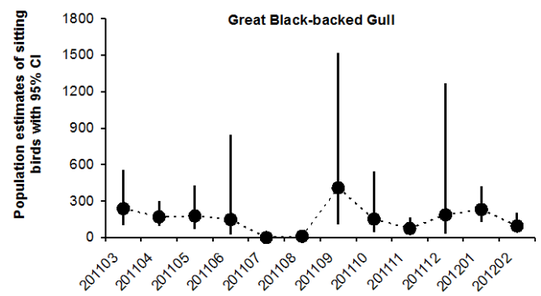
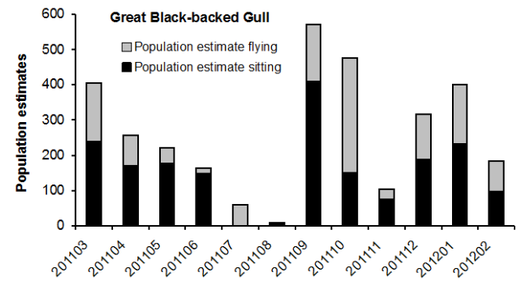


Table C.58 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.19	166	0.27	238	102	556
201104	0.10	89	0.19	169	95	301
201105	0.05	44	0.20	177	73	429
201106	0.02	15	0.17	149	26	848
201107	0.07	58	0.00	0	0	0
201108	0.00	0	0.01	9	2	52
201109	0.19	162	0.47	409	110	1519
201110	0.37	326	0.17	151	42	548
201111	0.03	29	0.09	75	34	165
201112	0.15	128	0.21	187	28	1267
201201	0.19	169	0.26	231	126	422
201202	0.10	87	0.11	96	46	202

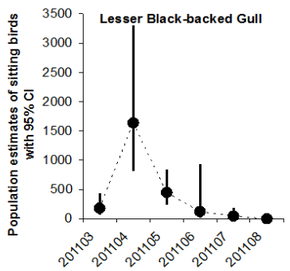




Lesser Black-backed Gull *Larus fuscus*

Table C.59 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.015	77	0.04	181	74	439
201104	0.100	516	0.32	1640	815	3297
201105	0.174	899	0.09	453	243	846
201106	0.060	307	0.02	124	17	929
201107	0.026	134	0.01	50	13	188
201108	0.015	77	0.000	0	0	0



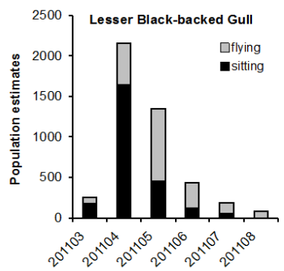
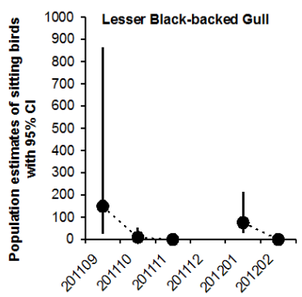


Table C.60 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.032	6	0.11	150	26	865
201110	0.003	1	0.01	9	20	52
201111	0.000	0	0.00	0	0	0
201112						
201201	0.017	4	0.06	76	27	213
201202	0.003	1	0.000	0	0	0



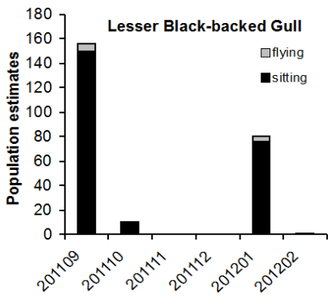
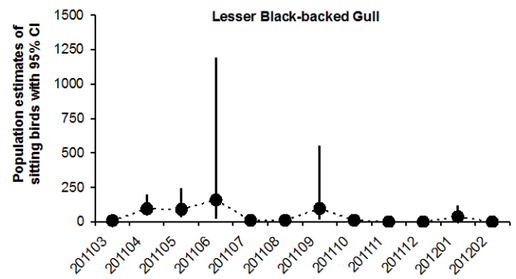
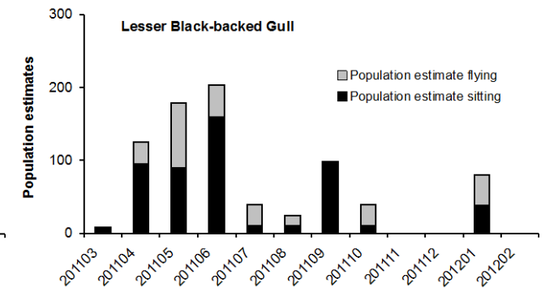


Table C.61 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.01	8	2	45
201104	0.03	30	0.11	95	46	198
201105	0.10	88	0.10	90	33	243
201106	0.05	44	0.18	159	21	1194
201107	0.03	29	0.01	10	2	56
201108	0.02	15	0.01	10	2	54
201109	0.00	0	0.11	98	17	554
201110	0.03	30	0.01	10	2	55
201111	0.00	0	0.00	0	0	0
201112	0.00	0	0.00	0	0	0
201201	0.05	42	0.04	38	12	122
201202	0.00	0	0.00	0	0	0

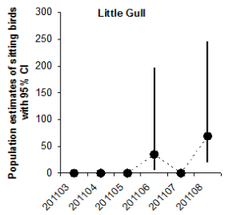




Little Gull *Larus minutus*

Table C.62 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.000	0	0.000	0	0	0
201104	0.000	0	0.000	0	0	0
201105	0.000	0	0.000	0	0	0
201106	0.000	0	0.007	35	6	198
201107	0.004	19	0.000	0	0	0
201108	0.000	0	0.013	69	20	246



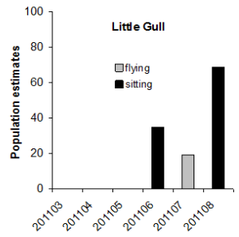
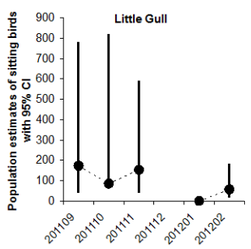


Table C.63 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.005	1	0.126	173	38	781
201110	0.036	11	0.062	85	90	823
201111	0.056	17	0.112	153	40	592
201112						
201201	0.000	0	0.000	0	0	0
201202	0.003	1	0.041	57	17	184



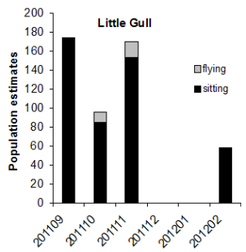
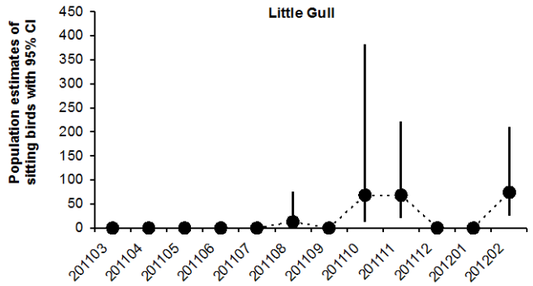
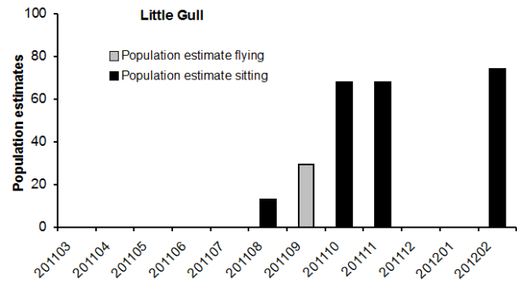


Table C.64 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.00	0	0	0
201104	0.00	0	0.00	0	0	0
201105	0.00	0	0.00	0	0	0
201106	0.00	0	0.00	0	0	0
201107	0.00	0	0.00	0	0	0
201108	0.00	0	0.02	13	2	76
201109	0.03	29	0.00	0	0	0
201110	0.00	0	0.08	68	12	382
201111	0.00	0	0.08	68	21	221
201112	0.00	0	0.00	0	0	0
201201	0.00	0	0.00	0	0	0
201202	0.00	0	0.08	74	26	211

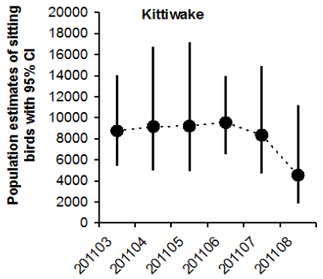




Kittiwake *Rissa tridactyla*

Table C.65 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.567	2927	1.694	8736	5438	14034
201104	0.263	1358	1.782	9189	5042	16749
201105	0.408	2103	1.785	9207	4922	17221
201106	1.001	5161	1.850	9541	6503	13999
201107	1.033	5328	1.618	8344	4676	14888
201108	0.141	729	0.883	4554	1858	11162



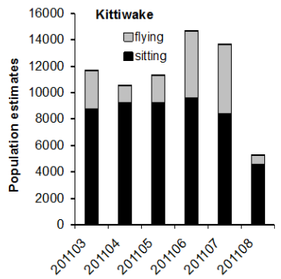
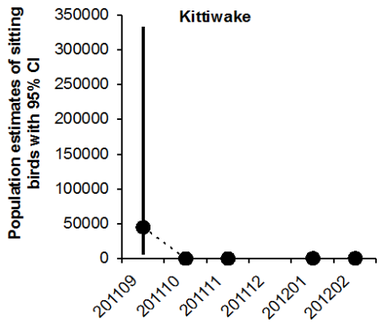


Table C.66 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.895	169	32.898	45038	6094	332830
201110	0.313	95	0.111	152	59	392
201111	0.354	108	0.054	74	25	216
201112						
201201	0.190	46	0.205	281	107	733
201202	0.231	71	0.330	451	279	730



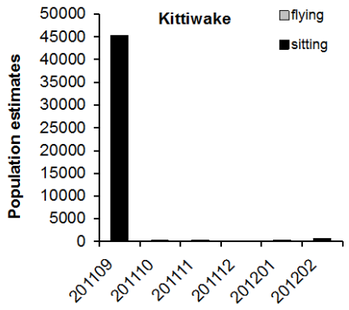
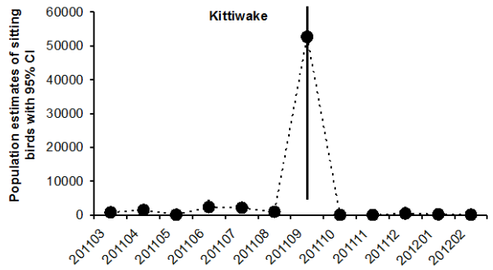
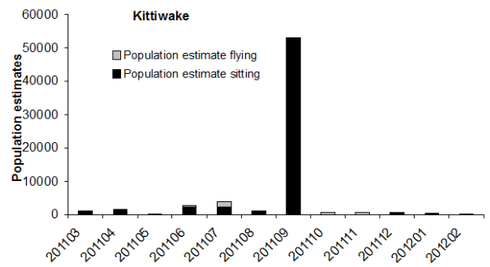


Table C.67 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.39	345	0.93	814	465	1425
201104	0.20	177	1.72	1504	1043	2168
201105	0.02	15	0.24	212	118	384
201106	0.45	394	2.72	2383	1216	4668
201107	1.86	1623	2.56	2239	1349	3717
201108	0.30	262	1.14	999	360	2773
201109	0.27	236	60.26	52710	4522	614410
201110	0.69	607	0.07	62	26	149
201111	0.50	440	0.13	112	16	774
201112	0.15	128	0.56	492	99	2446
201201	0.26	226	0.31	274	99	754
201202	0.21	188	0.20	174	78	388





Small gull species

Table C.68 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.616	3176	1.878	9685	6070	15454
201104	0.315	1625	1.874	9663	5363	17412
201105	0.415	2142	1.734	8941	4775	16742
201106	1.004	5180	1.899	9795	6651	14426
201107	1.078	5558	1.771	9133	5122	16284
201108	0.145	748	0.770	3973	1717	9191

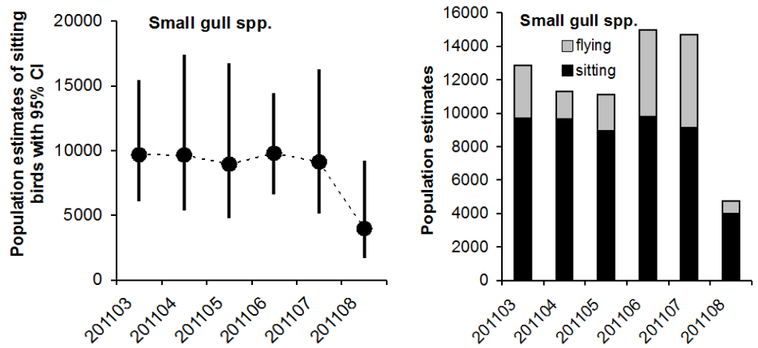
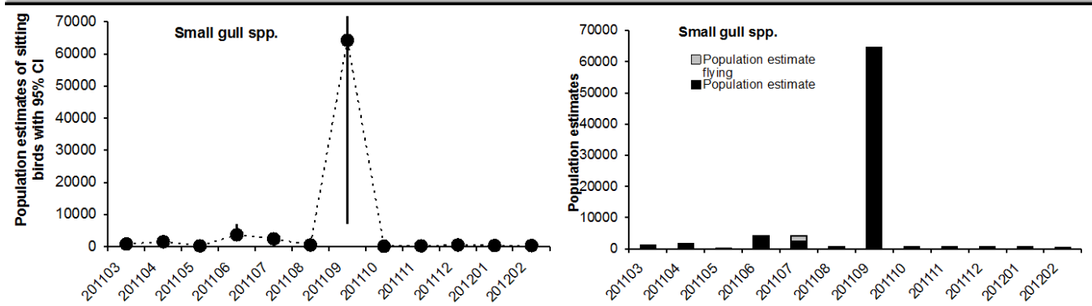


Figure C.6 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

No reliable population estimates could be calculated with Distance Analysis for this species group in the Hornsea sub-zones 1&2 in the period September 2011 – February 2012.

Table C.69 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

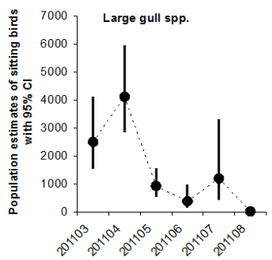
Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.44	383	0.94	825	472	1444
201104	0.25	222	1.65	1446	999	2093
201105	0.02	15	0.26	229	131	400
201106	0.45	394	4.21	3683	1918	7074
201107	1.86	1623	2.75	2406	1448	3997
201108	0.32	276	0.54	469	209	1053
201109	0.30	265	73.41	64209	7098	580800
201110	0.76	666	0.10	89	37	215
201111	0.57	498	0.19	164	58	464
201112	0.15	128	0.60	527	106	2624
201201	0.29	254	0.33	285	104	784
201202	0.28	246	0.31	275	152	501



Large gull species

Table C.70 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.234	1205	0.486	2507	1527	4114
201104	0.189	975	0.798	4118	2850	5950
201105	0.260	1339	0.180	927	551	1560
201106	0.104	537	0.074	380	148	975
201107	0.063	326	0.232	1198	432	3318
201108	0.033	173	0.005	23	4	134



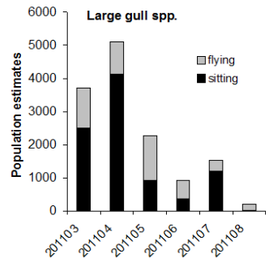
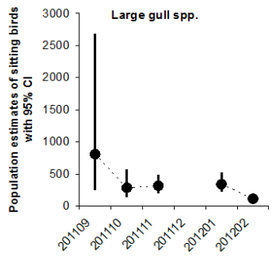


Table C.71 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.281	53	0.589	806	242	2683
201110	0.142	43	0.207	283	140	573
201111	0.259	79	0.230	315	201	492
201112						
201201	0.132	32	0.249	341	220	528
201202	0.153	47	0.083	114	67	194



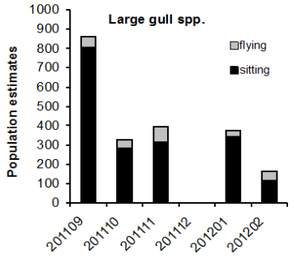
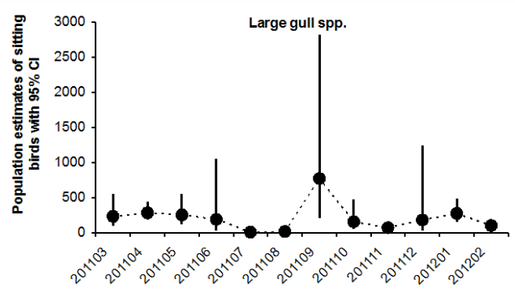
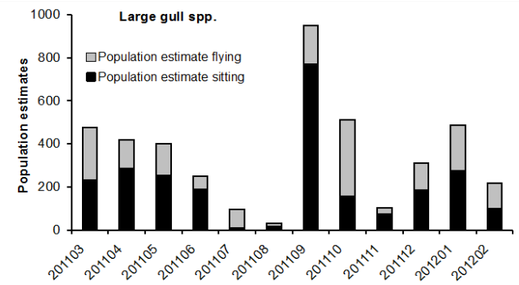


Table C.72 ensity and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.28	243	0.27	232	97	556
201104	0.15	133	0.32	284	183	440
201105	0.17	147	0.29	253	115	555
201106	0.07	58	0.22	191	35	1052
201107	0.10	88	0.01	9	2	52
201108	0.02	15	0.02	18	5	65
201109	0.20	177	0.88	771	211	2820
201110	0.41	355	0.18	155	50	476
201111	0.03	29	0.08	73	33	161
201112	0.15	128	0.21	183	27	1241
201201	0.24	212	0.31	275	156	484
201202	0.13	116	0.12	101	51	199

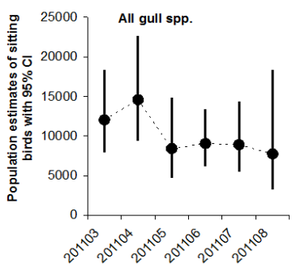




All gull species

Table C.73 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.849	4381	2.341	12074	7946	18346
201104	0.504	2601	2.830	14599	9421	22624
201105	0.675	3480	1.632	8418	4763	14877
201106	1.108	5717	1.760	9077	6165	13364
201107	1.141	5884	1.733	8937	5547	14397
201108	0.178	920	1.503	7752	3276	18339



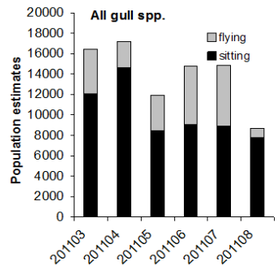
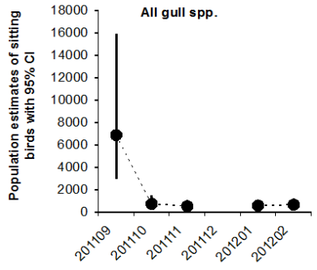


Table C.74 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	1.181	223	50.280	6883	2974	15932
201110	0.491	149	0.544	745	364	1524
201111	0.668	204	0.384	526	343	806
201112						
201201	0.322	78	0.423	578	352	950
201202	0.387	119	0.493	675	485	939



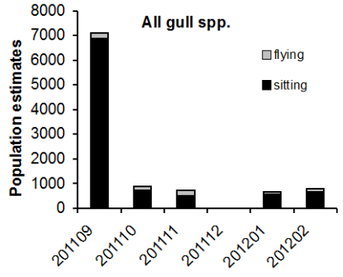
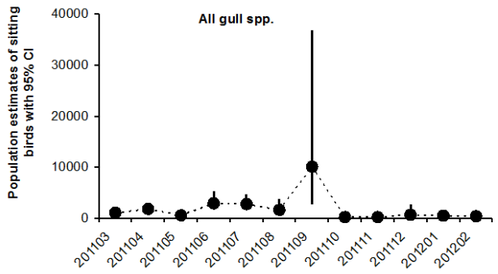
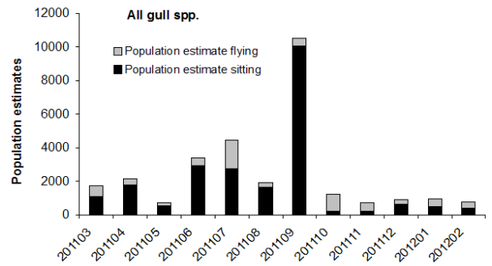


Table C.75 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.72	626	1.25	1095	695	1724
201104	0.41	355	2.04	1788	1256	2545
201105	0.19	162	0.63	549	308	980
201106	0.52	453	3.36	2939	1621	5327
201107	1.96	1711	3.16	2760	1655	4602
201108	0.33	291	1.89	1649	732	3714
201109	0.51	442	11.51	10063	2750	36822
201110	1.17	1021	0.27	234	122	447
201111	0.60	528	0.23	202	91	447
201112	0.29	256	0.75	657	156	2764
201201	0.53	466	0.57	503	268	942
201202	0.41	361	0.47	412	271	626





Common Tern *Sterna hirundo*

Table C.76 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.000	0	0.000	0	0	0
201104	0.000	0	0.000	0	0	0
201105	0.000	0	0.006	29	5	171
201106	0.000	0	0.006	29	5	165
201107	0.019	96	0.000	0	0	0
201108	0.394	2032	0.582	3003	787	11460

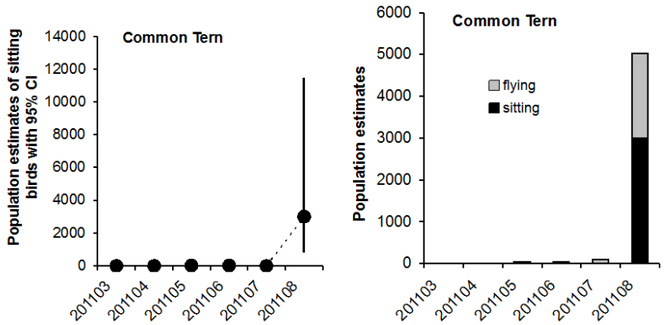
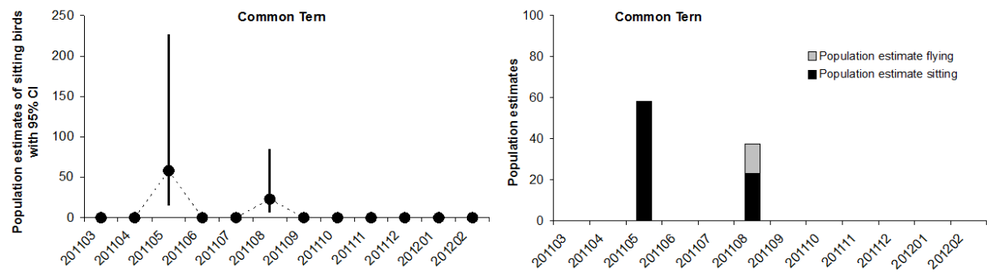


Figure C.7 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

No reliable population estimates could be calculated with Distance Analysis for this species in the Hornsea sub-zones 1&2 in the period September 2011 – February 2012.

Table C.77 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.00	0	0	0
201104	0.00	0	0.00	0	0	0
201105	0.00	0	0.07	58	15	227
201106	0.00	0	0.00	0	0	0
201107	0.00	0	0.00	0	0	0
201108	0.02	15	0.03	23	6	85
201109	0.00	0	0.00	0	0	0
201110	0.00	0	0.00	0	0	0
201111	0.00	0	0.00	0	0	0
201112	0.00	0	0.00	0	0	0
201201	0.00	0	0.00	0	0	0
201202	0.00	0	0.00	0	0	0



Common/Arctic tern *Sterna hirundo / S. paradisaea*

Table C.78 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.000	0	0.000	0	0	0
201104	0.000	0	0.043	221	1	35287
201105	0.000	0	0.005	27	5	155
201106	0.000	0	0.005	27	5	150
201107	0.045	230	0.010	53	9	306
201108	0.751	3873	2.289	11808	4419	31557

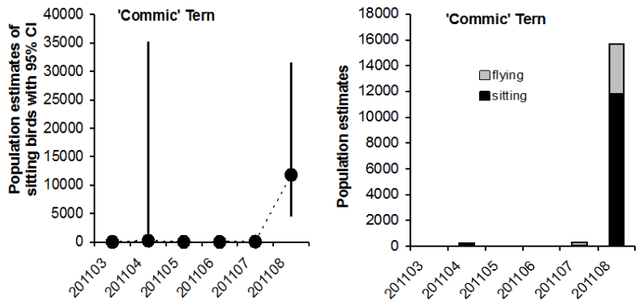
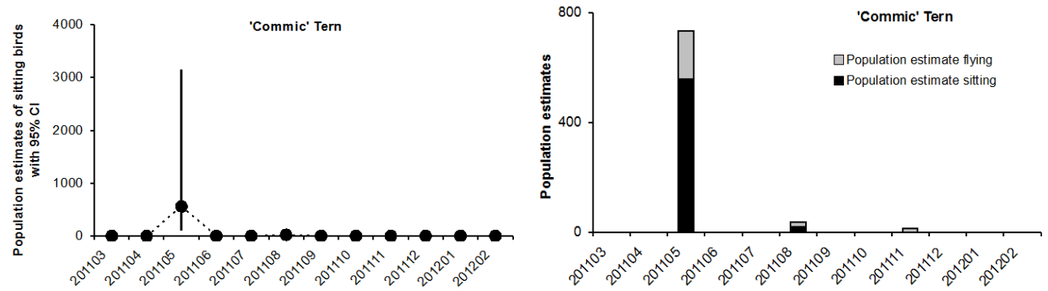


Figure C.8 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

No reliable population estimates could be calculated with Distance Analysis for this species group in the Hornsea sub-zones 1&2 in the period September 2011 – February 2012.

Table C.79 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.00	0	0	0
201104	0.00	0	0.00	0	0	0
201105	0.20	177	0.64	557	98	3154
201106	0.00	0	0.00	0	0	0
201107	0.00	0	0.00	0	0	0
201108	0.02	15	0.02	21	6	77
201109	0.00	0	0.00	0	0	0
201110	0.00	0	0.00	0	0	0
201111	0.02	15	0.00	0	0	0
201112	0.00	0	0.00	0	0	0
201201	0.00	0	0.00	0	0	0
201202	0.00	0	0.00	0	0	0



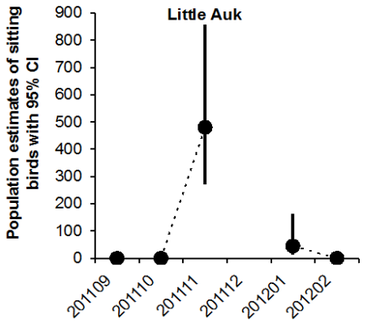
Little Auk *Alle alle*

Table C.80 Density and population estimates of flying and sitting birds in Hornsea area:

In Year 2 no observations of this species were made along the 6 km transect grid.

Table C.81 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.000	0	0.000	0	0	0
201110	0.000	0	0.000	0	0	0
201111	0.016	5	0.351	480	270	856
201112						
201201	0.000	0	0.033	45	13	163
201202	0.000	0	0.000	0	0	0



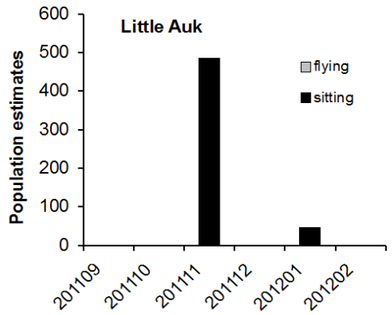
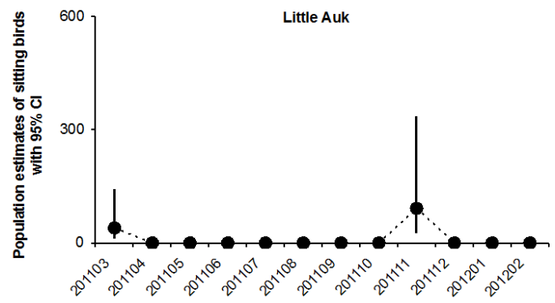
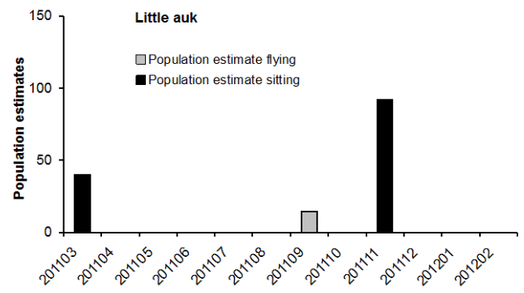


Table C.82 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.05	40	11	142
201104	0.00	0	0.00	0	0	0
201105	0.00	0	0.00	0	0	0
201106	0.00	0	0.00	0	0	0
201107	0.00	0	0.00	0	0	0
201108	0.00	0	0.00	0	0	0
201109	0.02	15	0.00	0	0	0
201110	0.00	0	0.00	0	0	0
201111	0.00	0	0.11	92	25	335
201112	0.00	0	0.00	0	0	0
201201	0.00	0	0.00	0	0	0
201202	0.00	0	0.00	0	0	0

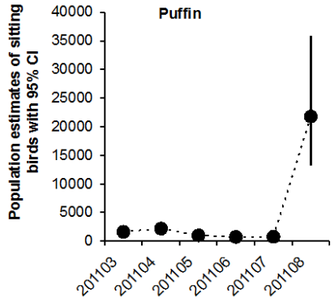




Puffin *Fratercula arctica*

Table C.83 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.004	19	0.317	1634	1220	2188
201104	0.000	0	0.428	2209	1528	3193
201105	0.004	19	0.202	1043	559	1946
201106	0.000	0	0.144	742	335	1644
201107	0.000	0	0.155	800	407	1572
201108	0.000	0	4.221	21771	13190	35937



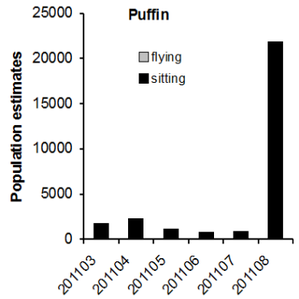
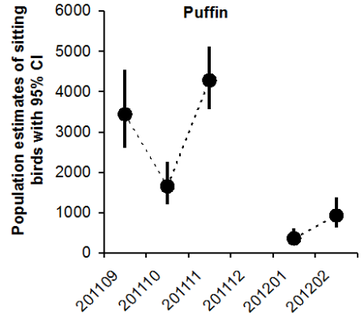


Table C.84 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.005	1	25.168	3445	2617	4537
201110	0.000	0	12.087	1655	1208	2266
201111	0.010	3	31.292	4284	3579	5127
201112						
201201	0.000	0	0.267	365	215	618
201202	0.007	2	0.681	932	630	1381



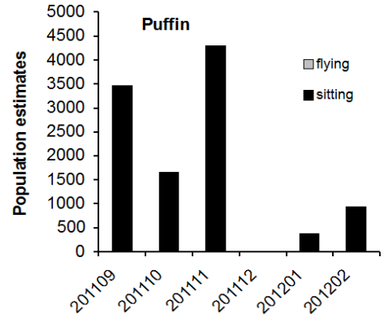
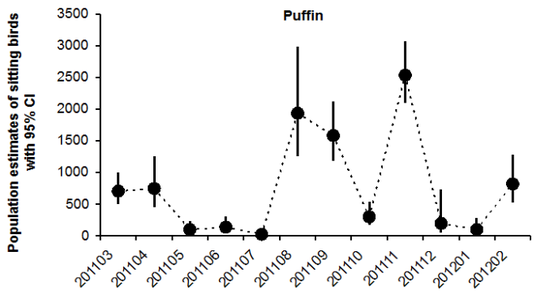
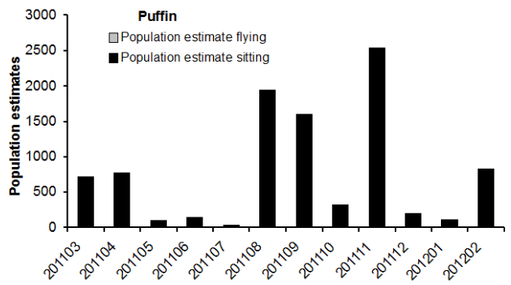


Table C.85 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	0.80	704	496	998
201104	0.02	15	0.86	750	447	1257
201105	0.00	0	0.11	100	43	233
201106	0.00	0	0.16	136	59	310
201107	0.00	0	0.03	26	7	96
201108	0.00	0	2.21	1932	1251	2983
201109	0.02	15	1.81	1581	1182	2115
201110	0.02	15	0.34	301	169	538
201111	0.00	0	2.90	2533	2092	3066
201112	0.00	0	0.22	195	53	728
201201	0.00	0	0.12	101	36	281
201202	0.00	0	0.94	820	522	1288

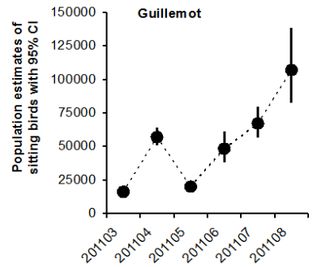




Guillemot *Uria aalge*

Table C.86 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.215	1110	3.132	16152	12603	20699
201104	0.007	38	11.050	56993	50827	63907
201105	0.037	191	3.896	20094	16416	24595
201106	0.071	365	9.362	48287	38162	61100
201107	0.100	517	13.000	67050	56445	79648
201108	0.000	0	20.699	106760	82568	138050



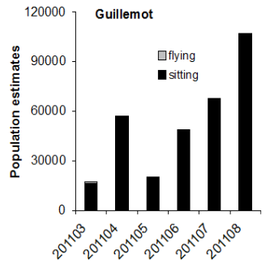
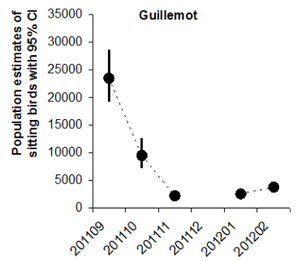


Table C.87 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.064	12	17.126	23446	19188	28648
201110	0.086	26	69.573	9525	7205	12591
201111	0.210	64	16.170	2214	1776	2759
201112						
201201	0.132	32	18.732	2564	1959	3356
201202	0.283	87	27.651	3785	3247	4413



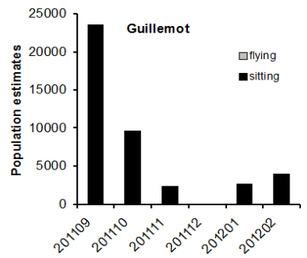
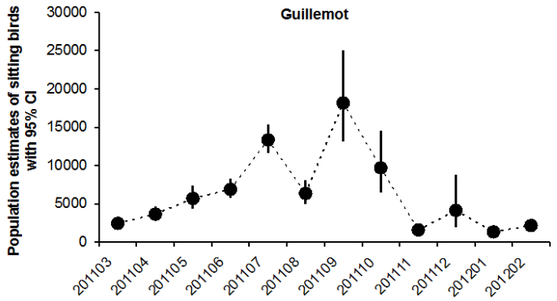
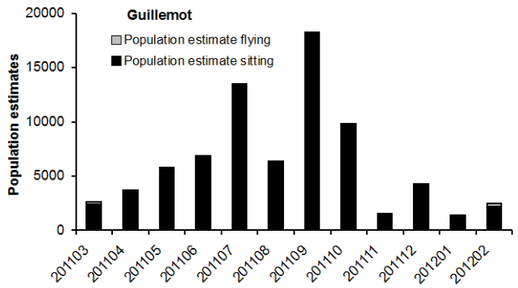


Table C.88 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.23	205	2.76	2417	1788	3268
201104	0.03	30	4.14	3618	2813	4653
201105	0.08	74	6.49	5681	4361	7400
201106	0.02	15	7.87	6880	5747	8237
201107	0.17	146	15.26	13348	11620	15333
201108	0.00	0	7.25	6337	4998	8036
201109	0.10	88	20.77	18163	13146	25096
201110	0.12	104	11.06	9672	6436	14534
201111	0.02	15	1.78	1553	1083	2225
201112	0.15	128	4.73	4136	1946	8788
201201	0.11	99	1.51	1325	988	1776
201202	0.31	274	2.46	2153	1701	2726

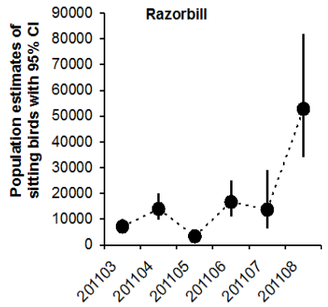




Razorbill ***Alca torda***

Table C.89 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.215	1110	1.374	7086	4971	10101
201104	0.011	57	2.707	13964	9799	19897
201105	0.030	153	0.649	3348	2080	5389
201106	0.060	307	3.228	16648	11021	25147
201107	0.007	38	2.659	13713	6457	29124
201108	0.000	0	10.230	52765	34044	81783



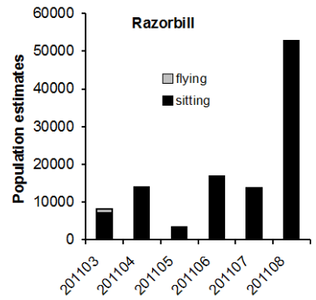
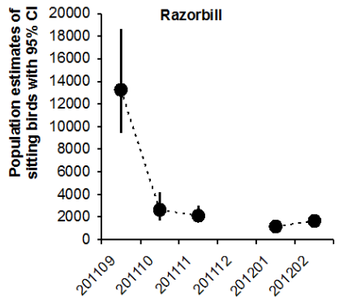


Table C.90 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.085	16	96.898	13265	9441	18640
201110	0.072	22	19.298	2642	1677	4161
201111	0.079	24	15.506	2123	1503	2998
201112						
201201	0.161	39	0.850	1164	852	1589
201202	0.033	10	11.971	1639	1199	2241



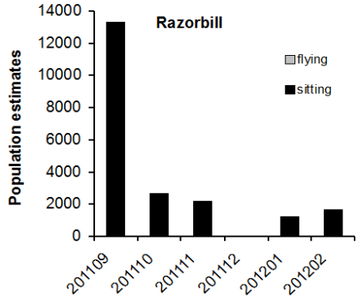
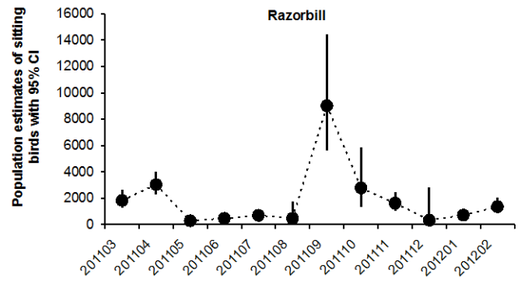
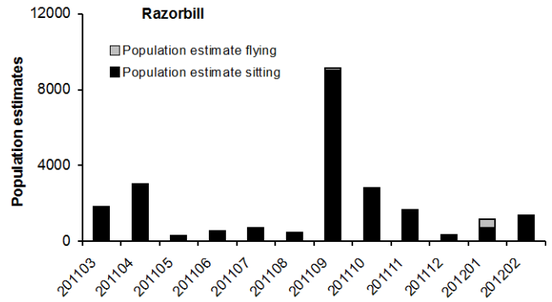


Table C.91 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.00	0	2.11	1841	1268	2674
201104	0.00	0	3.47	3038	2284	4040
201105	0.00	0	0.33	285	157	520
201106	0.07	58	0.53	467	301	723
201107	0.03	29	0.80	696	425	1142
201108	0.00	0	0.55	477	129	1768
201109	0.13	118	10.31	9021	5637	14439
201110	0.03	30	3.18	2782	1315	5885
201111	0.05	44	1.86	1628	1070	2476
201112	0.00	0	0.40	346	42	2843
201201	0.53	466	0.83	723	489	1068
201202	0.02	14	1.57	1369	923	2031

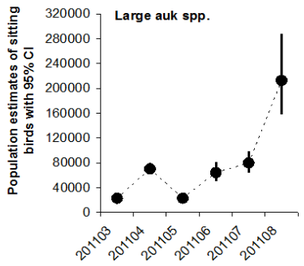




Large auk species

Table C.92 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.460	2372	4.500	23209	18650	28883
201104	0.019	96	13.696	70643	61820	80726
201105	0.067	344	4.476	23085	18898	28200
201106	0.130	671	12.528	64618	51075	81753
201107	0.108	556	15.477	79829	64355	99023
201108	0.000	0	41.353	213290	157890	288130



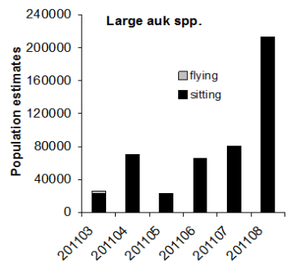
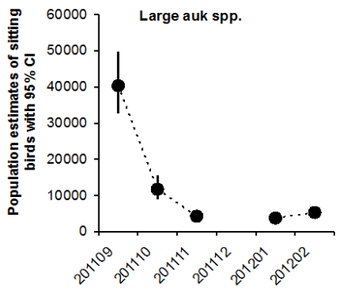


Table C.93 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201109	0.148	28	29.419	40275	32604	49751
201110	0.158	48	85.855	11754	8874	15567
201111	0.288	88	31.282	4283	3438	5334
201112						
201201	0.293	71	27.754	3800	3026	4771
201202	0.316	97	38.635	5289	4563	6131



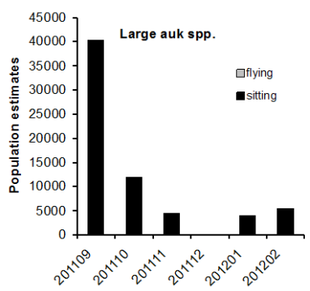
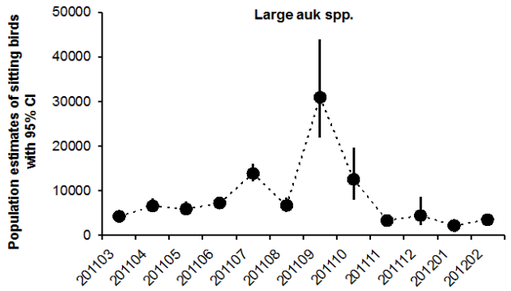
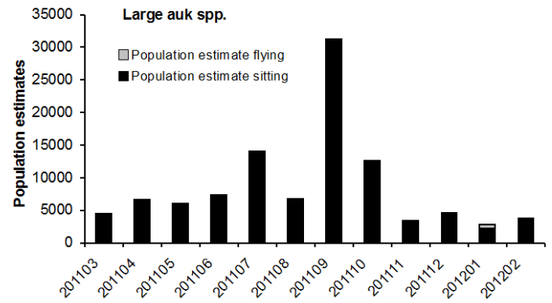


Table C.94 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.23	205	4.87	4261	3164	5740
201104	0.03	30	7.54	6591	5234	8300
201105	0.08	74	6.76	5913	4550	7684
201106	0.08	73	8.27	7235	6072	8620
201107	0.20	175	15.91	13913	12048	16068
201108	0.00	0	7.66	6700	5259	8535
201109	0.24	206	35.45	31009	21884	43939
201110	0.15	133	14.33	12534	7986	19672
201111	0.07	59	3.79	3318	2420	4549
201112	0.15	128	5.13	4486	2329	8641
201201	0.65	565	2.53	2216	1678	2926
201202	0.33	289	4.05	3539	2777	4509





All auk species

Table C.95 Density and population estimates of flying and sitting birds in Hornsea area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.464	2391	4.744	24467	19997	29937
201104	0.019	96	14.226	73376	64139	83944
201105	0.070	363	4.984	25704	21015	31440
201106	0.130	671	12.434	64131	50769	81010
201107	0.108	556	16.024	82651	66458	102790
201108	0.000	0	43.169	222660	159360	311100

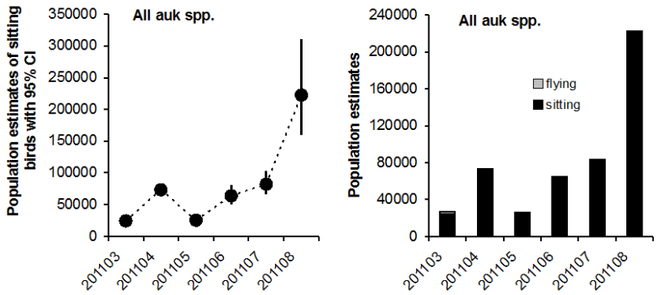
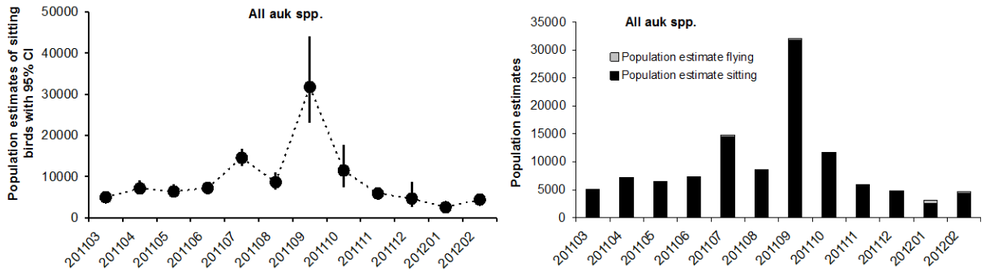


Figure C.9 Density and population estimates of flying and sitting birds in Hornsea sub-zones 1&2:

No reliable population estimates could be calculated with Distance Analysis for this species group in the Hornsea sub-zones 1&2 in the period September 2011 – February 2012.

Table C.96 Density and population estimates of flying and sitting birds in sub-zone 1 sub-area:

Survey (yyyymm)	Density flying birds per km2	Population estimate flying	Density sitting birds per km2	Population estimate sitting	Lower 95% Confidence interval	Higher 95% Confidence interval
201103	0.23	205	5.65	4939	3777	6460
201104	0.05	44	8.14	7122	5606	9047
201105	0.08	74	7.27	6355	4902	8239
201106	0.08	73	8.24	7210	6089	8538
201107	0.20	175	16.66	14575	12606	16852
201108	0.00	0	9.91	8671	6813	11036
201109	0.27	236	36.38	31822	23001	44026
201110	0.17	148	13.15	11506	7443	17786
201111	0.07	59	6.71	5865	4654	7392
201112	0.15	128	5.37	4700	2557	8636
201201	0.65	565	2.93	2561	1942	3377
201202	0.33	289	5.00	4375	3411	5611



Numbers of birds in sub-zone 1 at Hornsea with a distinction between the Development Area and surrounding buffer area

Introduction and methods

C.59. In this chapter population estimates are presented for sub-zone 1 within Hornsea with a distinction between the Development Area and surrounding buffer area on a monthly basis for two study years (with a total of 24 surveys in the period March 2010 – February 2012). Buffers were created around the sub-zone 1 development area (DA); each with a width of 1 km around the last (see figure C.10). For each of these buffers a surface cover was determined in ArcGIS. Population estimates for the different subareas (Heron Wind, Njord, DA+1, DA+1+2, DA+1+2+3 and sub-zone 1 (DA +1+2+3+4 km buffers) were then calculated based on the surface fraction of the sub-areas to the total surface of sub-zone 1 (for which Distance calculated total population sizes). We have chosen this approach as patterns of seabirds far offshore are very variable, and can rarely been attributed to certain habitat characteristics or subareas.

C.60. For every species the population figures are presented both in tables and figures. These consist of birds sitting on the water, based on calculations with the Distance Analysis software of CREEM and total numbers of flying birds, based on extrapolated densities of flying birds recorded with the snapshot methodology.

C.61. The variability of population estimates that comes with the Distance Analysis estimates of ship-based surveys are mainly determined by the variation in encounter rate between transects. This variation is not so much explained by fixed habitat related factors, but much more with temporal changes in conditions of food availability related with e.g. weather conditions. These changes can occur on a short time basis, yielding high variation in encounter rates between transects even close together (and a survey ship moves relatively slow through a study area, relatively to changes in food conditions and/or weather conditions which can occur on small time scales). Therefore we have assumed an equal distribution of seabirds across the whole study area (sub-zone 1). In theory, individual Distance Analysis could be done for each of the sub-zones by selecting sightings based on position, however with sub selecting transects the variation in estimates and there accompanying confidence intervals will increase due to less power of these models of limited study areas. Therefore we have chosen to proportionally calculate the population estimates for the different sub-zones based on different buffer contours around the DA based on the population estimates of the total study area (sub-zone 1).

C.62. Together with every population size per sub-zone an estimate of lower and upper range is given based on the confidence intervals determined in the chapters on the population estimates and densities at Hornsea - Year 1 and 2 respectively. This is also a proportional distribution based on surface fraction. This method of proportionally calculating ranges based on the confidence intervals of the estimates for the whole study area sub-zone 1 incorporates the same assumptions as explained above. It is clear that with this treatment of confidence intervals, the statistical value is lost and therefore in the tables below we present these as ranges and these should only be treated as indicative.

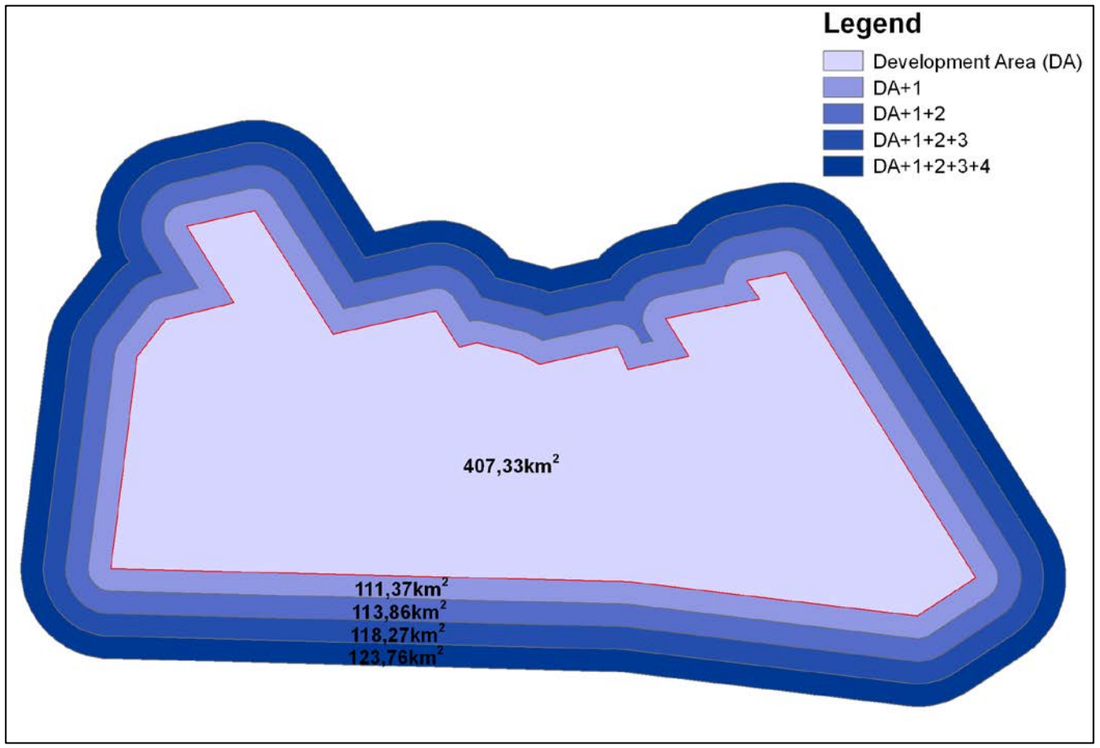


Figure C.10 sub-zone 1 study area (Sub-zone 1 Development Area with adjacent buffers of 1, 2, 3, and 4 km), with a subdivision of the DA into the Heron Wind and Njord initiative.

Northern Fulmar *Fulmarus glacialis*

Table C.97 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	102	47	223	88	40	191	74	34	161	60	28	132	48	22	104
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	622	387	1001	534	332	859	450	280	724	369	230	594	290	180	466
201006	465	302	716	399	259	615	336	218	518	276	179	425	217	141	333
201007	90	52	157	77	45	135	65	38	114	53	31	93	42	24	73
201008	320	156	656	275	134	563	231	113	474	190	93	389	149	73	306
201009	270	189	387	232	162	332	195	137	280	160	112	230	126	88	180
201010	17	3	96	15	3	82	12	2	69	10	2	57	8	1	45
201011	35	8	146	30	7	125	25	6	106	21	5	87	16	4	68
201012	95	48	188	82	41	161	69	35	136	56	28	111	44	22	88
201101	35	11	106	30	9	91	25	8	77	21	7	63	16	5	49
201102	107	50	227	92	43	195	77	36	164	63	30	135	50	23	106
201103	15	4	55	13	3	47	11	3	40	9	2	33	7	2	26
201104	154	76	313	132	65	269	111	55	226	91	45	186	72	35	146
201105	297	156	565	255	134	485	215	113	409	176	93	335	138	73	263
201106	2660	2077	3407	2284	1783	2925	1924	1502	2464	1578	1232	2021	1239	967	1587
201107	476	326	696	409	280	598	344	236	503	282	193	413	222	152	324
201108	204	113	370	175	97	318	148	82	268	121	67	219	95	53	172
201109	541	313	937	464	269	804	391	226	678	321	186	556	252	146	436
201110	181	87	378	155	75	325	131	63	273	107	52	224	84	41	176
201111	45	11	184	39	9	158	33	8	133	27	7	109	21	5	86
201112	261	52	1311	224	45	1125	189	38	948	155	31	778	122	24	611
201201	143	79	259	123	68	222	103	57	187	85	47	154	67	37	121
201202	77	38	158	66	33	136	56	27	114	46	23	94	36	18	74

Table C.98 Population estimates of sitting and flying Fulmars for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	102	435	537	88	373	461	74	314	388	60	258	318	48	203	250
201004	0	29	29	0	25	25	0	21	21	0	17	17	0	13	13
201005	622	275	897	534	236	770	450	199	649	369	163	532	290	128	418
201006	465	203	668	399	174	573	336	147	483	276	120	396	217	94	311
201007	90	29	119	77	25	102	65	21	86	53	17	70	42	13	55
201008	320	145	465	275	124	399	231	105	336	190	86	276	149	67	216
201009	270	123	393	232	105	337	195	89	284	160	73	233	126	57	183
201010	17	15	32	15	12	27	12	11	23	10	9	19	8	7	15
201011	35	72	107	30	62	92	25	52	78	21	43	64	16	34	50
201012	95	0	95	82	0	82	69	0	69	56	0	56	44	0	44
201101	35	145	180	30	124	154	25	105	130	21	86	107	16	67	84
201102	107	87	194	92	74	166	77	63	140	63	51	115	50	40	90
201103	15	64	79	13	55	68	11	46	57	9	38	47	7	30	37
201104	154	44	198	132	38	170	111	32	143	91	26	118	72	21	92
201105	297	147	444	255	127	381	215	107	321	176	87	264	138	69	207
201106	2660	511	3171	2284	439	2722	1924	370	2293	1578	303	1881	1239	238	1477
201107	476	380	856	409	326	735	344	275	619	282	225	508	222	177	399
201108	204	44	248	175	37	213	148	32	179	121	26	147	95	20	115
201109	541	0	541	464	0	464	391	0	391	321	0	321	252	0	252
201110	181	59	240	155	51	206	131	43	174	107	35	142	84	28	112
201111	45	59	104	39	50	89	33	42	75	27	35	61	21	27	48
201112	261	0	261	224	0	224	189	0	189	155	0	155	122	0	122
201201	143	184	327	123	158	280	103	133	236	85	109	194	67	85	152
201202	77	43	120	66	37	103	56	31	87	46	26	71	36	20	56

Sooty Shearwater *Puffinus griseus*

Table C.99 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	147	77	281	126	66	241	106	56	203	87	46	167	68	36	131
201010	160	71	362	137	61	311	116	51	262	95	42	215	75	33	169
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.100 Population estimates of sitting and flying Sooty Shearwaters for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	147	14	161	126	12	139	106	10	117	87	9	96	68	7	75
201010	160	58	218	137	50	187	116	42	158	95	34	129	75	27	102
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Northern Gannet *Morus bassanus*

Table C.101 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	147	14	161	126	12	139	106	10	117	87	9	96	68	7	75
201010	160	58	218	137	50	187	116	42	158	95	34	129	75	27	102
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.102 Population estimates of sitting and flying Northern Gannets for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	107	478	585	92	411	502	77	346	423	63	284	347	50	223	273
201004	65	58	123	56	50	106	47	42	89	39	34	73	30	27	57
201005	0	58	58	0	50	50	0	42	42	0	34	34	0	27	27
201006	102	29	131	88	25	112	74	21	95	60	17	78	48	13	61
201007	47	0	47	40	0	40	34	0	34	28	0	28	22	0	22
201008	443	217	660	380	186	567	320	157	477	263	129	392	206	101	307
201009	393	144	537	337	124	461	284	104	388	233	85	319	183	67	250
201010	357	407	764	306	349	656	258	294	552	212	241	453	166	189	356
201011	363	464	827	312	398	710	263	336	598	215	275	490	169	216	385
201012	8	73	81	7	62	69	6	53	58	5	43	48	4	34	38
201101	32	174	206	27	149	177	23	126	149	19	103	122	15	81	96
201102	146	116	262	125	99	225	106	84	189	87	69	155	68	54	122
201103	92	268	360	79	230	309	67	194	261	55	159	214	43	125	168
201104	72	59	131	62	51	113	52	43	95	43	35	78	34	28	61
201105	24	0	24	21	0	21	17	0	17	14	0	14	11	0	11
201106	64	0	64	55	0	55	46	0	46	38	0	38	30	0	30
201107	224	117	341	192	100	293	162	85	247	133	69	202	104	54	159
201108	154	29	183	132	25	157	111	21	132	91	17	109	72	14	85
201109	304	501	805	261	430	691	220	362	582	180	297	477	142	233	375
201110	446	178	624	383	152	535	323	128	451	265	105	370	208	83	290
201111	287	205	492	246	176	423	208	148	356	170	122	292	134	96	229
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	39	254	293	33	218	252	28	184	212	23	151	174	18	118	137
201202	0	14	14	0	12	12	0	10	10	0	9	9	0	7	7

Herring Gull *Larus argentatus*

Table C.103 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	15	4	54	13	3	46	11	3	39	9	2	32	7	2	25
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	7	1	42	6	1	36	5	1	30	4	1	25	3	0	20
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	74	19	293	64	16	252	54	14	212	44	11	174	34	9	136
201101	30	5	169	26	4	145	22	4	122	18	3	100	14	2	79
201102	30	9	93	26	8	80	22	7	67	18	5	55	14	4	43
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	23	8	65	20	7	56	17	6	47	14	5	39	11	4	30
201105	15	3	84	13	3	72	11	2	61	9	2	50	7	1	39
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	7	1	41	6	1	35	5	1	30	4	1	24	3	0	19
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.104 Population estimates of sitting and flying Herring Gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	15	14	29	13	12	25	11	10	21	9	9	17	7	7	14
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	7	0	7	6	0	6	5	0	5	4	0	4	3	0	3
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201011	0	29	29	0	25	25	0	21	21	0	17	17	0	14	14
201012	74	160	234	64	137	201	54	116	169	44	95	139	34	74	109
201101	30	14	44	26	12	38	22	10	32	18	9	26	14	7	21
201102	30	0	30	26	0	26	22	0	22	18	0	18	14	0	14
201103	0	51	51	0	44	44	0	37	37	0	30	30	0	24	24
201104	23	15	38	20	13	32	17	11	27	14	9	22	11	7	18
201105	15	15	30	13	13	26	11	11	22	9	9	18	7	7	14
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	15	15	0	13	13	0	11	11	0	9	9	0	7	7
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	7	0	7	6	0	6	5	0	5	4	0	4	3	0	3
201202	0	14	14	0	12	12	0	10	10	0	9	9	0	7	7

Great Black-backed Gull *Larus marinus*

Table C.105 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	79	27	229	68	23	197	57	20	166	47	16	136	37	13	107
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	218	41	1159	187	35	995	158	30	838	129	24	687	102	19	540
201010	28	7	118	24	6	101	20	5	85	17	4	70	13	3	55
201011	49	20	122	42	17	105	35	14	88	29	12	72	23	9	57
201012	53	21	137	46	18	118	38	15	99	31	12	81	25	10	64
201101	257	119	554	221	102	476	186	86	401	152	71	329	120	55	258
201102	197	100	387	169	86	332	142	72	280	117	59	230	92	47	180
201103	238	102	556	204	88	477	172	74	402	141	60	330	111	48	259
201104	169	95	301	145	82	258	122	69	218	100	56	179	79	44	140
201105	177	73	429	152	63	368	128	53	310	105	43	254	82	34	200
201106	149	26	848	128	22	728	108	19	613	88	15	503	69	12	395
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	9	2	52	8	2	45	7	1	38	5	1	31	4	1	24
201109	409	110	1519	351	94	1304	296	80	1099	243	65	901	190	51	707
201110	151	42	548	130	36	470	109	30	396	90	25	325	70	20	255
201111	75	34	165	64	29	142	54	25	119	44	20	98	35	16	77
201112	187	28	1267	161	24	1088	135	20	916	111	17	751	87	13	590
201201	231	126	422	198	108	362	167	91	305	137	75	250	108	59	197
201202	96	46	202	82	39	173	69	33	146	57	27	120	45	21	94

Table C.106 Population estimates of sitting and flying Great Black-backed Gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	79	43	122	68	37	105	57	31	89	47	26	73	37	20	57
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	29	29	0	25	25	0	21	21	0	17	17	0	13	13
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	29	29	0	25	25	0	21	21	0	17	17	0	13	13
201008	0	87	87	0	75	75	0	63	63	0	52	52	0	40	40
201009	218	65	283	187	56	243	158	47	205	129	38	168	102	30	132
201010	28	15	43	24	12	37	20	11	31	17	9	25	13	7	20
201011	49	72	121	42	62	104	35	52	88	29	43	72	23	34	57
201012	53	131	184	46	112	158	38	95	133	31	78	109	25	61	86
201101	257	217	474	221	186	407	186	157	343	152	129	281	120	101	221
201102	197	101	298	169	87	256	142	73	216	117	60	177	92	47	139
201103	238	166	404	204	143	347	172	120	292	141	99	240	111	77	188
201104	169	89	258	145	76	221	122	64	186	100	53	153	79	41	120
201105	177	44	221	152	38	190	128	32	160	105	26	131	82	21	103
201106	149	15	164	128	13	140	108	11	118	88	9	97	69	7	76
201107	0	58	58	0	50	50	0	42	42	0	35	35	0	27	27
201108	9	0	9	8	0	8	7	0	7	5	0	5	4	0	4
201109	409	162	571	351	139	490	296	117	413	243	96	339	190	75	266
201110	151	326	477	130	280	409	109	236	345	90	193	283	70	152	222
201111	75	29	104	64	25	90	54	21	75	44	17	62	35	14	49
201112	187	128	315	161	110	270	135	93	228	111	76	187	87	60	147
201201	231	169	400	198	145	344	167	123	290	137	100	237	108	79	186
201202	96	87	183	82	74	157	69	63	132	57	51	108	45	40	85

Lesser Black-backed Gull *Larus fuscus*

Table C.107 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	29	29	58	25	25	50	21	21	42	17	17	34	14	13	27
201005	29	29	58	25	25	50	21	21	42	17	17	34	14	13	27
201006	208	72	280	179	62	241	150	52	203	123	43	166	97	34	131
201007	29	158	187	25	136	161	21	115	136	17	94	111	14	74	87
201008	171	159	330	147	137	284	124	115	239	101	94	196	80	74	154
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	29	0	29	25	0	25	21	0	21	17	0	17	14	0	14
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	58	58	0	50	50	0	42	42	0	34	34	0	27	27
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	10	0	10	9	0	9	7	0	7	6	0	6	5	0	5
201103	8	0	8	7	0	7	6	0	6	5	0	5	4	0	4
201104	95	30	125	82	25	107	69	21	90	56	18	74	44	14	58
201105	90	88	178	77	76	153	65	64	129	53	52	106	42	41	83
201106	159	44	203	137	38	174	115	32	147	94	26	120	74	20	94
201107	10	29	39	9	25	34	7	21	28	6	17	23	5	14	18
201108	10	15	25	9	12	21	7	11	18	6	9	15	5	7	11
201109	98	0	98	84	0	84	71	0	71	58	0	58	46	0	46
201110	10	30	40	9	25	34	7	21	29	6	18	23	5	14	18
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	38	42	80	33	36	69	27	31	58	23	25	48	18	20	37
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.108 Population estimates of sitting and flying Lesser Black-backed Gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	29	29	58	25	25	50	21	21	42	17	17	34	14	13	27
201005	29	29	58	25	25	50	21	21	42	17	17	34	14	13	27
201006	208	72	280	179	62	241	150	52	203	123	43	166	97	34	131
201007	29	158	187	25	136	161	21	115	136	17	94	111	14	74	87
201008	171	159	330	147	137	284	124	115	239	101	94	196	80	74	154
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	29	0	29	25	0	25	21	0	21	17	0	17	14	0	14
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	58	58	0	50	50	0	42	42	0	34	34	0	27	27
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	10	0	10	9	0	9	7	0	7	6	0	6	5	0	5
201103	8	0	8	7	0	7	6	0	6	5	0	5	4	0	4
201104	95	30	125	82	25	107	69	21	90	56	18	74	44	14	58
201105	90	88	178	77	76	153	65	64	129	53	52	106	42	41	83
201106	159	44	203	137	38	174	115	32	147	94	26	120	74	20	94
201107	10	29	39	9	25	34	7	21	28	6	17	23	5	14	18
201108	10	15	25	9	12	21	7	11	18	6	9	15	5	7	11
201109	98	0	98	84	0	84	71	0	71	58	0	58	46	0	46
201110	10	30	40	9	25	34	7	21	29	6	18	23	5	14	18
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	38	42	80	33	36	69	27	31	58	23	25	48	18	20	37
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Little Gull *Larus minutus*

Table C.109 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	54	10	303	46	9	260	39	7	219	32	6	180	25	5	141
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	267	63	1132	229	54	972	193	46	819	158	37	671	124	29	527
201010	7649	5282	11076	6567	4535	9509	5532	3820	8011	4536	3133	6569	3562	2460	5159
201011	623	282	1380	535	242	1185	451	204	998	369	167	818	290	131	643
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	13	2	76	11	2	65	9	1	55	8	1	45	6	1	35
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	68	12	382	58	10	328	49	9	276	40	7	227	32	6	178
201111	68	21	221	58	18	190	49	15	160	40	12	131	32	10	103
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	74	26	211	64	22	181	54	19	153	44	15	125	34	12	98

Table C.110 Population estimates of sitting and flying Little Gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	54	0	54	46	0	46	39	0	39	32	0	32	25	0	25
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	267	65	332	229	56	285	193	47	240	158	38	197	124	30	155
201010	7649	4577	12226	6567	3929	10496	5532	3311	8843	4536	2715	7251	3562	2132	5694
201011	623	406	1029	535	348	883	451	294	744	369	241	610	290	189	479
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	13	0	13	11	0	11	9	0	9	8	0	8	6	0	6
201109	0	29	29	0	25	25	0	21	21	0	17	17	0	14	14
201110	68	0	68	58	0	58	49	0	49	40	0	40	32	0	32
201111	68	0	68	58	0	58	49	0	49	40	0	40	32	0	32
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	74	0	74	64	0	64	54	0	54	44	0	44	34	0	34

Kittiwake *Rissa tridactyla*

Table C.111 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	1625	1079	2448	1395	926	2102	1175	780	1771	964	640	1452	757	503	1140
201004	624	347	1122	536	298	963	451	251	812	370	206	665	291	162	523
201005	60	18	199	52	15	171	43	13	144	36	11	118	28	8	93
201006	3241	2404	4368	2782	2064	3750	2344	1739	3159	1922	1426	2591	1509	1120	2034
201007	834	302	2301	716	259	1975	603	218	1664	495	179	1365	388	141	1072
201008	19406	8496	44325	16660	7294	38053	14036	6145	32059	11509	5039	26288	9038	3957	20644
201009	5535	2801	10937	4752	2405	9389	4003	2026	7910	3283	1661	6487	2578	1305	5094
201010	2244	729	6912	1926	626	5934	1623	527	4999	1331	432	4099	1045	340	3219
201011	925	634	1351	794	544	1160	669	459	977	549	376	801	431	295	629
201012	175	96	318	150	82	273	127	69	230	104	57	189	82	45	148
201101	243	120	491	209	103	422	176	87	355	144	71	291	113	56	229
201102	585	320	1068	502	275	917	423	231	772	347	190	633	272	149	497
201103	814	465	1425	699	399	1223	589	336	1031	483	276	845	379	217	664
201104	1504	1043	2168	1291	895	1861	1088	754	1568	892	619	1286	700	486	1010
201105	212	118	384	182	101	330	153	85	278	126	70	228	99	55	179
201106	2383	1216	4668	2046	1044	4007	1724	879	3376	1413	721	2768	1110	566	2174
201107	2239	1349	3717	1922	1158	3191	1619	976	2688	1328	800	2204	1043	628	1731
201108	999	360	2773	858	309	2381	723	260	2006	592	214	1645	465	168	1292
201109	52710	4522	614410	45252	3882	527471	38124	3271	444385	31261	2682	364394	24549	2106	286157
201110	62	26	149	53	22	128	45	19	108	37	15	88	29	12	69
201111	112	16	774	96	14	664	81	12	560	66	9	459	52	7	360
201112	492	99	2446	422	85	2100	356	72	1769	292	59	1451	229	46	1139
201201	274	99	754	235	85	647	198	72	545	163	59	447	128	46	351
201202	174	78	388	149	67	333	126	56	281	103	46	230	81	36	181

Table C.112 Population estimates of sitting and flying Kittiwakes for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	1625	507	2132	1395	436	1831	1175	367	1542	964	301	1265	757	236	993
201004	624	159	783	536	137	672	451	115	567	370	94	465	291	74	365
201005	60	101	161	52	87	139	43	73	117	36	60	96	28	47	75
201006	3241	854	4095	2782	733	3515	2344	618	2962	1922	506	2429	1509	398	1907
201007	834	590	1424	716	507	1223	603	427	1030	495	350	845	388	275	663
201008	19406	941	20347	16660	808	17468	14036	681	14716	11509	558	12067	9038	438	9477
201009	5535	742	6277	4752	637	5389	4003	537	4540	3283	440	3723	2578	346	2924
201010	2244	160	2404	1926	137	2064	1623	116	1739	1331	95	1426	1045	74	1120
201011	925	1305	2230	794	1120	1914	669	944	1613	549	774	1322	431	608	1038
201012	175	290	465	150	249	400	127	210	337	104	172	276	82	135	217
201101	243	376	619	209	323	532	176	272	448	144	223	367	113	175	289
201102	585	448	1033	502	385	887	423	324	747	347	266	613	272	209	481
201103	814	345	1159	699	296	995	589	250	838	483	205	687	379	161	540
201104	1504	177	1681	1291	152	1443	1088	128	1216	892	105	997	700	83	783
201105	212	15	227	182	13	195	153	11	164	126	9	134	99	7	106
201106	2383	394	2777	2046	338	2384	1724	285	2009	1413	234	1647	1110	184	1293
201107	2239	1623	3862	1922	1393	3316	1619	1174	2793	1328	963	2291	1043	756	1799
201108	999	262	1261	858	225	1082	723	189	912	592	155	748	465	122	587
201109	52710	236	52946	45252	202	45454	38124	170	38294	31261	140	31401	24549	110	24659
201110	62	607	669	53	521	574	45	439	484	37	360	397	29	283	312
201111	112	440	552	96	378	474	81	318	399	66	261	327	52	205	257
201112	492	128	620	422	110	532	356	93	448	292	76	368	229	60	289
201201	274	226	500	235	194	429	198	163	362	163	134	296	128	105	233
201202	174	188	362	149	161	311	126	136	262	103	111	215	81	87	169

Small gull species

Figure C.11 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	1667	1107	2512	1431	950	2157	1206	801	1817	989	657	1490	776	516	1170
201004	735	406	1334	631	349	1145	532	294	965	436	241	791	342	189	621
201005	68	21	219	58	18	188	49	15	158	40	12	130	32	10	102
201006	3296	2445	4442	2830	2099	3813	2384	1768	3213	1955	1450	2634	1535	1139	2069
201007	1069	398	2874	918	342	2467	773	288	2079	634	236	1705	498	185	1339
201008	22515	10061	50381	19329	8637	43252	16284	7277	36439	13353	5967	29880	10486	4686	23465
201009	5128	2713	9691	4402	2329	8320	3709	1962	7009	3041	1609	5748	2388	1264	4514
201010	7289	5034	10555	6258	4322	9061	5272	3641	7634	4323	2986	6260	3395	2345	4916
201011	1298	907	1857	1114	779	1594	939	656	1343	770	538	1101	605	422	865
201012	174	100	304	149	86	261	126	72	220	103	59	180	81	47	142
201101	234	114	479	201	98	411	169	82	346	139	68	284	109	53	223
201102	571	313	1042	490	269	895	413	226	754	339	186	618	266	146	485
201103	825	472	1444	708	405	1240	597	341	1044	489	280	856	384	220	673
201104	1446	999	2093	1241	858	1797	1046	723	1514	858	592	1241	673	465	975
201105	229	131	400	197	112	343	166	95	289	136	78	237	107	61	186
201106	3683	1918	7074	3162	1647	6073	2664	1387	5116	2184	1138	4195	1715	893	3295
201107	2406	1448	3997	2066	1243	3431	1740	1047	2891	1427	859	2371	1121	674	1862
201108	469	209	1053	403	179	904	339	151	762	278	124	625	218	97	490
201109	64209	7098	580800	55123	6094	498617	46440	5134	420075	38081	4210	344461	29905	3306	270503
201110	89	37	215	76	32	185	64	27	156	53	22	128	41	17	100
201111	164	58	464	141	50	398	119	42	336	97	34	275	76	27	216
201112	527	106	2624	452	91	2253	381	77	1898	313	63	1556	245	49	1222
201201	285	104	784	245	89	673	206	75	567	169	62	465	133	48	365
201202	275	152	501	236	130	430	199	110	362	163	90	297	128	71	233

Table C.113 Population estimates of sitting and flying small gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	1667	507	2174	1431	436	1867	1206	367	1573	989	301	1290	776	236	1013
201004	735	174	909	631	149	780	532	126	657	436	103	539	342	81	423
201005	68	101	169	58	87	145	49	73	123	40	60	100	32	47	79
201006	3296	854	4150	2830	733	3563	2384	618	3002	1955	506	2461	1535	398	1933
201007	1069	590	1659	918	507	1425	773	427	1200	634	350	984	498	275	773
201008	22515	941	23456	19329	808	20137	16284	681	16965	13353	558	13911	10486	438	10925
201009	5128	814	5942	4402	699	5102	3709	589	4298	3041	483	3524	2388	379	2768
201010	7289	4737	12026	6258	4067	10324	5272	3426	8698	4323	2809	7132	3395	2206	5601
201011	1298	1711	3009	1114	1468	2583	939	1237	2176	770	1014	1784	605	797	1401
201012	174	305	479	149	262	411	126	221	346	103	181	284	81	142	223
201101	234	391	625	201	336	537	169	283	452	139	232	371	109	182	291
201102	571	448	1019	490	385	875	413	324	737	339	266	604	266	209	475
201103	825	383	1208	708	329	1037	597	277	874	489	227	717	384	179	563
201104	1446	222	1668	1241	190	1432	1046	160	1206	858	131	989	673	103	777
201105	229	15	244	197	13	209	166	11	176	136	9	145	107	7	114
201106	3683	394	4077	3162	338	3500	2664	285	2949	2184	234	2418	1715	184	1899
201107	2406	1623	4029	2066	1393	3459	1740	1174	2914	1427	963	2390	1121	756	1877
201108	469	276	745	403	237	640	339	200	539	278	164	442	218	129	347
201109	64209	265	64474	55123	228	55351	46440	192	46632	38081	157	38238	29905	123	30028
201110	89	666	755	76	572	648	64	482	546	53	395	448	41	310	352
201111	164	498	662	141	428	569	119	361	479	97	296	393	76	232	309
201112	527	128	655	452	110	562	381	93	474	313	76	389	245	60	305
201201	285	254	539	245	218	463	206	184	390	169	151	320	133	118	251
201202	275	246	521	236	211	447	199	178	377	163	146	309	128	114	242

Large gull species

Table C.114 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	90	36	224	77	31	192	65	26	162	53	21	133	42	17	104
201004	27	9	80	23	8	69	20	7	58	16	5	47	13	4	37
201005	49	10	239	42	9	205	35	7	173	29	6	142	23	5	111
201006	196	43	884	168	37	759	142	31	639	116	26	524	91	20	412
201007	27	9	79	23	8	68	20	7	57	16	5	47	13	4	37
201008	161	48	544	138	41	467	116	35	393	95	28	323	75	22	253
201009	213	40	1133	183	34	973	154	29	819	126	24	672	99	19	528
201010	60	17	208	52	15	179	43	12	150	36	10	123	28	8	97
201011	48	19	119	41	16	102	35	14	86	28	11	71	22	9	55
201012	106	36	316	91	31	271	77	26	229	63	21	187	49	17	147
201101	306	142	659	263	122	566	221	103	477	181	84	391	143	66	307
201102	238	133	424	204	114	364	172	96	307	141	79	251	111	62	197
201103	232	97	556	199	83	477	168	70	402	138	58	330	108	45	259
201104	284	183	440	244	157	378	205	132	318	168	109	261	132	85	205
201105	253	115	555	217	99	476	183	83	401	150	68	329	118	54	258
201106	191	35	1052	164	30	903	138	25	761	113	21	624	89	16	490
201107	9	2	52	8	2	45	7	1	38	5	1	31	4	1	24
201108	18	5	65	15	4	56	13	4	47	11	3	39	8	2	30
201109	771	211	2820	662	181	2421	558	153	2040	457	125	1672	359	98	1313
201110	155	50	476	133	43	409	112	36	344	92	30	282	72	23	222
201111	73	33	161	63	28	138	53	24	116	43	20	95	34	15	75
201112	183	27	1241	157	23	1065	132	20	898	109	16	736	85	13	578
201201	275	156	484	236	134	416	199	113	350	163	93	287	128	73	225
201202	101	51	199	87	44	171	73	37	144	60	30	118	47	24	93

Table C.115 Population estimates of sitting and flying large gulls for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	1667	1107	2512	1431	950	2157	1206	801	1817	989	657	1490	776	516	1170
201004	735	406	1334	631	349	1145	532	294	965	436	241	791	342	189	621
201005	68	21	219	58	18	188	49	15	158	40	12	130	32	10	102
201006	3296	2445	4442	2830	2099	3813	2384	1768	3213	1955	1450	2634	1535	1139	2069
201007	1069	398	2874	918	342	2467	773	288	2079	634	236	1705	498	185	1339
201008	22515	10061	50381	19329	8637	43252	16284	7277	36439	13353	5967	29880	10486	4686	23465
201009	5128	2713	9691	4402	2329	8320	3709	1962	7009	3041	1609	5748	2388	1264	4514
201010	7289	5034	10555	6258	4322	9061	5272	3641	7634	4323	2986	6260	3395	2345	4916
201011	1298	907	1857	1114	779	1594	939	656	1343	770	538	1101	605	422	865
201012	174	100	304	149	86	261	126	72	220	103	59	180	81	47	142
201101	234	114	479	201	98	411	169	82	346	139	68	284	109	53	223
201102	571	313	1042	490	269	895	413	226	754	339	186	618	266	146	485
201103	825	472	1444	708	405	1240	597	341	1044	489	280	856	384	220	673
201104	1446	999	2093	1241	858	1797	1046	723	1514	858	592	1241	673	465	975
201105	229	131	400	197	112	343	166	95	289	136	78	237	107	61	186
201106	3683	1918	7074	3162	1647	6073	2664	1387	5116	2184	1138	4195	1715	893	3295
201107	2406	1448	3997	2066	1243	3431	1740	1047	2891	1427	859	2371	1121	674	1862
201108	469	209	1053	403	179	904	339	151	762	278	124	625	218	97	490
201109	64209	7098	580800	55123	6094	498617	46440	5134	420075	38081	4210	344461	29905	3306	270503
201110	89	37	215	76	32	185	64	27	156	53	22	128	41	17	100
201111	164	58	464	141	50	398	119	42	336	97	34	275	76	27	216
201112	527	106	2624	452	91	2253	381	77	1898	313	63	1556	245	49	1222
201201	285	104	784	245	89	673	206	75	567	169	62	465	133	48	365
201202	275	152	501	236	130	430	199	110	362	163	90	297	128	71	233

All gull species

Table C.116 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	2475	1285	4768	2125	1103	4093	1790	929	3449	1468	762	2828	1153	598	2221
201004	647	361	1159	555	310	995	468	261	838	384	214	687	301	168	540
201005	96	39	233	82	33	200	69	28	169	57	23	138	45	18	109
201006	3380	2515	4543	2902	2159	3900	2445	1819	3286	2005	1492	2694	1574	1171	2116
201007	1026	429	2455	881	368	2108	742	310	1776	609	254	1456	478	200	1143
201008	13840	6433	29777	11882	5523	25564	10010	4653	21537	8208	3815	17660	6446	2996	13868
201009	4983	2735	9081	4278	2348	7796	3604	1978	6568	2955	1622	5386	2321	1274	4229
201010	7113	4989	10142	6107	4283	8707	5145	3608	7335	4219	2959	6015	3313	2324	4724
201011	1946	1346	2814	1671	1156	2416	1407	974	2035	1154	798	1669	906	627	1311
201012	348	183	664	299	157	570	252	132	480	206	109	394	162	85	309
201101	532	297	952	457	255	817	385	215	689	316	176	565	248	138	443
201102	867	528	1423	744	453	1222	627	382	1029	514	313	844	404	246	663
201103	1095	695	1724	940	597	1480	792	503	1247	649	412	1022	510	324	803
201104	1788	1256	2545	1535	1078	2185	1293	908	1841	1060	745	1509	833	585	1185
201105	549	308	980	471	264	841	397	223	709	326	183	581	256	143	456
201106	2939	1621	5327	2523	1392	4573	2126	1172	3853	1743	961	3159	1369	755	2481
201107	2760	1655	4602	2369	1421	3951	1996	1197	3328	1637	982	2729	1285	771	2143
201108	1649	732	3714	1416	628	3188	1193	529	2686	978	434	2203	768	341	1730
201109	10063	2750	36822	8639	2361	31612	7278	1989	26632	5968	1631	21838	4687	1281	17150
201110	234	122	447	201	105	384	169	88	323	139	72	265	109	57	208
201111	202	91	447	173	78	384	146	66	323	120	54	265	94	42	208
201112	657	156	2764	564	134	2373	475	113	1999	390	93	1639	306	73	1287
201201	503	268	942	432	230	809	364	194	681	298	159	559	234	125	439
201202	412	271	626	354	233	537	298	196	453	244	161	371	192	126	292

Table C.117 Population estimates of sitting and flying all gull species for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	2475	565	3040	2125	485	2610	1790	409	2199	1468	335	1803	1153	263	1416
201004	647	203	850	555	174	729	468	147	615	384	120	504	301	94	396
201005	96	159	255	82	137	219	69	115	185	57	94	151	45	74	119
201006	3380	926	4306	2902	795	3697	2445	670	3115	2005	549	2554	1574	431	2006
201007	1026	777	1803	881	667	1548	742	562	1304	609	461	1070	478	362	840
201008	13840	1187	15027	11882	1019	12901	10010	859	10869	8208	704	8912	6446	553	6999
201009	4983	879	5862	4278	755	5033	3604	636	4240	2955	521	3477	2321	410	2730
201010	7113	4752	11865	6107	4079	10186	5145	3437	8581	4219	2818	7037	3313	2213	5526
201011	1946	1812	3758	1671	1556	3226	1407	1311	2718	1154	1075	2229	906	844	1750
201012	348	653	1001	299	561	860	252	473	724	206	388	594	162	304	466
201101	532	623	1155	457	534	991	385	450	835	316	369	685	248	290	538
201102	867	564	1431	744	484	1228	627	408	1035	514	334	849	404	263	666
201103	1095	64	1159	940	55	995	792	46	838	649	38	687	510	30	540
201104	1788	44	1832	1535	38	1573	1293	32	1325	1060	26	1087	833	21	853
201105	549	147	696	471	127	598	397	107	504	326	87	413	256	69	324
201106	2939	511	3450	2523	439	2962	2126	370	2495	1743	303	2046	1369	238	1607
201107	2760	380	3140	2369	326	2696	1996	275	2271	1637	225	1862	1285	177	1463
201108	1649	44	1693	1416	37	1453	1193	32	1224	978	26	1004	768	20	788
201109	10063	0	10063	8639	0	8639	7278	0	7278	5968	0	5968	4687	0	4687
201110	234	59	293	201	51	252	169	43	212	139	35	174	109	28	137
201111	202	59	261	173	50	224	146	42	189	120	35	155	94	27	121
201112	657	0	657	564	0	564	475	0	475	390	0	390	306	0	306
201201	503	184	687	432	158	589	364	133	497	298	109	407	234	85	320
201202	412	43	455	354	37	391	298	31	329	244	26	270	192	20	212

Common Tern *Sterna hirundo*

Table C.118 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	23	4	129	20	3	111	17	3	93	14	2	77	11	2	60
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	791	305	2055	679	262	1764	572	221	1486	469	181	1219	368	142	957
201010	23	6	83	20	5	71	17	4	60	14	4	49	11	3	39
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	58	15	227	50	13	195	42	11	164	34	9	135	27	7	106
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	23	6	85	20	5	73	17	4	61	14	4	50	11	3	40
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.119 Population estimates of sitting and flying Common Terns for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	23	29	52	20	25	45	17	21	38	14	17	31	11	13	24
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	791	548	1339	679	470	1149	572	396	968	469	325	794	368	255	624
201010	23	102	125	20	87	107	17	74	90	14	60	74	11	47	58
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	58	0	58	50	0	50	42	0	42	34	0	34	27	0	27
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	23	15	38	20	12	32	17	11	27	14	9	22	11	7	17
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Common/Arctic tern *Sterna hirundo / S. paradisaea*

Table C.120 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	21	4	117	18	3	100	15	3	85	12	2	69	10	2	54
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	258	44	1495	221	38	1283	187	32	1081	153	26	887	120	20	696
201009	1258	476	3326	1080	409	2855	910	344	2406	746	282	1973	586	222	1549
201010	21	6	76	18	5	65	15	4	55	12	4	45	10	3	35
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	557	98	3154	478	84	2708	403	71	2281	330	58	1871	259	46	1469
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	21	6	77	18	5	66	15	4	56	12	4	46	10	3	36
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.121 Population estimates of sitting and flying 'Commic' terns for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	21	29	50	18	25	43	15	21	36	12	17	30	10	13	23
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	258	101	359	221	87	309	187	73	260	153	60	213	120	47	167
201009	1258	584	1842	1080	501	1581	910	422	1332	746	346	1092	586	272	858
201010	21	102	123	18	87	105	15	74	89	12	60	73	10	47	57
201011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	557	177	734	478	152	630	403	128	531	330	105	435	259	82	342
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	21	15	36	18	12	31	15	11	26	12	9	21	10	7	17
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	0	15	15	0	13	13	0	11	11	0	9	9	0	7	7
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Little Auk ***Alle alle***

Table C.122 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201011	882	437	1778	757	375	1526	638	316	1286	523	259	1054	411	204	828
201012	45	12	166	39	10	143	33	9	120	27	7	98	21	6	77
201101	204	69	602	175	59	517	148	50	435	121	41	357	95	32	280
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	40	11	142	34	9	122	29	8	103	24	7	84	19	5	66
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	92	25	335	79	21	288	67	18	242	55	15	199	43	12	156
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.123 Population estimates of sitting and flying Little Auks for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201011	882	29	911	757	25	782	638	21	659	523	17	540	411	14	424
201012	45	15	60	39	12	51	33	11	43	27	9	35	21	7	28
201101	204	0	204	175	0	175	148	0	148	121	0	121	95	0	95
201102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201103	40	0	40	34	0	34	29	0	29	24	0	24	19	0	19
201104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201109	0	15	15	0	13	13	0	11	11	0	9	9	0	7	7
201110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201111	92	0	92	79	0	79	67	0	67	55	0	55	43	0	43
201112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Puffin *Fratercula arctica*

Figure C.12 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	494	293	833	424	252	715	357	212	602	293	174	494	230	136	388
201004	1068	634	1801	917	544	1546	772	459	1303	633	376	1068	497	295	839
201005	949	608	1481	815	522	1271	686	440	1071	563	361	878	442	283	690
201006	2842	2123	3804	2440	1823	3266	2056	1536	2751	1686	1259	2256	1324	989	1772
201007	13	2	72	11	2	62	9	1	52	8	1	43	6	1	34
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	909	636	1300	780	546	1116	657	460	940	539	377	771	423	296	605
201010	1707	1093	2665	1465	938	2288	1235	791	1928	1012	648	1581	795	509	1241
201011	497	223	1109	427	191	952	359	161	802	295	132	658	231	104	517
201012	765	510	1150	657	438	987	553	369	832	454	302	682	356	238	536
201101	906	459	1787	778	394	1534	655	332	1292	537	272	1060	422	214	832
201102	254	126	514	218	108	441	184	91	372	151	75	305	118	59	239
201103	704	496	998	604	426	857	509	359	722	418	294	592	328	231	465
201104	750	447	1257	644	384	1079	542	323	909	445	265	746	349	208	585
201105	100	43	233	86	37	200	72	31	169	59	26	138	47	20	109
201106	136	59	310	117	51	266	98	43	224	81	35	184	63	27	144
201107	26	7	96	22	6	82	19	5	69	15	4	57	12	3	45
201108	1932	1251	2983	1659	1074	2561	1397	905	2158	1146	742	1769	900	583	1389
201109	1581	1182	2115	1357	1015	1816	1143	855	1530	938	701	1254	736	551	985
201110	301	169	538	258	145	462	218	122	389	179	100	319	140	79	251
201111	2533	2092	3066	2175	1796	2632	1832	1513	2218	1502	1241	1818	1180	974	1428
201112	195	53	728	167	46	625	141	38	527	116	31	432	91	25	339
201201	101	36	281	87	31	241	73	26	203	60	21	167	47	17	131
201202	820	522	1288	704	448	1106	593	378	932	486	310	764	382	243	600

Table C.124 Population estimates of sitting and flying Puffins for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	494	29	523	424	25	449	357	21	378	293	17	310	230	14	244
201004	1068	0	1068	917	0	917	772	0	772	633	0	633	497	0	497
201005	949	0	949	815	0	815	686	0	686	563	0	563	442	0	442
201006	2842	0	2842	2440	0	2440	2056	0	2056	1686	0	1686	1324	0	1324
201007	13	0	13	11	0	11	9	0	9	8	0	8	6	0	6
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	909	0	909	780	0	780	657	0	657	539	0	539	423	0	423
201010	1707	0	1707	1465	0	1465	1235	0	1235	1012	0	1012	795	0	795
201011	497	0	497	427	0	427	359	0	359	295	0	295	231	0	231
201012	765	0	765	657	0	657	553	0	553	454	0	454	356	0	356
201101	906	0	906	778	0	778	655	0	655	537	0	537	422	0	422
201102	254	0	254	218	0	218	184	0	184	151	0	151	118	0	118
201103	704	0	704	604	0	604	509	0	509	418	0	418	328	0	328
201104	750	15	765	644	13	657	542	11	553	445	9	454	349	7	356
201105	100	0	100	86	0	86	72	0	72	59	0	59	47	0	47
201106	136	0	136	117	0	117	98	0	98	81	0	81	63	0	63
201107	26	0	26	22	0	22	19	0	19	15	0	15	12	0	12
201108	1932	0	1932	1659	0	1659	1397	0	1397	1146	0	1146	900	0	900
201109	1581	15	1596	1357	13	1370	1143	11	1154	938	9	946	736	7	743
201110	301	15	316	258	13	271	218	11	228	179	9	187	140	7	147
201111	2533	0	2533	2175	0	2175	1832	0	1832	1502	0	1502	1180	0	1180
201112	195	0	195	167	0	167	141	0	141	116	0	116	91	0	91
201201	101	0	101	87	0	87	73	0	73	60	0	60	47	0	47
201202	820	0	820	704	0	704	593	0	593	486	0	486	382	0	382

Guillemot *Uria aalge*

Table C.125 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	2110	1539	2893	1811	1321	2484	1526	1113	2092	1251	913	1716	983	717	1347
201004	4570	3100	6738	3923	2661	5785	3305	2242	4873	2710	1839	3996	2128	1444	3138
201005	2763	2260	3378	2372	1940	2900	1998	1635	2443	1639	1340	2003	1287	1053	1573
201006	4709	3865	5738	4043	3318	4926	3406	2795	4150	2793	2292	3403	2193	1800	2672
201007	11544	9525	13990	9911	8177	12010	8349	6889	10119	6847	5649	8297	5377	4436	6516
201008	13802	11601	16420	11849	9959	14097	9983	8391	11876	8186	6880	9738	6428	5403	7647
201009	25147	21468	29457	21589	18430	25289	18188	15527	21305	14914	12732	17470	11712	9999	13719
201010	41947	33312	52820	36012	28598	45346	30339	24094	38203	24878	19757	31326	19537	15515	24601
201011	14477	11740	17853	12429	10079	15327	10471	8491	12913	8586	6963	10588	6743	5468	8315
201012	8616	7169	10356	7397	6155	8891	6232	5185	7490	5110	4252	6142	4013	3339	4823
201101	3448	2425	4903	2960	2082	4209	2494	1754	3546	2045	1438	2908	1606	1129	2284
201102	3260	2370	4485	2799	2035	3850	2358	1714	3244	1933	1406	2660	1518	1104	2089
201103	2417	1788	3268	2075	1535	2806	1748	1293	2364	1433	1060	1938	1126	833	1522
201104	3618	2813	4653	3106	2415	3995	2617	2035	3365	2146	1668	2760	1685	1310	2167
201105	5681	4361	7400	4877	3744	6353	4109	3154	5352	3369	2586	4389	2646	2031	3446
201106	6880	5747	8237	5906	4934	7071	4976	4157	5958	4080	3408	4885	3204	2677	3836
201107	13348	11620	15333	11459	9976	13163	9654	8404	11090	7916	6892	9094	6217	5412	7141
201108	6337	4998	8036	5440	4291	6899	4583	3615	5812	3758	2964	4766	2951	2328	3743
201109	18163	13146	25096	15593	11286	21545	13137	9508	18151	10772	7797	14884	8459	6123	11688
201110	9672	6436	14534	8303	5525	12477	6995	4655	10512	5736	3817	8620	4505	2998	6769
201111	1553	1083	2225	1333	930	1910	1123	783	1609	921	642	1320	723	504	1036
201112	4136	1946	8788	3551	1671	7545	2991	1407	6356	2453	1154	5212	1926	906	4093
201201	1325	988	1776	1138	848	1525	958	715	1285	786	586	1053	617	460	827
201202	2153	1701	2726	1848	1460	2340	1557	1230	1972	1277	1009	1617	1003	792	1270

Table C.126 Population estimates of sitting and flying Guillemots for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	2110	406	2516	1811	348	2160	1526	294	1820	1251	241	1492	983	189	1172
201004	4570	29	4599	3923	25	3948	3305	21	3326	2710	17	2728	2128	13	2142
201005	2763	43	2806	2372	37	2409	1998	31	2030	1639	26	1664	1287	20	1307
201006	4709	58	4767	4043	50	4092	3406	42	3448	2793	34	2827	2193	27	2220
201007	11544	29	11573	9911	25	9935	8349	21	8370	6847	17	6864	5377	13	5390
201008	13802	0	13802	11849	0	11849	9983	0	9983	8186	0	8186	6428	0	6428
201009	25147	7	25154	21589	6	21595	18188	5	18193	14914	4	14918	11712	3	11715
201010	41947	87	42034	36012	75	36086	30339	63	30402	24878	52	24930	19537	41	19577
201011	14477	145	14622	12429	124	12553	10471	105	10576	8586	86	8672	6743	68	6810
201012	8616	436	9052	7397	374	7771	6232	315	6547	5110	258	5368	4013	203	4216
201101	3448	883	4331	2960	758	3718	2494	639	3133	2045	524	2569	1606	411	2017
201102	3260	130	3390	2799	112	2910	2358	94	2452	1933	77	2011	1518	61	1579
201103	2417	205	2622	2075	176	2251	1748	148	1896	1433	121	1555	1126	95	1221
201104	3618	30	3648	3106	25	3131	2617	21	2638	2146	18	2163	1685	14	1699
201105	5681	74	5755	4877	63	4940	4109	53	4162	3369	44	3413	2646	34	2680
201106	6880	15	6895	5906	13	5919	4976	11	4987	4080	9	4089	3204	7	3211
201107	13348	146	13494	11459	126	11585	9654	106	9760	7916	87	8003	6217	68	6285
201108	6337	0	6337	5440	0	5440	4583	0	4583	3758	0	3758	2951	0	2951
201109	18163	88	18251	15593	76	15669	13137	64	13201	10772	52	10825	8459	41	8500
201110	9672	104	9776	8303	89	8392	6995	75	7070	5736	61	5798	4505	48	4553
201111	1553	15	1568	1333	13	1346	1123	11	1134	921	9	930	723	7	730
201112	4136	128	4264	3551	110	3661	2991	93	3084	2453	76	2529	1926	60	1986
201201	1325	99	1424	1138	85	1222	958	71	1030	786	59	844	617	46	663
201202	2153	274	2427	1848	236	2084	1557	199	1756	1277	163	1440	1003	128	1131

Razorbill ***Alca torda***

Table C.127 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	4161	2988	5796	3572	2565	4976	3010	2161	4192	2468	1772	3437	1938	1392	2699
201004	3094	1783	5368	2656	1531	4608	2238	1290	3883	1835	1057	3184	1441	830	2500
201005	299	156	571	257	134	490	216	113	413	177	93	339	139	73	266
201006	683	430	1085	586	369	931	494	311	785	405	255	643	318	200	505
201007	3271	2278	4697	2808	1956	4032	2366	1648	3397	1940	1351	2786	1523	1061	2188
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	12170	9239	16031	10448	7932	13763	8802	6682	11595	7218	5479	9508	5668	4303	7466
201010	15038	11654	19406	12910	10005	16660	10877	8429	14036	8919	6912	11509	7004	5428	9038
201011	2241	1699	2955	1924	1459	2537	1621	1229	2137	1329	1008	1753	1044	791	1376
201012	4060	3067	5374	3486	2633	4614	2936	2218	3887	2408	1819	3187	1891	1428	2503
201101	1573	909	2722	1350	780	2337	1138	657	1969	933	539	1614	733	423	1268
201102	1276	741	2196	1095	636	1885	923	536	1588	757	439	1302	594	345	1023
201103	1841	1268	2674	1580	1089	2296	1332	917	1934	1092	752	1586	857	591	1245
201104	3038	2284	4040	2608	1961	3468	2197	1652	2922	1802	1355	2396	1415	1064	1882
201105	285	157	520	245	135	446	206	114	376	169	93	308	133	73	242
201106	467	301	723	401	258	621	338	218	523	277	179	429	218	140	337
201107	696	425	1142	598	365	980	503	307	826	413	252	677	324	198	532
201108	477	129	1768	410	111	1518	345	93	1279	283	77	1049	222	60	823
201109	9021	5637	14439	7745	4839	12396	6525	4077	10443	5350	3343	8563	4201	2625	6725
201110	2782	1315	5885	2388	1129	5052	2012	951	4256	1650	780	3490	1296	612	2741
201111	1628	1070	2476	1398	919	2126	1177	774	1791	966	635	1468	758	498	1153
201112	346	42	2843	297	36	2441	250	30	2056	205	25	1686	161	20	1324
201201	723	489	1068	621	420	917	523	354	772	429	290	633	337	228	497
201202	1369	923	2031	1175	792	1744	990	668	1469	812	547	1205	638	430	946

Table C.128 Population estimates of sitting and flying Razorbills for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	4161	348	4509	3572	299	3871	3010	252	3261	2468	206	2674	1938	162	2100
201004	3094	159	3253	2656	137	2793	2238	115	2353	1835	94	1929	1441	74	1515
201005	299	14	313	257	12	269	216	10	227	177	9	186	139	7	146
201006	683	29	712	586	25	611	494	21	515	405	17	422	318	13	332
201007	3271	115	3386	2808	99	2907	2366	83	2449	1940	68	2008	1523	54	1577
201008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201009	12170	7	12177	10448	6	10454	8802	5	8807	7218	4	7222	5668	3	5671
201010	15038	203	15241	12910	175	13085	10877	147	11024	8919	121	9039	7004	95	7099
201011	2241	14	2255	1924	12	1936	1621	10	1631	1329	9	1338	1044	7	1050
201012	4060	44	4104	3486	37	3523	2936	32	2968	2408	26	2434	1891	20	1911
201101	1573	0	1573	1350	0	1350	1138	0	1138	933	0	933	733	0	733
201102	1276	43	1319	1095	37	1133	923	31	954	757	26	782	594	20	614
201103	1841	0	1841	1580	0	1580	1332	0	1332	1092	0	1092	857	0	857
201104	3038	0	3038	2608	0	2608	2197	0	2197	1802	0	1802	1415	0	1415
201105	285	0	285	245	0	245	206	0	206	169	0	169	133	0	133
201106	467	58	525	401	50	451	338	42	380	277	35	312	218	27	245
201107	696	29	725	598	25	623	503	21	525	413	17	430	324	14	338
201108	477	0	477	410	0	410	345	0	345	283	0	283	222	0	222
201109	9021	118	9139	7745	101	7846	6525	85	6610	5350	70	5420	4201	55	4256
201110	2782	30	2812	2388	25	2414	2012	21	2034	1650	18	1668	1296	14	1309
201111	1628	44	1672	1398	38	1435	1177	32	1209	966	26	992	758	20	779
201112	346	0	346	297	0	297	250	0	250	205	0	205	161	0	161
201201	723	466	1189	621	400	1021	523	337	860	429	276	705	337	217	554
201202	1369	14	1383	1175	12	1188	990	10	1001	812	9	820	638	7	644

Large auk species

Table C.129 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	6266	4813	8157	5379	4132	7003	4532	3481	5900	3716	2854	4838	2918	2242	3799
201004	7893	5241	11886	6776	4499	10204	5709	3791	8597	4681	3108	7049	3676	2441	5536
201005	3008	2500	3618	2582	2146	3106	2176	1808	2617	1784	1483	2146	1401	1164	1685
201006	5561	4639	6667	4774	3983	5724	4022	3355	4822	3298	2751	3954	2590	2161	3105
201007	14865	12613	17520	12762	10828	15041	10751	9123	12672	8816	7481	10391	6923	5874	8160
201008	13590	11423	16167	11667	9807	13879	9829	8262	11693	8060	6775	9588	6329	5320	7530
201009	50979	43396	59888	43765	37255	51414	36872	31387	43315	30235	25737	35518	23743	20211	27892
201010	60845	48128	76922	52235	41318	66038	44007	34810	55635	36086	28544	45621	28338	22415	35826
201011	17338	14199	21171	14885	12190	18175	12540	10270	15312	10283	8421	12556	8075	6613	9860
201012	12485	10554	14769	10718	9061	12679	9030	7633	10682	7405	6259	8759	5815	4915	6879
201101	5039	3564	7125	4326	3060	6117	3645	2578	5153	2989	2114	4226	2347	1660	3318
201102	4607	3346	6344	3955	2873	5446	3332	2420	4588	2732	1984	3763	2146	1558	2955
201103	4261	3164	5740	3658	2716	4928	3082	2288	4152	2527	1877	3404	1985	1474	2673
201104	6591	5234	8300	5658	4493	7126	4767	3786	6003	3909	3104	4923	3070	2438	3866
201105	5913	4550	7684	5076	3906	6597	4277	3291	5558	3507	2699	4557	2754	2119	3579
201106	7235	6072	8620	6211	5213	7400	5233	4392	6235	4291	3601	5112	3370	2828	4015
201107	13913	12048	16068	11944	10343	13794	10063	8714	11622	8252	7145	9530	6480	5611	7484
201108	6700	5259	8535	5752	4515	7327	4846	3804	6173	3974	3119	5062	3120	2449	3975
201109	31009	21884	43939	26621	18787	37722	22428	15828	31780	18391	12979	26059	14442	10192	20464
201110	12534	7986	19672	10760	6856	16888	9065	5776	14228	7434	4736	11667	5838	3719	9162
201111	3318	2420	4549	2849	2078	3905	2400	1750	3290	1968	1435	2698	1545	1127	2119
201112	4486	2329	8641	3851	1999	7418	3245	1684	6250	2661	1381	5125	2089	1085	4024
201201	2216	1678	2926	1902	1441	2512	1603	1214	2116	1314	995	1735	1032	782	1363
201202	3539	2777	4509	3038	2384	3871	2560	2009	3261	2099	1647	2674	1648	1293	2100

Table C.130 Population estimates of sitting and flying large auks for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	6266	841	7107	5379	722	6101	4532	608	5140	3716	499	4215	2918	392	3310
201004	7893	188	8081	6776	162	6938	5709	136	5845	4681	112	4793	3676	88	3764
201005	3008	58	3066	2582	50	2632	2176	42	2218	1784	34	1818	1401	27	1428
201006	5561	87	5648	4774	75	4849	4022	63	4085	3298	52	3350	2590	40	2630
201007	14865	144	15009	12762	124	12885	10751	104	10856	8816	85	8902	6923	67	6990
201008	13590	0	13590	11667	0	11667	9829	0	9829	8060	0	8060	6329	0	6329
201009	50979	22	51001	43765	19	43784	36872	16	36887	30235	13	30247	23743	10	23753
201010	60845	334	61179	52235	287	52522	44007	242	44249	36086	198	36284	28338	156	28494
201011	17338	159	17497	14885	137	15022	12540	115	12655	10283	95	10377	8075	74	8149
201012	12485	494	12979	10718	424	11142	9030	357	9387	7405	293	7697	5815	230	6045
201101	5039	898	5937	4326	771	5097	3645	649	4294	2989	532	3521	2347	418	2765
201102	4607	173	4780	3955	149	4104	3332	125	3458	2732	103	2835	2146	81	2226
201103	4261	205	4466	3658	176	3834	3082	148	3230	2527	121	2648	1985	95	2080
201104	6591	30	6621	5658	25	5684	4767	21	4788	3909	18	3927	3070	14	3083
201105	5913	74	5987	5076	63	5140	4277	53	4330	3507	44	3551	2754	34	2788
201106	7235	73	7308	6211	63	6274	5233	53	5286	4291	43	4334	3370	34	3404
201107	13913	175	14088	11944	151	12095	10063	127	10190	8252	104	8356	6480	82	6562
201108	6700	0	6700	5752	0	5752	4846	0	4846	3974	0	3974	3120	0	3120
201109	31009	206	31215	26621	177	26798	22428	149	22577	18391	122	18513	14442	96	14538
201110	12534	133	12667	10760	114	10875	9065	96	9162	7434	79	7513	5838	62	5900
201111	3318	59	3377	2849	50	2899	2400	42	2442	1968	35	2003	1545	27	1573
201112	4486	128	4614	3851	110	3961	3245	93	3337	2661	76	2737	2089	60	2149
201201	2216	565	2781	1902	485	2387	1603	408	2011	1314	335	1649	1032	263	1295
201202	3539	289	3828	3038	248	3286	2560	209	2769	2099	171	2270	1648	135	1783

All auk species

Table C.131 Population estimates of sitting birds (including lower and higher range estimates) for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Lower 95% Conf. interval	Higher 95% Conf. interval	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate	Pop. estimate sitting	Lower range estimate	Higher range estimate
201003	6544	5070	8447	5618	4353	7252	4733	3667	6109	3881	3007	5010	3048	2361	3934
201004	8773	5921	12999	7532	5083	11160	6345	4282	9402	5203	3512	7709	4086	2758	6054
201005	3797	3117	4627	3260	2676	3972	2746	2254	3347	2252	1849	2744	1768	1452	2155
201006	8047	6873	9422	6908	5900	8089	5820	4971	6815	4773	4076	5588	3748	3201	4388
201007	15169	12884	17861	13023	11061	15334	10971	9319	12918	8996	7641	10593	7065	6001	8319
201008	13734	11547	16336	11791	9913	14024	9933	8352	11815	8145	6848	9689	6397	5378	7608
201009	47572	40396	56022	40841	34680	48095	34407	29217	40519	28214	23958	33226	22156	18814	26092
201010	57476	45117	73222	49343	38733	62861	41571	32632	52959	34088	26758	43427	26769	21013	34103
201011	20086	16840	23958	17244	14457	20568	14528	12180	17328	11913	9987	14209	9355	7843	11158
201012	14219	12038	16795	12207	10335	14419	10284	8707	12147	8433	7140	9961	6622	5607	7822
201101	5965	4213	8445	5121	3617	7250	4314	3047	6108	3538	2499	5009	2778	1962	3933
201102	4922	3600	6730	4226	3091	5778	3560	2604	4868	2919	2135	3991	2292	1677	3134
201103	4939	3777	6460	4240	3243	5546	3572	2732	4672	2929	2240	3831	2300	1759	3009
201104	7122	5606	9047	6114	4813	7767	5151	4055	6543	4224	3325	5366	3317	2611	4214
201105	6355	4902	8239	5456	4208	7073	4596	3545	5959	3769	2907	4886	2960	2283	3837
201106	7210	6089	8538	6190	5227	7330	5215	4404	6175	4276	3611	5064	3358	2836	3977
201107	14575	12606	16852	12513	10822	14467	10542	9118	12189	8644	7476	9995	6788	5871	7849
201108	8671	6813	11036	7444	5849	9474	6271	4928	7982	5143	4041	6545	4038	3173	5140
201109	31822	23001	44026	27319	19746	37796	23016	16636	31843	18873	13641	26111	14821	10713	20505
201110	11506	7443	17786	9878	6390	15269	8322	5383	12864	6824	4414	10549	5359	3467	8284
201111	5865	4654	7392	5035	3995	6346	4242	3366	5346	3478	2760	4384	2732	2168	3443
201112	4700	2557	8636	4035	2195	7414	3399	1849	6246	2787	1517	5122	2189	1191	4022
201201	2561	1942	3377	2199	1667	2899	1852	1405	2442	1519	1152	2003	1193	904	1573
201202	4375	3411	5611	3756	2928	4817	3164	2467	4058	2595	2023	3328	2038	1589	2613

Table C.132 Population estimates of sitting and flying birds for the sub-zone 1 (DA +1+2+3+4 km buffers), DA +1+2+3 km buffers , DA +1+2 km buffers , DA +1 km buffers , and Development Area.

	Subzone 1			DA + 1+2+3 km buffers			DA + 1+2 km buffers			DA + 1 km buffers			DA		
Survey (yyyymm)	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total	Pop. estimate sitting	Pop. estimate flying	Pop. estimate total
201003	6544	870	7414	5618	747	6365	4733	629	5362	3881	516	4397	3048	405	3453
201004	8773	188	8961	7532	162	7693	6345	136	6481	5203	112	5315	4086	88	4174
201005	3797	58	3855	3260	50	3309	2746	42	2788	2252	34	2286	1768	27	1795
201006	8047	87	8134	6908	75	6983	5820	63	5883	4773	52	4824	3748	40	3788
201007	15169	144	15313	13023	124	13146	10971	104	11075	8996	85	9082	7065	67	7132
201008	13734	0	13734	11791	0	11791	9933	0	9933	8145	0	8145	6397	0	6397
201009	47572	22	47594	40841	19	40859	34407	16	34423	28214	13	28227	22156	10	22166
201010	57476	334	57810	49343	287	49630	41571	242	41812	34088	198	34286	26769	156	26925
201011	20086	188	20274	17244	162	17406	14528	136	14664	11913	112	12024	9355	88	9443
201012	14219	508	14727	12207	436	12643	10284	368	10652	8433	301	8734	6622	237	6859
201101	5965	898	6863	5121	771	5892	4314	649	4964	3538	532	4070	2778	418	3196
201102	4922	173	5095	4226	149	4374	3560	125	3685	2919	103	3022	2292	81	2373
201103	4939	205	5144	4240	176	4416	3572	148	3720	2929	121	3051	2300	95	2396
201104	7122	44	7166	6114	38	6152	5151	32	5183	4224	26	4250	3317	21	3338
201105	6355	74	6429	5456	63	5519	4596	53	4650	3769	44	3813	2960	34	2994
201106	7210	73	7283	6190	63	6252	5215	53	5268	4276	43	4319	3358	34	3392
201107	14575	175	14750	12513	151	12663	10542	127	10669	8644	104	8748	6788	82	6870
201108	8671	0	8671	7444	0	7444	6271	0	6271	5143	0	5143	4038	0	4038
201109	31822	236	32058	27319	202	27522	23016	170	23186	18873	140	19013	14821	110	14931
201110	11506	148	11654	9878	127	10005	8322	107	8429	6824	88	6912	5359	69	5428
201111	5865	59	5924	5035	50	5085	4242	42	4284	3478	35	3513	2732	27	2759
201112	4700	128	4828	4035	110	4145	3399	93	3492	2787	76	2863	2189	60	2249
201201	2561	565	3126	2199	485	2683	1852	408	2261	1519	335	1854	1193	263	1456
201202	4375	289	4664	3756	248	4004	3164	209	3373	2595	171	2766	2038	135	2172

Collision rate modelling using the SOSS Band (2012) basic model option 1

Introduction

C.63. Below the results of the SOSS Band (2012) basic collision rate modelling using site-based flight height data (option 1) are presented for year 1 (March 2010 to February 2011), year 2 (March 2011 to February 2012) and for both years combined for two projects within the Round 3 Hornsea area.

C.64. A total of two wind farm variants were modelled for project 1 (in sub-zone 1) and two in project 2 (in sub-zone 2) (to provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area). The parameters of each variant that were used in the collision rate modelling are given in tables C.133 and C.134. For each of the wind farm variants a monthly operating time of 85% was assumed, which was based on data provided by Mainstream.

Table C.133 Parameters used in collision rate modelling, for two wind farm variants at Hornsea project 1.

Variant	Number of blades	Rotation speed (rpm)	Rotor radius (m)	Minimum rotor height	Maximum blade width (m)	Pitch (°)	Number of turbines	Latitude (DD)
332 x 3.6MW	3	13.0	60	22	4.2	15[1]	332	53.89
150 x 8MW	3	11.9	89	22	5.9	15[1]	150	53.89

[1] Data based on nominal value.

Table C.134 Parameters used in collision rate modelling, for two wind farm variants at Hornsea project 2.

Variant	Number of blades	Rotation speed (rpm)	Rotor radius (m)	Minimum rotor height	Maximum blade width (m)	Pitch (°)	Number of turbines	Latitude (DD)
240 x 5MW	3	16.3	58	22	4.1[1]	15[2]	240	53.92
360 x 5MW	3	16.3	58	22	4.1[1]	15[2]	360	53.92

[1] Data estimated based on other turbine models.
[2] Data based on nominal value.

C.65. For each of the wind farm variants, collision rate modelling was carried out for a total of 14 species and three species groups. The parameters of each species that were used in the collision rate modelling are given in table C.135. During the ship-based surveys, not all individuals can be identified to the species level. By including the species groups: 'Large gulls combined'; 'Guillemot/Razorbill' and 'Common and Arctic Terns combined'; the densities of these groups can be compared with those for the identified birds. The group 'Large gulls combined' included all Great Black-backed Gulls, Lesser Black-backed Gulls, Herring Gulls and unidentified black-backed and large gulls. The group 'Guillemot/Razorbill' included all Guillemots, Razorbills and unidentified Guillemot/Razorbills. The group 'Common and Arctic Terns combined' included all Common Terns, Arctic Terns and unidentified Common and Arctic Terns. Furthermore, the densities for unidentified species groups, such as terns and auks, were assigned to the species level on the basis of the abundance of these species in the month in question.

C.66. For project 1, the densities of flying birds were based on those recorded during the specific sub-zone 1 ship-based surveys within the sub-zone 1 development area. For project 2, densities of flying birds were based on those recorded during the 6km transect ship-based surveys within the relevant sub-zone area.

C.67. The results of the basic collision rate modelling are given in:

Results Year 1 sub-zone 1; tables C.136 - C.142

Results Year 1 sub-zone 2; tables C.143 - C.149

Results Year 2 sub-zone 1; tables C.150 - C.156

Results Year 2 sub-zone 2; tables C.157 - C.163

Results Years 1 and 2 sub-zone 1; tables C.164 - C.170

Results Years 1 and 2 sub-zone 2; tables C.171 - C.177

Data for various stages of the models are presented as well as the results for various avoidance rates (see C.29). For each sub-zone and year the monthly densities of flying birds are presented. Data do not exist for all months, as is indicated by blank columns. For these months the monthly potential numbers of flights and potential numbers of collisions show '0', however, yearly figures presented are calculated from the monthly rates averaged across that year.

Table C.135 Parameters used in collision rate modelling for fourteen bird species and three species groups.

Species	Length[1] (m)	Wingspan[1] (m)	Flight speed (m/s)	Flapping (0) or gliding (1)	Nocturnal activity factor[5] (1-5)	Proportion at rotor height for Project 1[6]	Proportion at rotor height for Project 2[7]
Fulmar	0.475	1.09	13[2]	0	4	0.000	0.000
Gannet	0.935	1.725	14.9[3]	0	2	0.050	0.074
Kittiwake	0.39	1.075	13.1[2]	0	3	0.037	0.022
Little Gull	0.28	0.69	11.5[2]	0	2	0.006	0.023
Common Gull	0.43	1.035	13.4[2]	0	3	0.053	0.070
Great Black-backed Gull	0.74	1.66	13.7[2]	0	3	0.274	0.257
Lesser Black-backed Gull	0.56	1.34	13.1[2]	0	3	0.179	0.178
Herring Gull	0.61	1.44	12.8[2]	0	3	0.313	0.265
Large gulls combined	0.64[8]	1.48[8]	13.2[8]	0	3	0.214[8]	0.201[8]
Common Tern	0.355	0.75	10.55[9]	0	1	0.000	0.012
Arctic Tern	0.36	0.715	10.9[2]	0	1	0.000	0.000
Guillemot	0.395	0.67	19.1[4]	0	2	0.000	0.000
Razorbill	0.38	0.655	16[4]	0	1	0.000	0.000
Guillemot/Razorbill	0.38[10]	0.655[10]	16[10]	0	1	0.000	0.000
Common and Arctic Terns combined	0.355[11]	0.75[11]	10.55[11]	0	1	0.001[11]	0.033[11]
Arctic Skua	0.405	1.13	13.3[3]	0	1	0.016	0.00
Great Skua	0.54	1.325	14.9[3]	0	1	0.061	0.133

[1] *Taken from Cramp & Perrins (1974-1994) or Snow & Perrins (1997).*
[2] *Taken from Alerstam* et al. *(2007).*
[3] *Taken from Pennycuick (1997).*
[4] *Taken from Pennycuick (1987).*
[5] *Taken from Garthe & H*üppop (2004).
[6] *Based on observed flight heights from ship-based surveys carried out at Hornsea sub-zone 1 between March 2010 and February 2012. Taken as proportion of birds in categories 25-150m.*
[7] *Based on observed flight heights from ship-based surveys carried out at Hornsea Round 3 area between March 2010 and February 2012. Taken as proportion of birds in categories 25-150m*
[8] *Taken as the mean values of Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull.*
[9] *Taken as mean from upwind and downwind from Wakeling & Hodgson (1992).*
[10] *Taken as Razorbill.*
[11] *Taken as Common Tern.*
[12] *Taken as Common Tern, Arctic Tern and unidentified Common or Arctic Tern combined.*

Results Year 1 sub-zone 1

Table C.136 Densities of flying birds at Hornsea sub-zone 1 development area between March 2010 and February 2011. Data gathered during ship-based surveys.

Species	*Density (birds/km2) Jan*	*Density (birds/km2) Feb*	*Density (birds/km2) Mar*	*Density (birds/km2) Apr*	*Density (birds/km2) May*	*Density (birds/km2) Jun*	*Density (birds/km2) Jul*	*Density (birds/km2) Aug*	*Density (birds/km2) Sep*	*Density (birds/km2) Oct*	*Density (birds/km2) Nov*	*Density (birds/km2) Dec*
Fulmar	0.17	0.10	0.50	0.03	0.31	0.23	0.03	0.17	0.14	0.02	0.08	0.00
Gannet	0.20	0.13	0.55	0.07	0.07	0.03	0.00	0.25	0.16	0.47	0.53	0.08
Kittiwake	0.43	0.51	0.58	0.18	0.12	0.98	0.67	1.08	0.85	0.18	1.49	0.33
Little Gull	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	5.23	0.46	0.00
Common Gull	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02
Great Black-backed Gull	0.25	0.12	0.05	0.00	0.03	0.00	0.03	0.10	0.07	0.02	0.08	0.15
Lesser Black-backed Gull	0.00	0.00	0.00	0.03	0.03	0.08	0.18	0.18	0.00	0.00	0.00	0.07
Herring Gull	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.18
Large gulls combined	0.26	0.13	0.07	0.03	0.07	0.08	0.21	0.28	0.07	0.02	0.12	0.40
Common Tern	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.67	0.12	0.00	0.00
Arctic Tern	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00
Guillemot	1.03	0.15	0.52	0.03	0.05	0.07	0.03	0.00	0.01	0.11	0.17	0.51
Razorbill	0.00	0.05	0.44	0.18	0.02	0.03	0.13	0.00	0.01	0.27	0.02	0.05
Guillemot/Razorbill	1.03	0.20	0.96	0.22	0.07	0.10	0.16	0.00	0.02	0.38	0.18	0.56
Common/Arctic Terns combined	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.12	0.67	0.12	0.00	0.00
Arctic Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Great Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table C.137 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of transits through the rotor-swept area.

332 x 3.6MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	57	32	180	12	120	86	13	62	50	6	28	0	645
Gannet	0.088	6243	4150	21235	2762	3107	1570	0	11125	6491	16966	16733	2523	92905
Kittiwake	0.067	11803	13363	17781	5731	3962	33173	23428	35794	25851	5414	40327	8955	225584
Little Gull	0.064	0	0	0	0	0	0	0	0	249	16260	1247	0	17757
Common Gull	0.068	663	0	0	760	0	0	0	0	366	0	0	654	2443
Great Black-backed Gull	0.083	52230	23145	11690	0	8683	0	8766	25342	17326	3775	17184	30910	199051
Lesser Black-backed Gull	0.076	0	0	0	4976	5406	13425	30015	28926	0	0	0	8553	91301
Herring Gull	0.079	3709	3522	4151	0	0	0	0	0	0	0	7322	40244	58948
Large gulls combined	0.080	41906	19896	11724	6012	13063	16219	42857	54010	13032	2840	18096	62001	301657
Common Tern	0.071	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.057	284	41	177	12	20	28	14	0	4	37	46	137	800
Razorbill	0.059	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.059	84	18	115	30	11	17	28	0	3	41	15	43	403
Common/Arctic Terns combined	0.071	0	0	0	0	0	13	0	40	193	29	0	0	275
Arctic Skua	0.068	0	0	0	0	0	0	0	0	76	0	0	0	76
Great Skua	0.071	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	38	21	121	8	80	58	8	42	33	4	19	0	432
Gannet	0.084	4184	2781	14231	1851	2082	1052	0	7456	4350	11370	11214	1691	62263
Kittiwake	0.067	7910	8956	11917	3841	2655	22232	15701	23988	17325	3628	27027	6002	151182
Little Gull	0.067	0	0	0	0	0	0	0	0	167	10897	836	0	11900
Common Gull	0.068	444	0	0	510	0	0	0	0	245	0	0	438	1637
Great Black-backed Gull	0.081	35003	15511	7834	0	5819	0	5875	16984	11611	2530	11516	20715	133400
Lesser Black-backed Gull	0.075	0	0	0	3335	3623	8997	20116	19386	0	0	0	5732	61188
Herring Gull	0.078	2486	2360	2782	0	0	0	0	0	0	0	4907	26971	39506
Large gulls combined	0.078	28085	13334	7857	4029	8755	10870	28722	36197	8734	1903	12128	41552	202165
Common Tern	0.075	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.073	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.054	190	28	118	8	14	19	9	0	3	25	31	92	536
Razorbill	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.058	56	12	77	20	7	11	19	0	2	28	10	29	270
Common/Arctic Terns combined	0.075	0	0	0	0	0	9	0	27	129	19	0	0	184
Arctic Skua	0.067	0	0	0	0	0	0	0	0	51	0	0	0	51
Great Skua	0.068	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.138 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of collisions assuming no avoidance.

332 x 3.6MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	3	2	11	1	7	5	1	4	3	0	2	0	39
Gannet	465	309	1583	206	232	117	0	829	484	1265	1247	188	6926
Kittiwake	673	762	1013	327	226	1891	1335	2040	1473	309	2298	510	12857
Little Gull	0	0	0	0	0	0	0	0	14	883	68	0	964
Common Gull	38	0	0	44	0	0	0	0	21	0	0	38	141
Great Black-backed Gull	3696	1638	827	0	614	0	620	1793	1226	267	1216	2187	14085
Lesser Black-backed Gull	0	0	0	320	348	864	1931	1861	0	0	0	550	5875
Herring Gull	250	237	280	0	0	0	0	0	0	0	494	2714	3975
Large gulls combined	2835	1346	793	407	884	1097	2899	3654	882	192	1224	4194	20407
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	14	2	9	1	1	1	1	0	0	2	2	7	39
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	4	1	6	1	1	1	1	0	0	2	1	2	20
Common/Arctic Terns combined	0	0	0	0	0	1	0	2	12	2	0	0	17
Arctic Skua	0	0	0	0	0	0	0	0	4	0	0	0	4
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	2	1	7	0	5	3	1	3	2	0	1	0	26
Gannet	299	199	1016	132	149	75	0	532	310	811	800	121	4444
Kittiwake	450	510	678	219	151	1266	894	1366	986	207	1539	342	8607
Little Gull	0	0	0	0	0	0	0	0	9	617	47	0	674
Common Gull	25	0	0	29	0	0	0	0	14	0	0	25	94
Great Black-backed Gull	2403	1065	538	0	400	0	403	1166	797	174	791	1422	9158
Lesser Black-backed Gull	0	0	0	212	230	572	1279	1232	0	0	0	364	3890
Herring Gull	166	157	185	0	0	0	0	0	0	0	327	1796	2631
Large gulls combined	1865	885	522	268	581	722	1907	2404	580	126	805	2759	13425
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	9	1	5	0	1	1	0	0	0	1	1	4	25
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	3	1	4	1	0	1	1	0	0	1	1	1	13
Common/Arctic Terns combined	0	0	0	0	0	1	0	2	8	1	0	0	12
Arctic Skua	0	0	0	0	0	0	0	0	3	0	0	0	3
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.139 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 95%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	1	0	0	0	0	0	0	0	0	0	2
Gannet	23	15	79	10	12	6	0	41	24	63	62	9	346
Kittiwake	34	38	51	16	11	95	67	102	74	15	115	26	643
Little Gull	0	0	0	0	0	0	0	0	1	44	3	0	48
Common Gull	2	0	0	2	0	0	0	0	1	0	0	2	7
Great Black-backed Gull	185	82	41	0	31	0	31	90	61	13	61	109	704
Lesser Black-backed Gull	0	0	0	16	17	43	97	93	0	0	0	28	294
Herring Gull	13	12	14	0	0	0	0	0	0	0	25	136	199
Large gulls combined	142	67	40	20	44	55	145	183	44	10	61	210	1020
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	1	0	0	0	0	0	0	0	0	0	0	0	2
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	1	0	0	0	1
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	15	10	51	7	7	4	0	27	16	41	40	6	222
Kittiwake	23	25	34	11	8	63	45	68	49	10	77	17	430
Little Gull	0	0	0	0	0	0	0	0	0	31	2	0	34
Common Gull	1	0	0	1	0	0	0	0	1	0	0	1	5
Great Black-backed Gull	120	53	27	0	20	0	20	58	40	9	40	71	458
Lesser Black-backed Gull	0	0	0	11	12	29	64	62	0	0	0	18	194
Herring Gull	8	8	9	0	0	0	0	0	0	0	16	90	132
Large gulls combined	93	44	26	13	29	36	95	120	29	6	40	138	671
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	1
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.140 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 98%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	9	6	32	4	5	2	0	17	10	25	25	4	139
Kittiwake	13	15	20	7	5	38	27	41	29	6	46	10	257
Little Gull	0	0	0	0	0	0	0	0	0	18	1	0	19
Common Gull	1	0	0	1	0	0	0	0	0	0	0	1	3
Great Black-backed Gull	74	33	17	0	12	0	12	36	25	5	24	44	282
Lesser Black-backed Gull	0	0	0	6	7	17	39	37	0	0	0	11	117
Herring Gull	5	5	6	0	0	0	0	0	0	0	10	54	79
Large gulls combined	57	27	16	8	18	22	58	73	18	4	24	84	408
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	6	4	20	3	3	2	0	11	6	16	16	2	89
Kittiwake	9	10	14	4	3	25	18	27	20	4	31	7	172
Little Gull	0	0	0	0	0	0	0	0	0	12	1	0	13
Common Gull	1	0	0	1	0	0	0	0	0	0	0	1	2
Great Black-backed Gull	48	21	11	0	8	0	8	23	16	3	16	28	183
Lesser Black-backed Gull	0	0	0	4	5	11	26	25	0	0	0	7	78
Herring Gull	3	3	4	0	0	0	0	0	0	0	7	36	53
Large gulls combined	37	18	10	5	12	14	38	48	12	3	16	55	268
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.141 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 99%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	5	3	16	2	2	1	0	8	5	13	12	2	69
Kittiwake	7	8	10	3	2	19	13	20	15	3	23	5	129
Little Gull	0	0	0	0	0	0	0	0	0	9	1	0	10
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	37	16	8	0	6	0	6	18	12	3	12	22	141
Lesser Black-backed Gull	0	0	0	3	3	9	19	19	0	0	0	6	59
Herring Gull	3	2	3	0	0	0	0	0	0	0	5	27	40
Large gulls combined	28	13	8	4	9	11	29	37	9	2	12	42	204
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	3	2	10	1	1	1	0	5	3	8	8	1	44
Kittiwake	5	5	7	2	2	13	9	14	10	2	15	3	86
Little Gull	0	0	0	0	0	0	0	0	0	6	0	0	7
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	24	11	5	0	4	0	4	12	8	2	8	14	92
Lesser Black-backed Gull	0	0	0	2	2	6	13	12	0	0	0	4	39
Herring Gull	2	2	2	0	0	0	0	0	0	0	3	18	26
Large gulls combined	19	9	5	3	6	7	19	24	6	1	8	28	134
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.142 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 99.5%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	2	8	1	1	1	0	4	2	6	6	1	35
Kittiwake	3	4	5	2	1	9	7	10	7	2	11	3	64
Little Gull	0	0	0	0	0	0	0	0	0	4	0	0	5
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	18	8	4	0	3	0	3	9	6	1	6	11	70
Lesser Black-backed Gull	0	0	0	2	2	4	10	9	0	0	0	3	29
Herring Gull	1	1	1	0	0	0	0	0	0	0	2	14	20
Large gulls combined	14	7	4	2	4	5	14	18	4	1	6	21	102
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	1	1	5	1	1	0	0	3	2	4	4	1	22
Kittiwake	2	3	3	1	1	6	4	7	5	1	8	2	43
Little Gull	0	0	0	0	0	0	0	0	0	3	0	0	3
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Black-backed Gull	12	5	3	0	2	0	2	6	4	1	4	7	46
Lesser Black-backed Gull	0	0	0	1	1	3	6	6	0	0	0	2	19
Herring Gull	1	1	1	0	0	0	0	0	0	0	2	9	13
Large gulls combined	9	4	3	1	3	4	10	12	3	1	4	14	67
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Results Year 1 sub-zone 2

Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 2km transect surveys within this area.

Table C.143 Densities of flying birds at Hornsea sub-zone 2 between March 2010 and February 2011. Data gathered during ship-based surveys.

Species	*Density (birds/km2) Jan*	*Density (birds/km2) Feb*	*Density (birds/km2) Mar*	*Density (birds/km2) Apr*	*Density (birds/km2) May*	*Density (birds/km2) Jun*	*Density (birds/km2) Jul*	*Density (birds/km2) Aug*	*Density (birds/km2) Sep*	*Density (birds/km2) Oct*	*Density (birds/km2) Nov*	*Density (birds/km2) Dec*
Fulmar	0.16		0.04	0.22	0.95	0.29	0.14	0.18	0.29	0.04	0.15	0.22
Gannet	0.08		0.47	0.25	0.00	0.18	0.07	0.28	0.11	0.62	0.44	0.04
Kittiwake	0.31		0.11	0.15	0.44	0.36	1.44	1.16	0.29	0.40	1.56	0.22
Little Gull	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00	0.00
Common Gull	0.08		0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.15
Great Black-backed Gull	0.28		0.15	0.04	0.00	0.00	0.00	0.00	0.00	0.07	0.15	0.15
Lesser Black-backed Gull	0.00		0.00	0.11	0.00	0.11	0.00	0.07	0.00	0.00	0.00	0.00
Herring Gull	0.19		0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.07	0.04	0.04
Large gulls combined	0.47		0.15	0.15	0.00	0.14	0.00	0.07	0.00	0.15	0.18	0.18
Common Tern	0.00		0.00	0.00	0.00	0.00	0.00	0.00	2.38	0.00	0.00	0.00
Arctic Tern	0.00		0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00
Guillemot	0.00		0.11	0.00	0.07	0.11	0.43	0.00	0.00	0.18	0.73	0.18
Razorbill	0.00		0.00	0.00	0.00	0.07	0.14	0.00	0.00	0.15	0.00	0.00
Guillemot/Razorbill	0.00		0.11	0.00	0.07	0.18	0.58	0.00	0.00	0.33	0.73	0.18
Common/Arctic Terns combined	0.00		0.00	0.00	0.00	0.00	0.00	0.11	2.38	0.00	0.00	0.00
Arctic Skua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Great Skua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00

Table C.144 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of transits through the rotor-swept area.

240 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	21	0	5	31	142	42	22	26	41	5	19	30	419
Gannet	0.100	2527	0	19015	10991	0	8869	3592	13074	4476	23372	14209	1145	110476
Kittiwake	0.075	3486	0	1369	1873	6133	5019	20478	15823	3648	4855	17243	2410	89821
Little Gull	0.072	0	0	0	0	0	0	0	0	0	22286	0	0	24312
Common Gull	0.076	2858	0	0	0	0	0	0	0	1495	1447	1315	5268	13510
Great Black-backed Gull	0.095	38513	0	22407	5747	0	0	0	0	0	10836	19690	19722	127543
Lesser Black-backed Gull	0.086	0	0	0	11384	0	12204	0	7772	0	0	0	0	34211
Herring Gull	0.090	24677	0	0	0	0	5922	0	0	0	10414	4731	4739	55071
Large gulls combined	0.091	48320	0	16868	17306	0	18553	0	8861	0	16314	18528	18558	178155
Common Tern	0.082	0	0	0	0	0	0	0	0	8724	0	0	0	9518
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0.082	0	0	0	0	0	0	0	1343	25126	0	0	0	28875
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	0	0	0	1468	0	1602

360 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	32	0	8	46	213	63	33	39	61	8	29	44	628
Gannet	0.100	3790	0	28523	16487	0	13303	5388	19610	6714	35058	21313	1718	165714
Kittiwake	0.075	5229	0	2054	2809	9200	7529	30717	23734	5471	7282	25864	3615	134732
Little Gull	0.072	0	0	0	0	0	0	0	0	0	33429	0	0	36468
Common Gull	0.076	4287	0	0	0	0	0	0	0	2243	2171	1972	7903	20264
Great Black-backed Gull	0.095	57770	0	33611	8621	0	0	0	0	0	16253	29534	29582	191315
Lesser Black-backed Gull	0.086	0	0	0	17076	0	18306	0	11658	0	0	0	0	51317
Herring Gull	0.090	37015	0	0	0	0	8883	0	0	0	15621	7096	7108	82607
Large gulls combined	0.091	72480	0	25302	25960	0	27830	0	13292	0	24471	27791	27837	267232
Common Tern	0.082	0	0	0	0	0	0	0	0	13087	0	0	0	14276
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0.082	0	0	0	0	0	0	0	2015	37689	0	0	0	43313
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	0	0	0	2203	0	2403

Table C.145 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of collisions assuming no avoidance.

240 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	1	0	0	2	10	3	1	2	3	0	1	2	29
Gannet	215	0	1618	935	0	755	306	1113	381	1989	1209	97	9402
Kittiwake	223	0	87	120	392	321	1308	1011	233	310	1101	154	5738
Little Gull	0	0	0	0	0	0	0	0	0	1373	0	0	1498
Common Gull	185	0	0	0	0	0	0	0	97	94	85	341	874
Great Black-backed Gull	3103	0	1805	463	0	0	0	0	0	873	1586	1589	10276
Lesser Black-backed Gull	0	0	0	831	0	891	0	567	0	0	0	0	2498
Herring Gull	1898	0	0	0	0	455	0	0	0	801	364	364	4236
Large gulls combined	3721	0	1299	1333	0	1429	0	682	0	1256	1427	1429	13719
Common Tern	0	0	0	0	0	0	0	0	611	0	0	0	666
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	94	1759	0	0	0	2021
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	98	0	107

360 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	2	0	1	3	15	4	2	3	4	1	2	3	43
Gannet	323	0	2427	1403	0	1132	458	1669	571	2983	1814	146	14102
Kittiwake	334	0	131	179	588	481	1962	1516	350	465	1652	231	8606
Little Gull	0	0	0	0	0	0	0	0	0	2060	0	0	2247
Common Gull	277	0	0	0	0	0	0	0	145	140	128	511	1311
Great Black-backed Gull	4655	0	2708	695	0	0	0	0	0	1310	2380	2383	15414
Lesser Black-backed Gull	0	0	0	1247	0	1336	0	851	0	0	0	0	3746
Herring Gull	2847	0	0	0	0	683	0	0	0	1201	546	547	6354
Large gulls combined	5581	0	1948	1999	0	2143	0	1024	0	1884	2140	2144	20579
Common Tern	0	0	0	0	0	0	0	0	916	0	0	0	999
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	141	2638	0	0	0	3032
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	147	0	161

Table C.146 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 95%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	11	0	81	47	0	38	15	56	19	99	60	5	470
Kittiwake	11	0	4	6	20	16	65	51	12	16	55	8	287
Little Gull	0	0	0	0	0	0	0	0	0	69	0	0	75
Common Gull	9	0	0	0	0	0	0	0	5	5	4	17	44
Great Black-backed Gull	155	0	90	23	0	0	0	0	0	44	79	79	514
Lesser Black-backed Gull	0	0	0	42	0	45	0	28	0	0	0	0	125
Herring Gull	95	0	0	0	0	23	0	0	0	40	18	18	212
Large gulls combined	186	0	65	67	0	71	0	34	0	63	71	71	686
Common Tern	0	0	0	0	0	0	0	0	31	0	0	0	33
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	5	88	0	0	0	101
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	5	0	5

360 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	1	0	0	0	0	0	0	0	2
Gannet	16	0	121	70	0	57	23	83	29	149	91	7	705
Kittiwake	17	0	7	9	29	24	98	76	17	23	83	12	430
Little Gull	0	0	0	0	0	0	0	0	0	103	0	0	112
Common Gull	14	0	0	0	0	0	0	0	7	7	6	26	66
Great Black-backed Gull	233	0	135	35	0	0	0	0	0	65	119	119	771
Lesser Black-backed Gull	0	0	0	62	0	67	0	43	0	0	0	0	187
Herring Gull	142	0	0	0	0	34	0	0	0	60	27	27	318
Large gulls combined	279	0	97	100	0	107	0	51	0	94	107	107	1029
Common Tern	0	0	0	0	0	0	0	0	46	0	0	0	50
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	7	132	0	0	0	152
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	7	0	8

Table C.147 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 98%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	4	0	32	19	0	15	6	22	8	40	24	2	188
Kittiwake	4	0	2	2	8	6	26	20	5	6	22	3	115
Little Gull	0	0	0	0	0	0	0	0	0	27	0	0	30
Common Gull	4	0	0	0	0	0	0	0	2	2	2	7	17
Great Black-backed Gull	62	0	36	9	0	0	0	0	0	17	32	32	206
Lesser Black-backed Gull	0	0	0	17	0	18	0	11	0	0	0	0	50
Herring Gull	38	0	0	0	0	9	0	0	0	16	7	7	85
Large gulls combined	74	0	26	27	0	29	0	14	0	25	29	29	274
Common Tern	0	0	0	0	0	0	0	0	12	0	0	0	13
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	2	35	0	0	0	40
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	2	0	2

360 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	6	0	49	28	0	23	9	33	11	60	36	3	282
Kittiwake	7	0	3	4	12	10	39	30	7	9	33	5	172
Little Gull	0	0	0	0	0	0	0	0	0	41	0	0	45
Common Gull	6	0	0	0	0	0	0	0	3	3	3	10	26
Great Black-backed Gull	93	0	54	14	0	0	0	0	0	26	48	48	308
Lesser Black-backed Gull	0	0	0	25	0	27	0	17	0	0	0	0	75
Herring Gull	57	0	0	0	0	14	0	0	0	24	11	11	127
Large gulls combined	112	0	39	40	0	43	0	20	0	38	43	43	412
Common Tern	0	0	0	0	0	0	0	0	18	0	0	0	20
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	3	53	0	0	0	61
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	3	0	3

Table C.148 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 99%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	0	16	9	0	8	3	11	4	20	12	1	94
Kittiwake	2	0	1	1	4	3	13	10	2	3	11	2	57
Little Gull	0	0	0	0	0	0	0	0	0	14	0	0	15
Common Gull	2	0	0	0	0	0	0	0	1	1	1	3	9
Great Black-backed Gull	31	0	18	5	0	0	0	0	0	9	16	16	103
Lesser Black-backed Gull	0	0	0	8	0	9	0	6	0	0	0	0	25
Herring Gull	19	0	0	0	0	5	0	0	0	8	4	4	42
Large gulls combined	37	0	13	13	0	14	0	7	0	13	14	14	137
Common Tern	0	0	0	0	0	0	0	0	6	0	0	0	7
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	1	18	0	0	0	20
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	1	0	1

360 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	3	0	24	14	0	11	5	17	6	30	18	1	141
Kittiwake	3	0	1	2	6	5	20	15	3	5	17	2	86
Little Gull	0	0	0	0	0	0	0	0	0	21	0	0	22
Common Gull	3	0	0	0	0	0	0	0	1	1	1	5	13
Great Black-backed Gull	47	0	27	7	0	0	0	0	0	13	24	24	154
Lesser Black-backed Gull	0	0	0	12	0	13	0	9	0	0	0	0	37
Herring Gull	28	0	0	0	0	7	0	0	0	12	5	5	64
Large gulls combined	56	0	19	20	0	21	0	10	0	19	21	21	206
Common Tern	0	0	0	0	0	0	0	0	9	0	0	0	10
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	1	26	0	0	0	30
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	1	0	2

Table C.149 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2011. Potential number of collisions assuming an avoidance rate of 99.5%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	1	0	8	5	0	4	2	6	2	10	6	0	47
Kittiwake	1	0	0	1	2	2	7	5	1	2	6	1	29
Little Gull	0	0	0	0	0	0	0	0	0	7	0	0	7
Common Gull	1	0	0	0	0	0	0	0	0	0	0	2	4
Great Black-backed Gull	16	0	9	2	0	0	0	0	0	4	8	8	51
Lesser Black-backed Gull	0	0	0	4	0	4	0	3	0	0	0	0	12
Herring Gull	9	0	0	0	0	2	0	0	0	4	2	2	21
Large gulls combined	19	0	6	7	0	7	0	3	0	6	7	7	69
Common Tern	0	0	0	0	0	0	0	0	3	0	0	0	3
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	0	9	0	0	0	10
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

360 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	0	12	7	0	6	2	8	3	15	9	1	71
Kittiwake	2	0	1	1	3	2	10	8	2	2	8	1	43
Little Gull	0	0	0	0	0	0	0	0	0	10	0	0	11
Common Gull	1	0	0	0	0	0	0	0	1	1	1	3	7
Great Black-backed Gull	23	0	14	3	0	0	0	0	0	7	12	12	77
Lesser Black-backed Gull	0	0	0	6	0	7	0	4	0	0	0	0	19
Herring Gull	14	0	0	0	0	3	0	0	0	6	3	3	32
Large gulls combined	28	0	10	10	0	11	0	5	0	9	11	11	103
Common Tern	0	0	0	0	0	0	0	0	5	0	0	0	5
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	1	13	0	0	0	15
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	1	0	1

Results Year 2 sub-zone 1

Table C.150 Densities of flying birds at Hornsea sub-zone 1 development area between March 2011 and February 2012. Data gathered during ship-based surveys.

Species	*Density (birds/km2) Jan*	*Density (birds/km2) Feb*	*Density (birds/km2) Mar*	*Density (birds/km2) Apr*	*Density (birds/km2) May*	*Density (birds/km2) Jun*	*Density (birds/km2) Jul*	*Density (birds/km2) Aug*	*Density (birds/km2) Sep*	*Density (birds/km2) Oct*	*Density (birds/km2) Nov*	*Density (birds/km2) Dec*
Fulmar	0.21	0.05	0.07	0.05	0.17	0.58	0.43	0.05	0.07	0.07	0.00	0.00
Gannet	0.29	0.02	0.31	0.07	0.00	0.00	0.13	0.03	0.20	0.23	0.57	0.00
Kittiwake	0.26	0.21	0.39	0.20	0.02	0.45	1.86	0.30	0.69	0.50	0.27	0.15
Little Gull	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Common Gull	0.03	0.07	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Great Black-backed Gull	0.19	0.10	0.21	0.10	0.05	0.02	0.07	0.00	0.37	0.03	0.19	0.15
Lesser Black-backed Gull	0.05	0.00	0.00	0.03	0.10	0.05	0.03	0.02	0.03	0.00	0.00	0.00
Herring Gull	0.00	0.03	0.07	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Large gulls combined	0.24	0.13	0.28	0.15	0.17	0.07	0.10	0.02	0.41	0.03	0.20	0.15
Common Tern	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Arctic Tern	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Guillemot	0.11	0.31	0.23	0.03	0.08	0.02	0.17	0.00	0.12	0.02	0.10	0.15
Razorbill	0.53	0.02	0.00	0.00	0.00	0.07	0.03	0.00	0.03	0.05	0.13	0.00
Guillemot/Razorbill	0.65	0.33	0.23	0.03	0.08	0.08	0.20	0.00	0.15	0.07	0.24	0.15
Common/Arctic Terns combined	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.02	0.00	0.02	0.00	0.00
Arctic Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Great Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00

Table C.151 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of transits through the rotor-swept area.

332 x 3.6MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	73	16	26	18	64	218	166	19	24	24	0	0	648
Gannet	0.088	9131	518	11918	2819	0	0	6435	1489	7999	8558	18067	0	66935
Kittiwake	0.067	7082	5600	12098	6382	576	15311	64417	9950	21133	14897	7285	3949	168682
Little Gull	0.064	0	0	0	0	0	0	0	0	0	0	91	0	91
Common Gull	0.068	1292	2515	654	2329	0	0	0	0	0	1449	0	0	8239
Great Black-backed Gull	0.083	40742	19825	49933	24475	13251	4350	17805	0	86977	7618	38417	30292	333685
Lesser Black-backed Gull	0.076	6341	0	0	5079	16500	8124	5543	2640	4923	0	0	0	49150
Herring Gull	0.079	0	7039	16366	4345	4705	0	0	0	0	0	3720	0	36177
Large gulls combined	0.080	38307	19883	49116	27615	33226	13087	20089	3189	71372	5730	31524	22785	335923
Common Tern	0.071	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.057	31	87	80	12	35	7	71	0	41	5	28	39	436
Razorbill	0.059	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.059	53	29	28	5	14	14	34	0	19	7	20	11	233
Common/Arctic Terns combined	0.071	0	0	0	0	75	0	0	6	0	4	0	0	85
Arctic Skua	0.068	0	0	0	0	0	0	0	0	470	0	0	0	470
Great Skua	0.071	0	0	0	0	0	0	0	787	666	0	0	0	1453

150 x 8MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	49	11	18	12	43	146	112	13	16	16	0	0	434
Gannet	0.084	6119	347	7987	1889	0	0	4313	998	5361	5736	12108	0	44859
Kittiwake	0.067	4746	3753	8108	4277	386	10261	43171	6668	14163	9984	4882	2647	113047
Little Gull	0.067	0	0	0	0	0	0	0	0	0	0	61	0	61
Common Gull	0.068	866	1685	438	1561	0	0	0	0	0	971	0	0	5522
Great Black-backed Gull	0.081	27305	13286	33464	16403	8881	2915	11932	0	58291	5105	25746	20301	223629
Lesser Black-backed Gull	0.075	4250	0	0	3404	11058	5445	3714	1769	3299	0	0	0	32940
Herring Gull	0.078	0	4718	10968	2912	3153	0	0	0	0	0	2493	0	24245
Large gulls combined	0.078	25673	13325	32917	18507	22267	8771	13463	2137	47832	3840	21127	15270	225129
Common Tern	0.075	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.073	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.054	21	58	54	8	23	5	47	0	28	4	19	26	292
Razorbill	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.058	35	20	19	3	9	9	23	0	13	5	13	7	156
Common/Arctic Terns combined	0.075	0	0	0	0	50	0	0	4	0	3	0	0	57
Arctic Skua	0.067	0	0	0	0	0	0	0	0	315	0	0	0	315
Great Skua	0.068	0	0	0	0	0	0	0	527	446	0	0	0	974

Table C.152 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of collisions assuming no avoidance.

332 x 3.6MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	4	1	2	1	4	13	10	1	1	1	0	0	39
Gannet	681	39	888	210	0	0	480	111	596	638	1347	0	4990
Kittiwake	404	319	689	364	33	873	3671	567	1204	849	415	225	9614
Little Gull	0	0	0	0	0	0	0	0	0	0	5	0	5
Common Gull	74	145	38	134	0	0	0	0	0	83	0	0	475
Great Black-backed Gull	2883	1403	3533	1732	938	308	1260	0	6154	539	2718	2143	23611
Lesser Black-backed Gull	408	0	0	327	1062	523	357	170	317	0	0	0	3163
Herring Gull	0	475	1104	293	317	0	0	0	0	0	251	0	2439
Large gulls combined	2592	1345	3323	1868	2248	885	1359	216	4828	388	2133	1541	22725
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	2	4	4	1	2	0	3	0	2	0	1	2	21
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	3	1	1	0	1	1	2	0	1	0	1	1	12
Common/Arctic Terns combined	0	0	0	0	5	0	0	0	0	0	0	0	5
Arctic Skua	0	0	0	0	0	0	0	0	27	0	0	0	27
Great Skua	0	0	0	0	0	0	0	47	40	0	0	0	87

150 x 8MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	3	1	1	1	3	9	7	1	1	1	0	0	26
Gannet	437	25	570	135	0	0	308	71	383	409	864	0	3201
Kittiwake	270	214	462	243	22	584	2458	380	806	568	278	151	6436
Little Gull	0	0	0	0	0	0	0	0	0	0	3	0	3
Common Gull	50	97	25	90	0	0	0	0	0	56	0	0	317
Great Black-backed Gull	1875	912	2297	1126	610	200	819	0	4002	350	1768	1394	15353
Lesser Black-backed Gull	270	0	0	216	703	346	236	112	210	0	0	0	2094
Herring Gull	0	314	731	194	210	0	0	0	0	0	166	0	1615
Large gulls combined	1705	885	2186	1229	1479	582	894	142	3176	255	1403	1014	14949
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	1	3	2	0	1	0	2	0	1	0	1	1	14
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	2	1	1	0	0	0	1	0	1	0	1	0	8
Common/Arctic Terns combined	0	0	0	0	3	0	0	0	0	0	0	0	4
Arctic Skua	0	0	0	0	0	0	0	0	18	0	0	0	18
Great Skua	0	0	0	0	0	0	0	31	26	0	0	0	57

Table C.153 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 95%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	1	1	0	0	0	0	0	2
Gannet	34	2	44	11	0	0	24	6	30	32	67	0	249
Kittiwake	20	16	34	18	2	44	184	28	60	42	21	11	481
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	4	7	2	7	0	0	0	0	0	4	0	0	24
Great Black-backed Gull	144	70	177	87	47	15	63	0	308	27	136	107	1181
Lesser Black-backed Gull	20	0	0	16	53	26	18	8	16	0	0	0	158
Herring Gull	0	24	55	15	16	0	0	0	0	0	13	0	122
Large gulls combined	130	67	166	93	112	44	68	11	241	19	107	77	1136
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	1	0	0	0	1
Great Skua	0	0	0	0	0	0	0	2	2	0	0	0	4

150 x 8MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	22	1	29	7	0	0	15	4	19	20	43	0	160
Kittiwake	14	11	23	12	1	29	123	19	40	28	14	8	322
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	2	5	1	4	0	0	0	0	0	3	0	0	16
Great Black-backed Gull	94	46	115	56	30	10	41	0	200	18	88	70	768
Lesser Black-backed Gull	14	0	0	11	35	17	12	6	10	0	0	0	105
Herring Gull	0	16	37	10	11	0	0	0	0	0	8	0	81
Large gulls combined	85	44	109	61	74	29	45	7	159	13	70	51	747
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	1	0	0	0	1
Great Skua	0	0	0	0	0	0	0	2	1	0	0	0	3

Table C.154 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 98%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	14	1	18	4	0	0	10	2	12	13	27	0	100
Kittiwake	8	6	14	7	1	17	73	11	24	17	8	5	192
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	1	3	1	3	0	0	0	0	0	2	0	0	9
Great Black-backed Gull	58	28	71	35	19	6	25	0	123	11	54	43	472
Lesser Black-backed Gull	8	0	0	7	21	10	7	3	6	0	0	0	63
Herring Gull	0	9	22	6	6	0	0	0	0	0	5	0	49
Large gulls combined	52	27	66	37	45	18	27	4	97	8	43	31	455
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	1	0	0	0	1
Great Skua	0	0	0	0	0	0	0	1	1	0	0	0	2

150 x 8MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	9	0	11	3	0	0	6	1	8	8	17	0	64
Kittiwake	5	4	9	5	0	12	49	8	16	11	6	3	129
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	1	2	1	2	0	0	0	0	0	1	0	0	6
Great Black-backed Gull	37	18	46	23	12	4	16	0	80	7	35	28	307
Lesser Black-backed Gull	5	0	0	4	14	7	5	2	4	0	0	0	42
Herring Gull	0	6	15	4	4	0	0	0	0	0	3	0	32
Large gulls combined	34	18	44	25	30	12	18	3	64	5	28	20	299
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	1	0	0	0	1

Table C.155 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 99%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	7	0	9	2	0	0	5	1	6	6	13	0	50
Kittiwake	4	3	7	4	0	9	37	6	12	8	4	2	96
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	1	1	0	1	0	0	0	0	0	1	0	0	5
Great Black-backed Gull	29	14	35	17	9	3	13	0	62	5	27	21	236
Lesser Black-backed Gull	4	0	0	3	11	5	4	2	3	0	0	0	32
Herring Gull	0	5	11	3	3	0	0	0	0	0	3	0	24
Large gulls combined	26	13	33	19	22	9	14	2	48	4	21	15	227
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

150 x 8MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	4	0	6	1	0	0	3	1	4	4	9	0	32
Kittiwake	3	2	5	2	0	6	25	4	8	6	3	2	64
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	1	0	1	0	0	0	0	0	1	0	0	3
Great Black-backed Gull	19	9	23	11	6	2	8	0	40	4	18	14	154
Lesser Black-backed Gull	3	0	0	2	7	3	2	1	2	0	0	0	21
Herring Gull	0	3	7	2	2	0	0	0	0	0	2	0	16
Large gulls combined	17	9	22	12	15	6	9	1	32	3	14	10	149
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

Table C.156 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 99.5%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	3	0	4	1	0	0	2	1	3	3	7	0	25
Kittiwake	2	2	3	2	0	4	18	3	6	4	2	1	48
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	1	0	1	0	0	0	0	0	0	0	0	2
Great Black-backed Gull	14	7	18	9	5	2	6	0	31	3	14	11	118
Lesser Black-backed Gull	2	0	0	2	5	3	2	1	2	0	0	0	16
Herring Gull	0	2	6	1	2	0	0	0	0	0	1	0	12
Large gulls combined	13	7	17	9	11	4	7	1	24	2	11	8	114
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	0	3	1	0	0	2	0	2	2	4	0	16
Kittiwake	1	1	2	1	0	3	12	2	4	3	1	1	32
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	2
Great Black-backed Gull	9	5	11	6	3	1	4	0	20	2	9	7	77
Lesser Black-backed Gull	1	0	0	1	4	2	1	1	1	0	0	0	10
Herring Gull	0	2	4	1	1	0	0	0	0	0	1	0	8
Large gulls combined	9	4	11	6	7	3	4	1	16	1	7	5	75
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Results Year 2 sub-zone 2

Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area.

Table C.157 Densities of flying birds at Hornsea sub-zone 2 between March 2011 and February 2012. Data gathered during ship-based surveys.

Species	*Density (birds/km2) Jan*	*Density (birds/km2) Feb*	*Density (birds/km2) Mar*	*Density (birds/km2) Apr*	*Density (birds/km2) May*	*Density (birds/km2) Jun*	*Density (birds/km2) Jul*	*Density (birds/km2) Aug*	*Density (birds/km2) Sep*	*Density (birds/km2) Oct*	*Density (birds/km2) Nov*	*Density (birds/km2) Dec*
Fulmar			0.11	0.00	0.36	0.29	0.18	0.04			0.00	
Gannet			0.07	0.00	0.11	0.07	0.11	0.11			0.28	
Kittiwake			0.29	0.18	1.66	0.95	0.51	0.15			0.00	
Little Gull			0.00	0.00	0.00	0.00	0.00	0.00			0.00	
Common Gull			0.00	0.04	0.00	0.00	0.00	0.00			0.00	
Great Black-backed Gull			0.07	0.00	0.04	0.00	0.00	0.07			0.00	
Lesser Black-backed Gull			0.04	0.04	0.36	0.00	0.04	0.00			0.00	
Herring Gull			0.07	0.00	0.07	0.00	0.00	0.00			0.00	
Large gulls combined			0.18	0.04	0.47	0.00	0.04	0.07			0.00	
Common Tern			0.00	0.00	0.00	0.00	0.00	1.06			0.00	
Arctic Tern			0.00	0.00	0.00	0.00	0.00	0.00			0.00	
Guillemot			0.22	0.00	0.04	0.00	0.07	0.00			0.00	
Razorbill			0.00	0.00	0.00	0.00	0.00	0.00			0.00	
Guillemot/Razorbill			0.22	0.00	0.04	0.00	0.07	0.00			0.00	
Common/Arctic Terns combined			0.00	0.00	0.00	0.00	0.00	1.06			0.00	
Arctic Skua			0.00	0.00	0.00	0.00	0.00	0.00			0.00	
Great Skua			0.00	0.00	0.00	0.00	0.00	0.04			0.00	

Table C.158 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of transits through the rotor-swept area.

240 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	0	0	16	0	54	43	28	5	0	0	0	0	249
Gannet	0.100	0	0	2938	0	5262	3599	5485	5074	0	0	9302	0	54275
Kittiwake	0.075	0	0	3667	2353	23236	13240	7297	1985	0	0	0	0	88762
Little Gull	0.072	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0.076	0	0	0	1543	0	0	0	0	0	0	0	0	2646
Great Black-backed Gull	0.095	0	0	11252	0	6201	0	0	12183	0	0	0	0	50804
Lesser Black-backed Gull	0.086	0	0	3715	3814	40940	0	4224	0	0	0	0	0	90331
Herring Gull	0.090	0	0	10814	0	11919	0	0	0	0	0	0	0	38972
Large gulls combined	0.091	0	0	21176	4349	60682	0	4816	9171	0	0	0	0	171762
Common Tern	0.082	0	0	0	0	0	0	0	4666	0	0	0	0	7998
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0.082	0	0	0	0	0	0	0	13437	0	0	0	0	23035
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	2627	0	0	0	0	4504

360 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	0	0	23	0	81	64	41	8	0	0	0	0	374
Gannet	0.100	0	0	4407	0	7893	5398	8228	7611	0	0	13954	0	81413
Kittiwake	0.075	0	0	5500	3530	34855	19859	10946	2977	0	0	0	0	133143
Little Gull	0.072	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0.076	0	0	0	2315	0	0	0	0	0	0	0	0	3969
Great Black-backed Gull	0.095	0	0	16878	0	9301	0	0	18274	0	0	0	0	76206
Lesser Black-backed Gull	0.086	0	0	5572	5722	61410	0	6337	0	0	0	0	0	135497
Herring Gull	0.090	0	0	16221	0	17879	0	0	0	0	0	0	0	58457
Large gulls combined	0.091	0	0	31764	6524	91023	0	7225	13757	0	0	0	0	257644
Common Tern	0.082	0	0	0	0	0	0	0	6999	0	0	0	0	11997
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0.082	0	0	0	0	0	0	0	20155	0	0	0	0	34552
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	3941	0	0	0	0	6756

Table C.159 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of collisions assuming no avoidance.

240 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	0	0	1	0	4	3	2	0	0	0	0	0	17
Gannet	0	0	250	0	448	306	467	432	0	0	792	0	4619
Kittiwake	0	0	234	150	1484	846	466	127	0	0	0	0	5670
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	100	0	0	0	0	0	0	0	0	171
Great Black-backed Gull	0	0	907	0	500	0	0	982	0	0	0	0	4093
Lesser Black-backed Gull	0	0	271	278	2989	0	308	0	0	0	0	0	6595
Herring Gull	0	0	832	0	917	0	0	0	0	0	0	0	2997
Large gulls combined	0	0	1631	335	4673	0	371	706	0	0	0	0	13227
Common Tern	0	0	0	0	0	0	0	327	0	0	0	0	560
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	941	0	0	0	0	1613
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	176	0	0	0	0	301

360 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	0	0	2	0	6	4	3	1	0	0	0	0	26
Gannet	0	0	375	0	672	459	700	648	0	0	1187	0	6928
Kittiwake	0	0	351	225	2226	1269	699	190	0	0	0	0	8505
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	150	0	0	0	0	0	0	0	0	257
Great Black-backed Gull	0	0	1360	0	749	0	0	1472	0	0	0	0	6140
Lesser Black-backed Gull	0	0	407	418	4483	0	463	0	0	0	0	0	9892
Herring Gull	0	0	1248	0	1375	0	0	0	0	0	0	0	4496
Large gulls combined	0	0	2446	502	7009	0	556	1059	0	0	0	0	19840
Common Tern	0	0	0	0	0	0	0	490	0	0	0	0	840
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	1411	0	0	0	0	2419
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	264	0	0	0	0	452

Table C.160 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 95%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	0	0	13	0	22	15	23	22	0	0	40	0	231
Kittiwake	0	0	12	8	74	42	23	6	0	0	0	0	283
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	5	0	0	0	0	0	0	0	0	9
Great Black-backed Gull	0	0	45	0	25	0	0	49	0	0	0	0	205
Lesser Black-backed Gull	0	0	14	14	149	0	15	0	0	0	0	0	330
Herring Gull	0	0	42	0	46	0	0	0	0	0	0	0	150
Large gulls combined	0	0	82	17	234	0	19	35	0	0	0	0	661
Common Tern	0	0	0	0	0	0	0	16	0	0	0	0	28
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	47	0	0	0	0	81
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	9	0	0	0	0	15

360 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	0	0	19	0	34	23	35	32	0	0	59	0	346
Kittiwake	0	0	18	11	111	63	35	10	0	0	0	0	425
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	7	0	0	0	0	0	0	0	0	13
Great Black-backed Gull	0	0	68	0	37	0	0	74	0	0	0	0	307
Lesser Black-backed Gull	0	0	20	21	224	0	23	0	0	0	0	0	495
Herring Gull	0	0	62	0	69	0	0	0	0	0	0	0	225
Large gulls combined	0	0	122	25	350	0	28	53	0	0	0	0	992
Common Tern	0	0	0	0	0	0	0	24	0	0	0	0	42
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	71	0	0	0	0	121
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	13	0	0	0	0	23

Table C.161 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 98%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	0	0	5	0	9	6	9	9	0	0	16	0	92
Kittiwake	0	0	5	3	30	17	9	3	0	0	0	0	113
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	2	0	0	0	0	0	0	0	0	3
Great Black-backed Gull	0	0	18	0	10	0	0	20	0	0	0	0	82
Lesser Black-backed Gull	0	0	5	6	60	0	6	0	0	0	0	0	132
Herring Gull	0	0	17	0	18	0	0	0	0	0	0	0	60
Large gulls combined	0	0	33	7	93	0	7	14	0	0	0	0	265
Common Tern	0	0	0	0	0	0	0	7	0	0	0	0	11
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	19	0	0	0	0	32
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	4	0	0	0	0	6

360 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	0	0	8	0	13	9	14	13	0	0	24	0	139
Kittiwake	0	0	7	5	45	25	14	4	0	0	0	0	170
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	3	0	0	0	0	0	0	0	0	5
Great Black-backed Gull	0	0	27	0	15	0	0	29	0	0	0	0	123
Lesser Black-backed Gull	0	0	8	8	90	0	9	0	0	0	0	0	198
Herring Gull	0	0	25	0	28	0	0	0	0	0	0	0	90
Large gulls combined	0	0	49	10	140	0	11	21	0	0	0	0	397
Common Tern	0	0	0	0	0	0	0	10	0	0	0	0	17
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	28	0	0	0	0	48
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	5	0	0	0	0	9

Table C.162 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 99%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	0	0	3	0	4	3	5	4	0	0	8	0	46
Kittiwake	0	0	2	2	15	8	5	1	0	0	0	0	57
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	1	0	0	0	0	0	0	0	0	2
Great Black-backed Gull	0	0	9	0	5	0	0	10	0	0	0	0	41
Lesser Black-backed Gull	0	0	3	3	30	0	3	0	0	0	0	0	66
Herring Gull	0	0	8	0	9	0	0	0	0	0	0	0	30
Large gulls combined	0	0	16	3	47	0	4	7	0	0	0	0	132
Common Tern	0	0	0	0	0	0	0	3	0	0	0	0	6
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	9	0	0	0	0	16
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	2	0	0	0	0	3

360 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	0	0	4	0	7	5	7	6	0	0	12	0	69
Kittiwake	0	0	4	2	22	13	7	2	0	0	0	0	85
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	1	0	0	0	0	0	0	0	0	3
Great Black-backed Gull	0	0	14	0	7	0	0	15	0	0	0	0	61
Lesser Black-backed Gull	0	0	4	4	45	0	5	0	0	0	0	0	99
Herring Gull	0	0	12	0	14	0	0	0	0	0	0	0	45
Large gulls combined	0	0	24	5	70	0	6	11	0	0	0	0	198
Common Tern	0	0	0	0	0	0	0	5	0	0	0	0	8
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	14	0	0	0	0	24
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	3	0	0	0	0	5

Table C.163 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2011 and February 2012. Potential number of collisions assuming an avoidance rate of 99.5%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	0	0	1	0	2	2	2	2	0	0	4	0	23
Kittiwake	0	0	1	1	7	4	2	1	0	0	0	0	28
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	0	0	5	0	2	0	0	5	0	0	0	0	20
Lesser Black-backed Gull	0	0	1	1	15	0	2	0	0	0	0	0	33
Herring Gull	0	0	4	0	5	0	0	0	0	0	0	0	15
Large gulls combined	0	0	8	2	23	0	2	4	0	0	0	0	66
Common Tern	0	0	0	0	0	0	0	2	0	0	0	0	3
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	5	0	0	0	0	8
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	0	0	0	0	2

360 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	0	0	2	0	3	2	4	3	0	0	6	0	35
Kittiwake	0	0	2	1	11	6	3	1	0	0	0	0	43
Little Gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Gull	0	0	0	1	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	0	0	7	0	4	0	0	7	0	0	0	0	31
Lesser Black-backed Gull	0	0	2	2	22	0	2	0	0	0	0	0	49
Herring Gull	0	0	6	0	7	0	0	0	0	0	0	0	22
Large gulls combined	0	0	12	3	35	0	3	5	0	0	0	0	99
Common Tern	0	0	0	0	0	0	0	2	0	0	0	0	4
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common and Arctic Terns combined	0	0	0	0	0	0	0	7	0	0	0	0	12
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	0	0	0	0	2

Results Years 1 and 2 sub-zone 1

Table C.164 Densities of flying birds at Hornsea sub-zone 1 development area between March 2010 and February 2012. Data gathered during ship-based surveys.

Species	*Density (birds/km2) Jan*	*Density (birds/km2) Feb*	*Density (birds/km2) Mar*	*Density (birds/km2) Apr*	*Density (birds/km2) May*	*Density (birds/km2) Jun*	*Density (birds/km2) Jul*	*Density (birds/km2) Aug*	*Density (birds/km2) Sep*	*Density (birds/km2) Oct*	*Density (birds/km2) Nov*	*Density (birds/km2) Dec*
Fulmar	0.19	0.07	0.29	0.04	0.24	0.41	0.23	0.11	0.10	0.04	0.04	0.00
Gannet	0.24	0.07	0.43	0.07	0.03	0.02	0.07	0.14	0.18	0.35	0.55	0.04
Kittiwake	0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24
Little Gull	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	2.62	0.25	0.00
Common Gull	0.02	0.03	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01
Great Black-backed Gull	0.22	0.11	0.13	0.05	0.04	0.01	0.05	0.05	0.22	0.03	0.13	0.15
Lesser Black-backed Gull	0.02	0.00	0.00	0.03	0.07	0.07	0.11	0.10	0.02	0.00	0.00	0.03
Herring Gull	0.01	0.02	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.09
Large gulls combined	0.25	0.13	0.17	0.09	0.12	0.07	0.16	0.15	0.24	0.03	0.16	0.27
Common Tern	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.33	0.06	0.00	0.00
Arctic Tern	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.06	0.00	0.01	0.00	0.00
Guillemot	0.57	0.23	0.38	0.03	0.07	0.04	0.10	0.00	0.07	0.07	0.13	0.33
Razorbill	0.27	0.03	0.22	0.09	0.01	0.05	0.08	0.00	0.02	0.16	0.08	0.03
Guillemot/Razorbill	0.84	0.26	0.60	0.12	0.08	0.09	0.18	0.00	0.09	0.22	0.21	0.36
Common/Arctic Terns combined	0.00	0.00	0.00	0.00	0.10	0.02	0.00	0.07	0.33	0.07	0.00	0.00
Arctic Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Great Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

Table C.165 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of transits through the rotor-swept area.

332 x 3.6MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	65	24	103	15	92	152	90	40	37	15	14	0	647
Gannet	0.088	7687	2334	16577	2791	1553	785	3218	6307	7245	12762	17400	1262	79920
Kittiwake	0.067	9443	9482	14939	6057	2269	24242	43922	22872	23492	10156	23806	6452	197133
Little Gull	0.064	0	0	0	0	0	0	0	0	124	8130	669	0	8924
Common Gull	0.068	977	1257	327	1544	0	0	0	0	183	725	0	327	5341
Great Black-backed Gull	0.083	46486	21485	30812	12238	10967	2175	13285	12671	52151	5696	27801	30601	266368
Lesser Black-backed Gull	0.076	3171	0	0	5028	10953	10774	17779	15783	2461	0	0	4277	70226
Herring Gull	0.079	1855	5281	10259	2173	2353	0	0	0	0	0	5521	20122	47562
Large gulls combined	0.080	40107	19890	30420	16813	23144	14653	31473	28600	42202	4285	24810	42393	318790
Common Tern	0.071	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.057	157	64	128	12	28	17	42	0	23	21	37	88	618
Razorbill	0.059	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.059	68	24	72	17	12	15	31	0	11	24	18	27	318
Common/Arctic Terns combin	0.071	0	0	0	0	38	6	0	23	96	17	0	0	180
Arctic Skua	0.068	0	0	0	0	0	0	0	0	273	0	0	0	273
Great Skua	0.071	0	0	0	0	0	0	0	393	333	0	0	0	726

150 x 8MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.071	44	16	69	10	62	102	60	27	25	10	9	0	433
Gannet	0.084	5152	1564	11109	1870	1041	526	2156	4227	4855	8553	11661	845	53561
Kittiwake	0.067	6328	6354	10012	4059	1521	16247	29436	15328	15744	6806	15955	4324	132114
Little Gull	0.067	0	0	0	0	0	0	0	0	83	5449	448	0	5980
Common Gull	0.068	655	843	219	1035	0	0	0	0	123	486	0	219	3579
Great Black-backed Gull	0.081	31154	14399	20649	8201	7350	1458	8903	8492	34951	3818	18631	20508	178515
Lesser Black-backed Gull	0.075	2125	0	0	3369	7341	7221	11915	10577	1650	0	0	2866	47064
Herring Gull	0.078	1243	3539	6875	1456	1577	0	0	0	0	0	3700	13485	31875
Large gulls combined	0.078	26879	13330	20387	11268	15511	9820	21093	19167	28283	2872	16627	28411	213647
Common Tern	0.075	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0.073	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.054	106	43	86	8	19	12	28	0	15	14	25	59	414
Razorbill	0.058	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.058	46	16	48	11	8	10	21	0	7	16	12	18	213
Common/Arctic Terns combin	0.075	0	0	0	0	25	4	0	15	65	11	0	0	121
Arctic Skua	0.067	0	0	0	0	0	0	0	0	183	0	0	0	183
Great Skua	0.068	0	0	0	0	0	0	0	264	223	0	0	0	487

Table C.166 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming no avoidance.

332 x 3.6MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	4	1	6	1	6	9	5	2	2	1	1	0	39
Gannet	573	174	1236	208	116	59	240	470	540	951	1297	94	5958
Kittiwake	538	540	851	345	129	1382	2503	1304	1339	579	1357	368	11235
Little Gull	0	0	0	0	0	0	0	0	7	441	36	0	484
Common Gull	56	72	19	89	0	0	0	0	11	42	0	19	308
Great Black-backed Gull	3289	1520	2180	866	776	154	940	897	3690	403	1967	2165	18848
Lesser Black-backed Gull	204	0	0	324	705	693	1144	1016	158	0	0	275	4519
Herring Gull	125	356	692	147	159	0	0	0	0	0	372	1357	3207
Large gulls combined	2713	1346	2058	1137	1566	991	2129	1935	2855	290	1678	2868	21566
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	8	3	6	1	1	1	2	0	1	1	2	4	30
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	3	1	4	1	1	1	2	0	1	1	1	1	16
Common/Arctic Terns combin	0	0	0	0	2	0	0	1	6	1	0	0	11
Arctic Skua	0	0	0	0	0	0	0	0	16	0	0	0	16
Great Skua	0	0	0	0	0	0	0	24	20	0	0	0	44

150 x 8MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	3	1	4	1	4	6	4	2	1	1	1	0	26
Gannet	368	112	793	133	74	38	154	302	347	610	832	60	3822
Kittiwake	360	362	570	231	87	925	1676	873	896	387	908	246	7521
Little Gull	0	0	0	0	0	0	0	0	5	308	25	0	339
Common Gull	38	48	13	59	0	0	0	0	7	28	0	13	205
Great Black-backed Gull	2139	989	1418	563	505	100	611	583	2399	262	1279	1408	12255
Lesser Black-backed Gull	135	0	0	214	467	459	757	672	105	0	0	182	2992
Herring Gull	83	236	458	97	105	0	0	0	0	0	246	898	2123
Large gulls combined	1785	885	1354	748	1030	652	1401	1273	1878	191	1104	1887	14187
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	5	2	4	0	1	1	1	0	1	1	1	3	19
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	2	1	2	1	0	1	1	0	0	1	1	1	11
Common/Arctic Terns combin	0	0	0	0	2	0	0	1	4	1	0	0	8
Arctic Skua	0	0	0	0	0	0	0	0	10	0	0	0	10
Great Skua	0	0	0	0	0	0	0	15	13	0	0	0	28

Table C.167 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 95%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	2
Gannet	29	9	62	10	6	3	12	24	27	48	65	5	298
Kittiwake	27	27	43	17	6	69	125	65	67	29	68	18	562
Little Gull	0	0	0	0	0	0	0	0	0	22	2	0	24
Common Gull	3	4	1	4	0	0	0	0	1	2	0	1	15
Great Black-backed Gull	164	76	109	43	39	8	47	45	185	20	98	108	942
Lesser Black-backed Gull	10	0	0	16	35	35	57	51	8	0	0	14	226
Herring Gull	6	18	35	7	8	0	0	0	0	0	19	68	160
Large gulls combined	136	67	103	57	78	50	106	97	143	14	84	143	1078
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	1
Arctic Skua	0	0	0	0	0	0	0	0	1	0	0	0	1
Great Skua	0	0	0	0	0	0	0	1	1	0	0	0	2

150 x 8MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	18	6	40	7	4	2	8	15	17	31	42	3	191
Kittiwake	18	18	29	12	4	46	84	44	45	19	45	12	376
Little Gull	0	0	0	0	0	0	0	0	0	15	1	0	17
Common Gull	2	2	1	3	0	0	0	0	0	1	0	1	10
Great Black-backed Gull	107	49	71	28	25	5	31	29	120	13	64	70	613
Lesser Black-backed Gull	7	0	0	11	23	23	38	34	5	0	0	9	150
Herring Gull	4	12	23	5	5	0	0	0	0	0	12	45	106
Large gulls combined	89	44	68	37	51	33	70	64	94	10	55	94	709
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	1
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	1	0	0	0	1
Great Skua	0	0	0	0	0	0	0	1	1	0	0	0	1

Table C.168 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 98%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	11	3	25	4	2	1	5	9	11	19	26	2	119
Kittiwake	11	11	17	7	3	28	50	26	27	12	27	7	225
Little Gull	0	0	0	0	0	0	0	0	0	9	1	0	10
Common Gull	1	1	0	2	0	0	0	0	0	1	0	0	6
Great Black-backed Gull	66	30	44	17	16	3	19	18	74	8	39	43	377
Lesser Black-backed Gull	4	0	0	6	14	14	23	20	3	0	0	6	90
Herring Gull	3	7	14	3	3	0	0	0	0	0	7	27	64
Large gulls combined	54	27	41	23	31	20	43	39	57	6	34	57	431
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	1
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

150 x 8MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	7	2	16	3	1	1	3	6	7	12	17	1	76
Kittiwake	7	7	11	5	2	18	34	17	18	8	18	5	150
Little Gull	0	0	0	0	0	0	0	0	0	6	1	0	7
Common Gull	1	1	0	1	0	0	0	0	0	1	0	0	4
Great Black-backed Gull	43	20	28	11	10	2	12	12	48	5	26	28	245
Lesser Black-backed Gull	3	0	0	4	9	9	15	13	2	0	0	4	60
Herring Gull	2	5	9	2	2	0	0	0	0	0	5	18	42
Large gulls combined	36	18	27	15	21	13	28	25	38	4	22	38	284
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

Table C.169 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 99%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	6	2	12	2	1	1	2	5	5	10	13	1	60
Kittiwake	5	5	9	3	1	14	25	13	13	6	14	4	112
Little Gull	0	0	0	0	0	0	0	0	0	4	0	0	5
Common Gull	1	1	0	1	0	0	0	0	0	0	0	0	3
Great Black-backed Gull	33	15	22	9	8	2	9	9	37	4	20	22	188
Lesser Black-backed Gull	2	0	0	3	7	7	11	10	2	0	0	3	45
Herring Gull	1	4	7	1	2	0	0	0	0	0	4	14	32
Large gulls combined	27	13	21	11	16	10	21	19	29	3	17	29	216
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	4	1	8	1	1	0	2	3	3	6	8	1	38
Kittiwake	4	4	6	2	1	9	17	9	9	4	9	2	75
Little Gull	0	0	0	0	0	0	0	0	0	3	0	0	3
Common Gull	0	0	0	1	0	0	0	0	0	0	0	0	2
Great Black-backed Gull	21	10	14	6	5	1	6	6	24	3	13	14	123
Lesser Black-backed Gull	1	0	0	2	5	5	8	7	1	0	0	2	30
Herring Gull	1	2	5	1	1	0	0	0	0	0	2	9	21
Large gulls combined	18	9	14	7	10	7	14	13	19	2	11	19	142
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C.170 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 99.5%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	3	1	6	1	1	0	1	2	3	5	6	0	30
Kittiwake	3	3	4	2	1	7	13	7	7	3	7	2	56
Little Gull	0	0	0	0	0	0	0	0	0	2	0	0	2
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	2
Great Black-backed Gull	16	8	11	4	4	1	5	4	18	2	10	11	94
Lesser Black-backed Gull	1	0	0	2	4	3	6	5	1	0	0	1	23
Herring Gull	1	2	3	1	1	0	0	0	0	0	2	7	16
Large gulls combined	14	7	10	6	8	5	11	10	14	1	8	14	108
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	1	4	1	0	0	1	2	2	3	4	0	19
Kittiwake	2	2	3	1	0	5	8	4	4	2	5	1	38
Little Gull	0	0	0	0	0	0	0	0	0	2	0	0	2
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0	1
Great Black-backed Gull	11	5	7	3	3	1	3	3	12	1	6	7	61
Lesser Black-backed Gull	1	0	0	1	2	2	4	3	1	0	0	1	15
Herring Gull	0	1	2	0	1	0	0	0	0	0	1	4	11
Large gulls combined	9	4	7	4	5	3	7	6	9	1	6	9	71
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

Results Years 1 and 2 sub-zone 2

Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area.

Table C.171 Densities of flying birds at Hornsea sub-zone 2 between March 2010 and February 2012. Data gathered during ship-based surveys.

Species	Density (birds/km2) Jan	Density (birds/km2) Feb	Density (birds/km2) Mar	Density (birds/km2) Apr	Density (birds/km2) May	Density (birds/km2) Jun	Density (birds/km2) Jul	Density (birds/km2) Aug	Density (birds/km2) Sep	Density (birds/km2) Oct	Density (birds/km2) Nov	Density (birds/km2) Dec
Fulmar	0.16		0.07	0.11	0.66	0.29	0.16	0.11	0.29	0.04	0.07	0.22
Gannet	0.08		0.27	0.13	0.05	0.13	0.09	0.20	0.11	0.62	0.36	0.04
Kittiwake	0.31		0.20	0.16	1.05	0.66	0.98	0.65	0.29	0.40	0.78	0.22
Little Gull	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00	0.00
Common Gull	0.08		0.00	0.02	0.00	0.00	0.00	0.00	0.04	0.04	0.02	0.15
Great Black-backed Gull	0.28		0.11	0.02	0.02	0.00	0.00	0.04	0.00	0.07	0.07	0.15
Lesser Black-backed Gull	0.00		0.02	0.07	0.18	0.05	0.02	0.04	0.00	0.00	0.00	0.00
Herring Gull	0.19		0.04	0.00	0.04	0.02	0.00	0.00	0.00	0.07	0.02	0.04
Large gulls combined	0.47		0.16	0.09	0.23	0.07	0.02	0.07	0.00	0.15	0.09	0.18
Common Tern	0.00		0.00	0.00	0.00	0.00	0.00	0.53	2.38	0.00	0.00	0.00
Arctic Tern	0.00		0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Guillemot	0.00		0.16	0.00	0.05	0.05	0.25	0.00	0.00	0.18	0.36	0.18
Razorbill	0.00		0.00	0.00	0.00	0.04	0.07	0.00	0.00	0.15	0.00	0.00
Guillemot/Razorbill	0.00		0.16	0.00	0.05	0.09	0.33	0.00	0.00	0.33	0.36	0.18
Common/Arctic Terns combined	0.00		0.00	0.00	0.00	0.00	0.00	0.58	2.38	0.00	0.00	0.00
Arctic Skua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Great Skua	0.00		0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00

Table C.172 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of transits through the rotor-swept area.

240 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	21	0	10	15	98	43	25	16	41	5	10	30	341
Gannet	0.100	2527	0	10977	5496	2631	6234	4538	9074	4476	23372	11756	1145	89701
Kittiwake	0.075	3486	0	2518	2113	14685	9129	13887	8904	3648	4855	8621	2410	81007
Little Gull	0.072	0	0	0	0	0	0	0	0	0	22286	0	0	24312
Common Gull	0.076	2858	0	0	772	0	0	0	0	1495	1447	657	5268	13634
Great Black-backed Gull	0.095	38513	0	16830	2874	3100	0	0	6091	0	10836	9845	19722	117611
Lesser Black-backed Gull	0.086	0	0	1857	7599	20470	6102	2112	3886	0	0	0	0	45847
Herring Gull	0.090	24677	0	5407	0	5960	2961	0	0	0	10414	2365	4739	61661
Large gulls combined	0.091	48320	0	19022	10828	30341	9277	2408	9016	0	16314	9264	18558	189106
Common Tern	0.082	0	0	0	0	0	0	0	2333	8724	0	0	0	12062
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0.082	0	0	0	0	0	0	0	7390	25126	0	0	0	35472
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	1314	0	0	734	0	2234

360 x 5MW

Species	Probability of collision during single rotor crossing	Potential number of transits through rotor-swept area Jan	Potential number of transits through rotor-swept area Feb	Potential number of transits through rotor-swept area Mar	Potential number of transits through rotor-swept area Apr	Potential number of transits through rotor-swept area May	Potential number of transits through rotor-swept area Jun	Potential number of transits through rotor-swept area Jul	Potential number of transits through rotor-swept area Aug	Potential number of transits through rotor-swept area Sep	Potential number of transits through rotor-swept area Oct	Potential number of transits through rotor-swept area Nov	Potential number of transits through rotor-swept area Dec	TOTAL transits through rotor-swept area per YEAR
Fulmar	0.080	32	0	16	23	147	64	37	24	61	8	14	44	512
Gannet	0.100	3790	0	16465	8244	3947	9351	6808	13611	6714	35058	17633	1718	134551
Kittiwake	0.075	5229	0	3777	3170	22027	13694	20831	13356	5471	7282	12932	3615	121510
Little Gull	0.072	0	0	0	0	0	0	0	0	0	33429	0	0	36468
Common Gull	0.076	4287	0	0	1158	0	0	0	0	2243	2171	986	7903	20451
Great Black-backed Gull	0.095	57770	0	25245	4311	4651	0	0	9137	0	16253	14767	29582	176417
Lesser Black-backed Gull	0.086	0	0	2786	11399	30705	9153	3168	5829	0	0	0	0	68771
Herring Gull	0.090	37015	0	8111	0	8939	4441	0	0	0	15621	3548	7108	92491
Large gulls combined	0.091	72480	0	28533	16242	45512	13915	3612	13524	0	24471	13896	27837	283660
Common Tern	0.082	0	0	0	0	0	0	0	3499	13087	0	0	0	18094
Arctic Tern	0.081	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0.061	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0.082	0	0	0	0	0	0	0	11085	37689	0	0	0	53208
Arctic Skua	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0.079	0	0	0	0	0	0	0	1971	0	0	1101	0	3351

Table C.173 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of collisions assuming no avoidance.

240 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	1	0	1	1	7	3	2	1	3	0	1	2	23
Gannet	215	0	934	468	224	531	386	772	381	1989	1000	97	7634
Kittiwake	223	0	161	135	938	583	887	569	233	310	551	154	5175
Little Gull	0	0	0	0	0	0	0	0	0	1373	0	0	1498
Common Gull	185	0	0	50	0	0	0	0	97	94	43	341	882
Great Black-backed Gull	3103	0	1356	232	250	0	0	491	0	873	793	1589	9476
Lesser Black-backed Gull	0	0	136	555	1494	445	154	284	0	0	0	0	3347
Herring Gull	1898	0	416	0	458	228	0	0	0	801	182	364	4743
Large gulls combined	3721	0	1465	834	2336	714	185	694	0	1256	713	1429	14562
Common Tern	0	0	0	0	0	0	0	163	611	0	0	0	844
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	517	1759	0	0	0	2483
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	88	0	0	49	0	150

360 x 5MW

Species	Collisions per month NO AVOIDANCE Jan	Collisions per month NO AVOIDANCE Feb	Collisions per month NO AVOIDANCE Mar	Collisions per month NO AVOIDANCE Apr	Collisions per month NO AVOIDANCE May	Collisions per month NO AVOIDANCE Jun	Collisions per month NO AVOIDANCE Jul	Collisions per month NO AVOIDANCE Aug	Collisions per month NO AVOIDANCE Sep	Collisions per month NO AVOIDANCE Oct	Collisions per month NO AVOIDANCE Nov	Collisions per month NO AVOIDANCE Dec	TOTAL COLLISIONS per YEAR NO AVOIDANCE
Fulmar	2	0	1	2	10	4	3	2	4	1	1	3	35
Gannet	323	0	1401	702	336	796	579	1158	571	2983	1501	146	11450
Kittiwake	334	0	241	202	1407	875	1331	853	350	465	826	231	7762
Little Gull	0	0	0	0	0	0	0	0	0	2060	0	0	2247
Common Gull	277	0	0	75	0	0	0	0	145	140	64	511	1323
Great Black-backed Gull	4655	0	2034	347	375	0	0	736	0	1310	1190	2383	14214
Lesser Black-backed Gull	0	0	203	832	2242	668	231	426	0	0	0	0	5021
Herring Gull	2847	0	624	0	688	342	0	0	0	1201	273	547	7114
Large gulls combined	5581	0	2197	1251	3505	1072	278	1041	0	1884	1070	2144	21844
Common Tern	0	0	0	0	0	0	0	245	916	0	0	0	1267
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	776	2638	0	0	0	3725
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	132	0	0	74	0	224

Table C.174 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 95%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	11	0	47	23	11	27	19	39	19	99	50	5	382
Kittiwake	11	0	8	7	47	29	44	28	12	16	28	8	259
Little Gull	0	0	0	0	0	0	0	0	0	69	0	0	75
Common Gull	9	0	0	2	0	0	0	0	5	5	2	17	44
Great Black-backed Gull	155	0	68	12	12	0	0	25	0	44	40	79	474
Lesser Black-backed Gull	0	0	7	28	75	22	8	14	0	0	0	0	167
Herring Gull	95	0	21	0	23	11	0	0	0	40	9	18	237
Large gulls combined	186	0	73	42	117	36	9	35	0	63	36	71	728
Common Tern	0	0	0	0	0	0	0	8	31	0	0	0	42
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	26	88	0	0	0	124
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	4	0	0	2	0	7

360 x 5MW

Species	Collisions per month with avoidance rate 0.95 Jan	Collisions per month with avoidance rate 0.95 Feb	Collisions per month with avoidance rate 0.95 Mar	Collisions per month with avoidance rate 0.95 Apr	Collisions per month with avoidance rate 0.95 May	Collisions per month with avoidance rate 0.95 Jun	Collisions per month with avoidance rate 0.95 Jul	Collisions per month with avoidance rate 0.95 Aug	Collisions per month with avoidance rate 0.95 Sep	Collisions per month with avoidance rate 0.95 Oct	Collisions per month with avoidance rate 0.95 Nov	Collisions per month with avoidance rate 0.95 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.95
Fulmar	0	0	0	0	1	0	0	0	0	0	0	0	2
Gannet	16	0	70	35	17	40	29	58	29	149	75	7	573
Kittiwake	17	0	12	10	70	44	67	43	17	23	41	12	388
Little Gull	0	0	0	0	0	0	0	0	0	103	0	0	112
Common Gull	14	0	0	4	0	0	0	0	7	7	3	26	66
Great Black-backed Gull	233	0	102	17	19	0	0	37	0	65	59	119	711
Lesser Black-backed Gull	0	0	10	42	112	33	12	21	0	0	0	0	251
Herring Gull	142	0	31	0	34	17	0	0	0	60	14	27	356
Large gulls combined	279	0	110	63	175	54	14	52	0	94	54	107	1092
Common Tern	0	0	0	0	0	0	0	12	46	0	0	0	63
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	39	132	0	0	0	186
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	7	0	0	4	0	11

Table C.175 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 98%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	4	0	19	9	4	11	8	15	8	40	20	2	153
Kittiwake	4	0	3	3	19	12	18	11	5	6	11	3	103
Little Gull	0	0	0	0	0	0	0	0	0	27	0	0	30
Common Gull	4	0	0	1	0	0	0	0	2	2	1	7	18
Great Black-backed Gull	62	0	27	5	5	0	0	10	0	17	16	32	190
Lesser Black-backed Gull	0	0	3	11	30	9	3	6	0	0	0	0	67
Herring Gull	38	0	8	0	9	5	0	0	0	16	4	7	95
Large gulls combined	74	0	29	17	47	14	4	14	0	25	14	29	291
Common Tern	0	0	0	0	0	0	0	3	12	0	0	0	17
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	10	35	0	0	0	50
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	2	0	0	1	0	3

360 x 5MW

Species	Collisions per month with avoidance rate 0.98 Jan	Collisions per month with avoidance rate 0.98 Feb	Collisions per month with avoidance rate 0.98 Mar	Collisions per month with avoidance rate 0.98 Apr	Collisions per month with avoidance rate 0.98 May	Collisions per month with avoidance rate 0.98 Jun	Collisions per month with avoidance rate 0.98 Jul	Collisions per month with avoidance rate 0.98 Aug	Collisions per month with avoidance rate 0.98 Sep	Collisions per month with avoidance rate 0.98 Oct	Collisions per month with avoidance rate 0.98 Nov	Collisions per month with avoidance rate 0.98 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.98
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	1
Gannet	6	0	28	14	7	16	12	23	11	60	30	3	229
Kittiwake	7	0	5	4	28	17	27	17	7	9	17	5	155
Little Gull	0	0	0	0	0	0	0	0	0	41	0	0	45
Common Gull	6	0	0	1	0	0	0	0	3	3	1	10	26
Great Black-backed Gull	93	0	41	7	7	0	0	15	0	26	24	48	284
Lesser Black-backed Gull	0	0	4	17	45	13	5	9	0	0	0	0	100
Herring Gull	57	0	12	0	14	7	0	0	0	24	5	11	142
Large gulls combined	112	0	44	25	70	21	6	21	0	38	21	43	437
Common Tern	0	0	0	0	0	0	0	5	18	0	0	0	25
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	16	53	0	0	0	74
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	3	0	0	1	0	4

Table C.176 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 99%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	0	9	5	2	5	4	8	4	20	10	1	76
Kittiwake	2	0	2	1	9	6	9	6	2	3	6	2	52
Little Gull	0	0	0	0	0	0	0	0	0	14	0	0	15
Common Gull	2	0	0	0	0	0	0	0	1	1	0	3	9
Great Black-backed Gull	31	0	14	2	2	0	0	5	0	9	8	16	95
Lesser Black-backed Gull	0	0	1	6	15	4	2	3	0	0	0	0	33
Herring Gull	19	0	4	0	5	2	0	0	0	8	2	4	47
Large gulls combined	37	0	15	8	23	7	2	7	0	13	7	14	146
Common Tern	0	0	0	0	0	0	0	2	6	0	0	0	8
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	5	18	0	0	0	25
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	0	0	0	0	1

360 x 5MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	3	0	14	7	3	8	6	12	6	30	15	1	115
Kittiwake	3	0	2	2	14	9	13	9	3	5	8	2	78
Little Gull	0	0	0	0	0	0	0	0	0	21	0	0	22
Common Gull	3	0	0	1	0	0	0	0	1	1	1	5	13
Great Black-backed Gull	47	0	20	3	4	0	0	7	0	13	12	24	142
Lesser Black-backed Gull	0	0	2	8	22	7	2	4	0	0	0	0	50
Herring Gull	28	0	6	0	7	3	0	0	0	12	3	5	71
Large gulls combined	56	0	22	13	35	11	3	10	0	19	11	21	218
Common Tern	0	0	0	0	0	0	0	2	9	0	0	0	13
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	8	26	0	0	0	37
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	0	0	1	0	2

Table C.177 Results of collision rate monitoring for Hornsea sub-zone 2 between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 99.5%.

240 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	1	0	5	2	1	3	2	4	2	10	5	0	38
Kittiwake	1	0	1	1	5	3	4	3	1	2	3	1	26
Little Gull	0	0	0	0	0	0	0	0	0	7	0	0	7
Common Gull	1	0	0	0	0	0	0	0	0	0	0	2	4
Great Black-backed Gull	16	0	7	1	1	0	0	2	0	4	4	8	47
Lesser Black-backed Gull	0	0	1	3	7	2	1	1	0	0	0	0	17
Herring Gull	9	0	2	0	2	1	0	0	0	4	1	2	24
Large gulls combined	19	0	7	4	12	4	1	3	0	6	4	7	73
Common Tern	0	0	0	0	0	0	0	1	3	0	0	0	4
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	3	9	0	0	0	12
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	1

360 x 5MW

Species	Collisions per month with avoidance rate 0.995 Jan	Collisions per month with avoidance rate 0.995 Feb	Collisions per month with avoidance rate 0.995 Mar	Collisions per month with avoidance rate 0.995 Apr	Collisions per month with avoidance rate 0.995 May	Collisions per month with avoidance rate 0.995 Jun	Collisions per month with avoidance rate 0.995 Jul	Collisions per month with avoidance rate 0.995 Aug	Collisions per month with avoidance rate 0.995 Sep	Collisions per month with avoidance rate 0.995 Oct	Collisions per month with avoidance rate 0.995 Nov	Collisions per month with avoidance rate 0.995 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.995
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	2	0	7	4	2	4	3	6	3	15	8	1	57
Kittiwake	2	0	1	1	7	4	7	4	2	2	4	1	39
Little Gull	0	0	0	0	0	0	0	0	0	10	0	0	11
Common Gull	1	0	0	0	0	0	0	0	1	1	0	3	7
Great Black-backed Gull	23	0	10	2	2	0	0	4	0	7	6	12	71
Lesser Black-backed Gull	0	0	1	4	11	3	1	2	0	0	0	0	25
Herring Gull	14	0	3	0	3	2	0	0	0	6	1	3	36
Large gulls combined	28	0	11	6	18	5	1	5	0	9	5	11	109
Common Tern	0	0	0	0	0	0	0	1	5	0	0	0	6
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combined	0	0	0	0	0	0	0	4	13	0	0	0	19
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	1	0	0	0	0	1

Collision rate modelling using the SOSS Band (2012) extended model option 4

Introduction

C.68. Below the results of the collision rate modelling using the extended model (option 4) are presented for both years combined for two projects within the Round 3 Hornsea area. A total of two wind farm variants were modelled for project 1 (sub-zone 1) and two in project 2 (sub-zone 2) (Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area). The parameters of each variant that were used in the collision rate modelling are given in tables C.133 and C.134.

C.69. For each of the wind farm variants, collision rate modelling was carried out for four species: Gannet; Kittiwake; Lesser Black-backed Gull and Great Black-backed Gull. These species were deemed as higher concern as the initial collision rate modelling with the basic model revealed these as having the highest collision rates, partly as these species were some of the most abundant species recorded flying throughout the year. Therefore, these species were subject to further investigation using the extended model. The parameters used in the collision risk modelling for these species are given in table C.135. For project 1, the densities of flying birds were based on those recorded during the specific sub-zone 1 ship-based surveys within the sub-zone 1 development area (Table C.164). For project 2, densities of flying birds were based on those recorded during the 6km transect ship-based surveys within the relevant sub-zone area (Table C.171) (Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area).

C.70. The results of the extended collision rate model are given in tables C.178 – C.182 (results Year 1 and 2 subzone 1) and tables C.183 - C.187 (results Year 1 and 2 subzone 2). Data for various stages of the models are presented as well as the results for various avoidance rates (see C.29). Data do not exist for all months, as is indicated by blank columns. For these months the monthly potential numbers of flights and potential numbers of collisions show '0', however, yearly figures presented are calculated from the monthly rates averaged across that year.

Results Years 1 and 2 sub-zone 1

Table C.178 Collision risk per rotor crossing and proportion of birds at rotor height for two wind farms variants for the four species modelled with the extended model.

Wind farm	Variant	Species	Collision risk for single rotor crossing (%)	Percentage of birds at rotor height (%)
Hornsea sub-zone 1	332 x 3.6MW	Gannet	5.6	6.5
		Kittiwake	3.6	1.8
		Lesser Black-backed Gull	4.3	14.4
		Great Black-backed Gull	5.8	21.2
Hornsea sub-zone 1	150 x 8MW	Gannet	5.3	6.0
		Kittiwake	3.6	1.7
		Lesser Black-backed Gull	4.2	14.0
		Great Black-backed Gull	5.2	21.1

Table C.179 Results of collision rate monitoring with extended model for Gannet for Hornsea sub-zone 1 development area between March 2010 and February 2012.

Hornsea sub-zone 1 - 332 x 3.6MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	13	4	28	5	3	1	5	11	12	21	29	2	134	134
0.98	5	2	11	2	1	1	2	4	5	9	12	1	54	54
0.99	3	1	6	1	1	0	1	2	2	4	6	0	27	27
0.995	1	0	3	0	0	0	1	1	1	2	3	0	13	13

Hornsea sub-zone 1 - 150 x 8MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	6	2	13	2	1	1	3	5	6	10	14	1	64	64
0.98	2	1	5	1	0	0	1	2	2	4	6	0	26	26
0.99	1	0	3	0	0	0	1	1	1	2	3	0	13	13
0.995	1	0	1	0	0	0	0	1	1	1	1	0	6	6

Table C.180 Results of collision rate monitoring with extended model for Kittiwake for Hornsea sub-zone 1 development area between March 2010 and February 2012.

Hornsea sub-zone 1 - 332 x 3.6MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	4	4	6	2	1	10	17	9	9	4	9	3	78	78
0.98	1	1	2	1	0	4	7	4	4	2	4	1	31	31
0.99	1	1	1	0	0	2	3	2	2	1	2	1	16	16
0.995	0	0	1	0	0	1	2	1	1	0	1	0	8	8

Hornsea sub-zone 1 - 150 x 8MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	2	2	3	1	0	5	9	5	5	2	5	1	41	41
0.98	1	1	1	1	0	2	4	2	2	1	2	1	16	16
0.99	0	0	1	0	0	1	2	1	1	0	1	0	8	8
0.995	0	0	0	0	0	1	1	0	0	0	0	0	4	4

Table C.181 Results of collision rate monitoring with extended model for Lesser Black-backed Gull for Hornsea sub-zone 1 development area between March 2010 and February 2012.

Hornsea sub-zone 1 - 332 x 3.6MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	3	0	0	4	9	9	14	13	2	0	0	3	56	56
0.98	1	0	0	2	3	3	6	5	1	0	0	1	22	22
0.99	1	0	0	1	2	2	3	3	0	0	0	1	11	11
0.995	0	0	0	0	1	1	1	1	0	0	0	0	6	6

Hornsea sub-zone 1 - 150 x 8MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	1	0	0	2	5	4	7	7	1	0	0	2	29	29
0.98	1	0	0	1	2	2	3	3	0	0	0	1	12	12
0.99	0	0	0	0	1	1	1	1	0	0	0	0	6	6
0.995	0	0	0	0	0	0	1	1	0	0	0	0	3	3

Table C.182 Results of collision rate monitoring with extended model for Great Black-backed Gull for Hornsea sub-zone 1 development area between March 2010 and February 2012.

Hornsea sub-zone 1 - 332 x 3.6MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	55	26	37	15	13	3	16	15	62	7	33	36	316	316
0.98	22	10	15	6	5	1	6	6	25	3	13	15	127	127
0.99	11	5	7	3	3	1	3	3	12	1	7	7	63	63
0.995	6	3	4	1	1	0	2	2	6	1	3	4	32	32

Hornsea sub-zone 1 - 150 x 8MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	28	13	18	7	7	1	8	8	31	3	17	18	159	159
0.98	11	5	7	3	3	1	3	3	12	1	7	7	63	63
0.99	6	3	4	1	1	0	2	2	6	1	3	4	32	32
0.995	3	1	2	1	1	0	1	1	3	0	2	2	16	16

Results Years 1 and 2 sub-zone 2

Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area.

Table C.183 Collision risk per rotor crossing and proportion of birds at rotor height for two wind farms variants for the four species modelled with the extended model.

Wind farm	Variant	Species	Collision risk for single rotor crossing (%)	Percentage of birds at rotor height (%)
Hornsea sub-zone 2	240 x 5MW	Gannet	7.0	6.4
		Kittiwake	4.5	1.7
		Lesser Black-backed Gull	5.4	14.3
		Great Black-backed Gull	7.1	21.6
Hornsea sub-zone 2	360 x 5MW	Gannet	7.0	6.4
		Kittiwake	4.5	1.7
		Lesser Black-backed Gull	5.4	14.3
		Great Black-backed Gull	7.1	21.6

Table C.184 Results of collision rate monitoring with extended model for Gannet for Hornsea sub-zone 2 between March 2010 and February 2012.

Hornsea sub-zone 2 - 240 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	4	15	8	4	9	6	13	6	33	16	2		115	125
0.98	1	6	3	1	3	3	5	3	13	7	1		46	50
0.99	1	3	2	1	2	1	3	1	7	3	0		23	25
0.995	0	2	1	0	1	1	1	1	3	2	0		11	13

Hornsea sub-zone 2 - 360 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	5	23	12	6	13	10	19	9	49	25	2		172	188
0.98	2	9	5	2	5	4	8	4	20	10	1		69	75
0.99	1	5	2	1	3	2	4	2	10	5	0		34	38
0.995	1	2	1	1	1	1	2	1	5	2	0		17	19

Table C.185 Results of collision rate monitoring with extended model for Kittiwake for Hornsea sub-zone 2 between March 2010 and February 2012.

Hornsea sub-zone 2 - 240 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	3	2	2	12	8	12	8	3	4	7	2		63	69
0.98	1	1	1	5	3	5	3	1	2	3	1		25	27
0.99	1	0	0	2	2	2	2	1	1	1	0		13	14
0.995	0	0	0	1	1	1	1	0	0	1	0		6	7

Hornsea sub-zone 2 - 360 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	4	3	3	19	12	18	11	5	6	11	3		94	103
0.98	2	1	1	7	5	7	5	2	2	4	1		38	41
0.99	1	1	1	4	2	4	2	1	1	2	1		19	21
0.995	0	0	0	2	1	2	1	0	1	1	0		9	10

Table C.186 Results of collision rate monitoring with extended model for Lesser Black-backed Gull for Hornsea sub-zone 2 between March 2010 and February 2012.

Hornsea sub-zone 2 - 240 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	0	2	8	21	6	2	4	0	0	0	0	0	43	47
0.98	0	1	3	8	3	1	2	0	0	0	0	0	17	19
0.99	0	0	2	4	1	0	1	0	0	0	0	0	9	9
0.995	0	0	1	2	1	0	0	0	0	0	0	0	4	5

Hornsea sub-zone 2 - 360 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	0	3	12	31	9	3	6	0	0	0	0	0	65	71
0.98	0	1	5	13	4	1	2	0	0	0	0	0	26	28
0.99	0	1	2	6	2	1	1	0	0	0	0	0	13	14
0.995	0	0	1	3	1	0	1	0	0	0	0	0	6	7

Table C.187 Results of collision rate monitoring with extended model for Great Black-backed Gull for Hornsea sub-zone 2 between March 2010 and February 2012.

Hornsea sub-zone 2 - 240 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	62	27	5	5	0	0	10	0	18	16	32	175	191
0.98	25	11	2	2	0	0	4	0	7	6	13	70	76
0.99	12	5	1	1	0	0	2	0	4	3	6	35	38
0.995	6	3	0	1	0	0	1	0	2	2	3	17	19

Hornsea sub-zone 2 - 360 x 5MW

Avoiance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly total	Corrected for missing months
0.95	94	41	7	8	0	0	15	0	26	24	48	262	286
0.98	37	16	3	3	0	0	6	0	11	10	19	105	114
0.99	19	8	1	2	0	0	3	0	5	5	10	52	57
0.995	9	4	1	1	0	0	1	0	3	2	5	26	29

Discussion

Collision rate modelling using the basic model

C.71. The results of the collision rate modelling for two wind farm variants for the Hornsea sub-zone 1 area and two for the sub-zone 2 area are presented in the chapter on collision rate modelling using the SOSS Band (2012) basic model option 1 (Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area). These results are presented for years 1, 2 and for both years combined. Results are based on densities of flying birds recorded in the relevant area. For project 1, densities were based on the 2 km wide surveys within the development area and for project 2 on the 6 km wide surveys.

Sub-zone 1

C.72. For project 1, a total of two wind farm variants were modelled. These variants differed in the type, size and operating characteristics of turbines as well as the numbers of turbines. These differences translate into differing collision risk for a single transit across the rotor-swept area and also the total number of transits through this area. In terms of the model used, in general a larger turbine relates to a lower collision risk per transit but a greater potential number of transits through the rotor-swept area for any given species. The total number of transits through the rotor-swept area for a wind farm is also influenced by the total number of turbines. For the variants modelled, the highest collision risk per transit for most species was for the smallest turbine (3.6MW) and the lowest collision risk was for the largest turbine (8MW). Only for Little Gull, Arctic Tern and Common Tern was the collision risk vice versa, which was here l influenced by the rotor rotation speed and relatively slow flight speeds of the birds. The total number of transits per year was lowest for the variant with the fewest turbines (150 x 8MW) and highest for the variant with the most turbines (332 x 3.6MW).

C.73. For the model used, and for any given turbine, collision risk is related to the size and flight speed of the bird in question. Of the 17 species assessed, the largest, Northern Gannet, had the highest collision risk and the fastest flying, and also one of the smallest, Guillemot, the lowest. Collision risk per transit varied from 5.4% for Guillemot with an 8MW turbine to 8.8% for Northern Gannet with a 3.6MW turbine. The combination of this collision risk and the potential number of transits resulted in the species-specific and variant-specific collision rates to which various avoidance factors were applied. This avoidance factor reduces the estimated numbers of collisions proportionately. Here avoidance rates of 95%, 98%, 99% and 99.5% were applied, which reduced the estimated numbers of collisions correspondingly.

C.74. For both wind farm variants, the highest numbers of collisions were for the group 'large gulls' closely followed by Great Black-backed Gull and Kittiwake. Collision rates for Great Black-backed Gull in the absence of avoidance behaviour varied between 18,848 (3.6MW variant) and 12,255 (8MW variant) estimated collisions per year. The application of avoidance rates reduced the estimated number of collisions per year. For Great Black-backed Gull and the 332 x 3.6MW variant, an avoidance rate of 99% reduced the estimated number of collisions to 188 per year; for a rate of 99.5% this was 94 estimated collisions per year.

Sub-zone 2

C.75. Results for project 2 provide indicative results to inform the project 1 cumulative impact assessment only. Bird densities for project 2 are based on 6km transect surveys within this area. For sub-zone 2, two wind farm variants were modelled. The wind turbine in both variants was the same, meaning that the collision risk were identical for both variants. The wind farm variants differed only in the number of turbines, which meant that the total number of transits per year was lowest for the variant with the fewest turbines (240 x 5MW) and highest for the variant with the most turbines (360 x 5MW). For the model used, and for any given turbine, collision risk is related to the size and flight speed of the bird in question. Of the 17 species assessed, the largest, Northern Gannet, had the highest collision risk and the fastest flying, and also one of the smallest, Guillemot, the lowest. Collision risk per transit varied from 6.1% for Guillemot to 10.0% for Northern Gannet with the 5MW turbine. Species-specific and variant-specific collision rates result from a combination of the collision risk and the potential number of transits. This avoidance rates can be were applied to these estimates, namely: 95%; 98%; 99% and 99.5%. These avoidance rates reduce the estimated numbers of collisions correspondingly.

C.76. For both wind farm variants, the highest numbers of collisions were for the group 'large gulls', followed by Great Black-backed Gull and Northern Gannet. Collision rates were lowest for the 240 x 5MW variant and highest for the 360 x 5MW variant; this was due to the numbers of turbines. Collision rates for Northern Gannet in the absence of avoidance behaviour varied between 7,634 (240 x 5MW variant) and 11,450 (360 x 5MW variant) estimated collisions per year. The application of an avoidance rate of 99% reduced the estimated number of collisions per year to 76 and 115 respectively. An avoidance rate of 99.5% reduced these estimates further to 38 and 57.

Collision rate modelling using the extended model

C.77. The results of the collision rate modelling using the extended model for flight heights are presented in the chapter on collision rate modelling using the SOSS Band (2012) extended model option 4. These results are presented for four species and for two wind farm variants in each of sub-zone 1 and sub-zone 2. Results are based on densities of flying birds recorded in the relevant area. For sub-zone 1, densities were based on the 3 km wide surveys within the development area and for sub-zone 2 on the 6 km wide surveys.

C.78. Although the densities of birds used in the extended collision risk model are the same as for the basic model, the numbers of transits through the rotor-swept area are different due to the differences in the proportions of birds at rotor height used. Furthermore, the extended model results in a lower collision probability for a transit through the rotor-swept area. For each of the four species this collision probability was around half that of in the basic model. This is largely a result of the lower encounter probability and collision probability associated with the vertical extremities of the rotors. The proportion of birds at rotor height used in the basic and extended models is largely similar. As the tidal aspect of the extended model has not been applied, any differences are due to the categorisation of flight heights into 1 m bands. Both the proportions of birds at rotor height and the collision risk for a single crossing independently have a proportionate influence on the results. This means that in general, the lower collision risk for a single crossing explains the lower numbers of collisions more than the proportions of birds at rotor height. Only for the two wind farm variants in sub-zone 1 for Kittiwake does the proportion of birds at rotor height have more influence than the collision risk.

Collision rate estimates

C.79. The estimates of collision rates for birds at Hornsea were produced using the SOSS Band model, which makes a number of assumptions and simplifications of birds, turbines and their interactions. Furthermore, simplification of input data adds to the variability and uncertainty of output values. The main sources of uncertainty are outlined in Band (2011) and include, amongst others, the use of fixed parameters for dynamic variables like wingspan, flight speed, flight direction, turbine speed, wind speed and bird abundance. Uncertainly also exists in the data for bird abundance, which often shows high variability, both spatially and temporally. These factors influence the uncertainty surrounding estimates to varying degrees, however, it is arguably avoidance behaviour that has most influence on this uncertainty. Currently, few published figures exist for the level of avoidance exhibited by birds in relation to wind turbines, certainly for the offshore environment. This, coupled with the strong bearing of the avoidance rate on the modelled results, means that the uncertainty arising from avoidance rates used are likely to overshadow any uncertainty resulting due to other factors. Band (2011) outlines the uncertainly surrounding the modelled results should be expressed numerically. For most factors, however, these cannot be assessed empirically and would therefore be an ambiguous appraisal of the error involved.

References

Alerstam, T., M. Rosén, J. Bäckman, P.G.P. Ericson & O. Hellgren (2007). *Flight speeds among bird species: Allometric and phylogenetic effects.* PLoS Biol 5(8): e197. doi:10.1371/journal.pbio.0050197.

Band, W., M. (2012). *Using a collision risk model to assess bird collision risks for offshore windfarms.* Final version, March 2012. SOSS, The Crown Estate, 62pp. http://www.bto.org/science/wetland-and-marine/soss/projects.

Band, W., M. Madders & D.P. Whitfield, (2007). *Developing field and analytical methods to assess avian collision risk at wind farms*. in M. de Lucas, G.F.E. Janss & M. Ferrer. Birds and Wind Farms: Risk Assessment and Mitigation. pp. 259-275. Quercus. Madrid.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L. (1993). *DISTANCE Sampling: Estimating abundance of biological populations.* Chapman & Hall, London, reprinted 1999 by RUWPA, University of St. Andrews, Scotland.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., Thomas, L. (2001). *Introduction to Distance Sampling*. Oxford University Press, Oxford. 432pp.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., Thomas, L. (eds) (2004). *Advanced Distance Sampling*. Oxford University Press, Oxford. 434pp.

Camphuysen, C.J., A.D. Fox, M.F. Leopold & I.K. Petersen, (2004). *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K*. - A comparison of ship and aerial sampling methods for marine birds, and their applicability to offshore wind farm assessments. Report COWRIE - BAM -02-2002.

Chamberlain, D.E., M.R. Rehfisch, A.D. Fox, M. Desholm & S.J. Anthony, (2006). *The effect of avoidance rates on bird mortality predictions made by wind tubine collision risk models*. Ibis 148: 198-202.

Cramp, S. and C.M. Perrins, (1977-1994). *Handbook of the birds of Europe, the Middle East and Africa.* The birds of the western Palearctic. Oxford University Press, Oxford.

Garthe, S. & O. Hüppop, (2004). *Scaling possoble adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index*. Journal of Applied Ecology 41: 724-734.

JNCC, 2006. SAST Computer Coding Manual 6th Edition. 27pp.

Pennycuick, C.J. (1997). *Actual and 'optimum' flight speeds: Field data reassessed*. The Journal of Experimental Biology 200: 2355-2361.

Pennycuick, C.J. (1987). *Flight of auks (Alcidae) and other northern seabirds compared with southern Procellariiformes: ornithodolite observations.* Journal of Experimental Biology 128: 335-347.

Snow D.W. & C. Perrins (1997). *Birds of the Western Palearctic. Concise edition. Volume 1, Non-passerines.* Oxford University Press, Oxford.

Thaxter, C.B., S. Wanless, F. Daunt, M.P. Harris, S. Benvenuti. Y. Watanuki, D. Grénillet & K.C. Harmer, (2010). *Influence of wing loading on the trade-off between pursuit-diving and flight in common guillemots and razorbills*. The Journal of Experimental Biology 213: 1018-1025.

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P. (2010). *Distance software: design and analysis of distance sampling surveys for estimating population size.* Journal of Applied Ecology 47: 5-14.

Tasker M.L., P.H. Jones, T.J. Dixon & B.F. Blake, (1984). *Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach.* Auk 101: 567-577.

Wakeling, J.M. & J. Hodgson, (1992). *Optimisation of the flight speed of the Little, Common and Sandwich Tern*. Journal of Experimental Biology 169: 261 - 266.

Migration Modelling and Collision Risk Modelling in Relation to Hornsea Subzone 1 Development - DRAFT

Draft

November 2012

APEM REF: 412552

APEM LTD
Riverview, A17 Embankment Business Park, Heaton Mersey, Stockport SK4 3GN
Tel: 0161 442 8938 Fax: 0161 432 6083
Registered in England No. 2530851
Website: http://www.apemltd.co.uk

PROJECT DIRECTOR: Dr Mark Rehfisch

PROJECT MANAGER: Dr Stephanie McGovern

WRITTEN BY: Dr Stephanie McGovern & Helen Rowell

This report is draft and should not be cited.

Introduction

Background

D.1 Offshore wind development is underway around the coast of the UK, and Round 3 developments will deliver more turbines across a wide area of sea, extending further offshore. An integral part of gaining consent is the ability of the competent authority to make an Appropriate Assessment as part of the Habitats Regulations Assessment, particularly for waterbirds and seabirds. To provide confidence in their assessment, it is important to provide information to the competent authority on the likely origins of migratory birds and numbers which may pass though offshore wind developments. Whilst monthly field surveys can provide information on the presence of species, the survey effort required to adequately assess magnitude and frequency of these events is not realistically possible for developments that are larger and further offshore. Moreover, failure to detect any given species during field surveys does not necessarily lead to a conclusion that the species in question will never interact with the proposed development. Therefore, during migration windows there remain questions about the potential number of birds passing through proposed wind farm footprints.

D.2 One solution is to model migratory bird movements theoretically. To help determine connectivity between SPAs and the operational wind farm site, together with potential mortality rates, APEM have developed a theoretical modelling tool to derive estimates of migrating birds passing through the wind farm development sites, with a measure of confidence. The species focused upon are those associated with non-breeding SPAs; i.e. waders and wildfowl migrating into the UK for the winter, with a point to point broad front migration between continental Europe and the UK.

D.3 This report describes the use of Migropath, a modelling tool to theoretically quantify bird migration through the proposed Hornsea subzone 1 wind farm.

Methodology

Approach

D.4 For Natura 2000 sites, there are regular estimates of bird populations in any given winter (e.g. from the Wetland Bird Survey), as well as the original SPA designation figures. We thus have information on the numbers of birds over-wintering on these sites. From ringing / tagging data, as well as other literature, we also have information on the likely origin of some or all of these populations, including transboundary migrations. We can thus define a broad- front migration area for a given number (population) of birds. Furthermore, data from continental sites (e.g. staging posts, observatories) can be used to further refine the likely fronts, as well as provide information on temporal components of migration (for example, daily passage rate and duration of migration events). This work was progressed by the Crown Estate's

Strategic Ornithological Support Service (SOSS) (Wright *et al*., 2012) and fed in to this report. We thus have a known number of birds arriving (or departing) across a broad front that can be defined based on data and best knowledge.

D.5 It is therefore possible to estimate the likelihood of differing proportions of the population encountering wind farms of interest. Furthermore, it will be possible to make estimates for birds associated with one SPA, with a defined group of SPAs, or with a regional suite of SPAs by feeding in appropriate count data and defining appropriate migratory corridors. Flight height data from individual wind farm surveys, or literature, can be used to later inform proportions of bird numbers estimated passing through a wind farm area that would be at risk of collision with turbine rotors.

D.6 The approach is a relatively uncomplicated method to answer a pressing set of questions. In order to develop more complex models simulating bird movement, additional environmental variables such as weather and photoperiod, and biological factors such as flight speed, energy budget, flocking behaviour and manoeuvrability would need to be considered. APEM has been involved in similar simulations for fish passage at tidal barrage locations (Willis & O'Keeffe, in prep.), using hydrodynamic and behavioural modelling.

Assumptions

D.7 The model inevitably makes several assumptions. Chief amongst these is the assumption that migration is in a straight line between the SPA of interest and a given point (or defined area) outwith the UK.

D.8 Birds migrating between continental areas and UK SPAs that do not pass through the wind farm development areas are not considered to be at collision risk from the proposed development, based on the assumption of straight-line migration. Such no-risk movements can be factored in to estimate proportions of birds arriving on / departing from SPAs but not encountering wind farm development footprints.

D.9 Another key assumption is that all migration of a particular species to a particular suite of SPAs can be defined within a set corridor. This corridor should aim to realistically represent the broad front area across which birds must move.

Technical Method

D.10 The centrepoint of each SPA was calculated using the geometry function within ESRI® ArcMapTM 9.2. The coastline of Continental Europe was split into 1 km segments, and each segment labelled with a unique ID. Using the ET Geowizard tool each segment along the European coast was joined to the centre of each SPA, with each line classified as either passing within or outwith each offshore development area (Figure D.1).

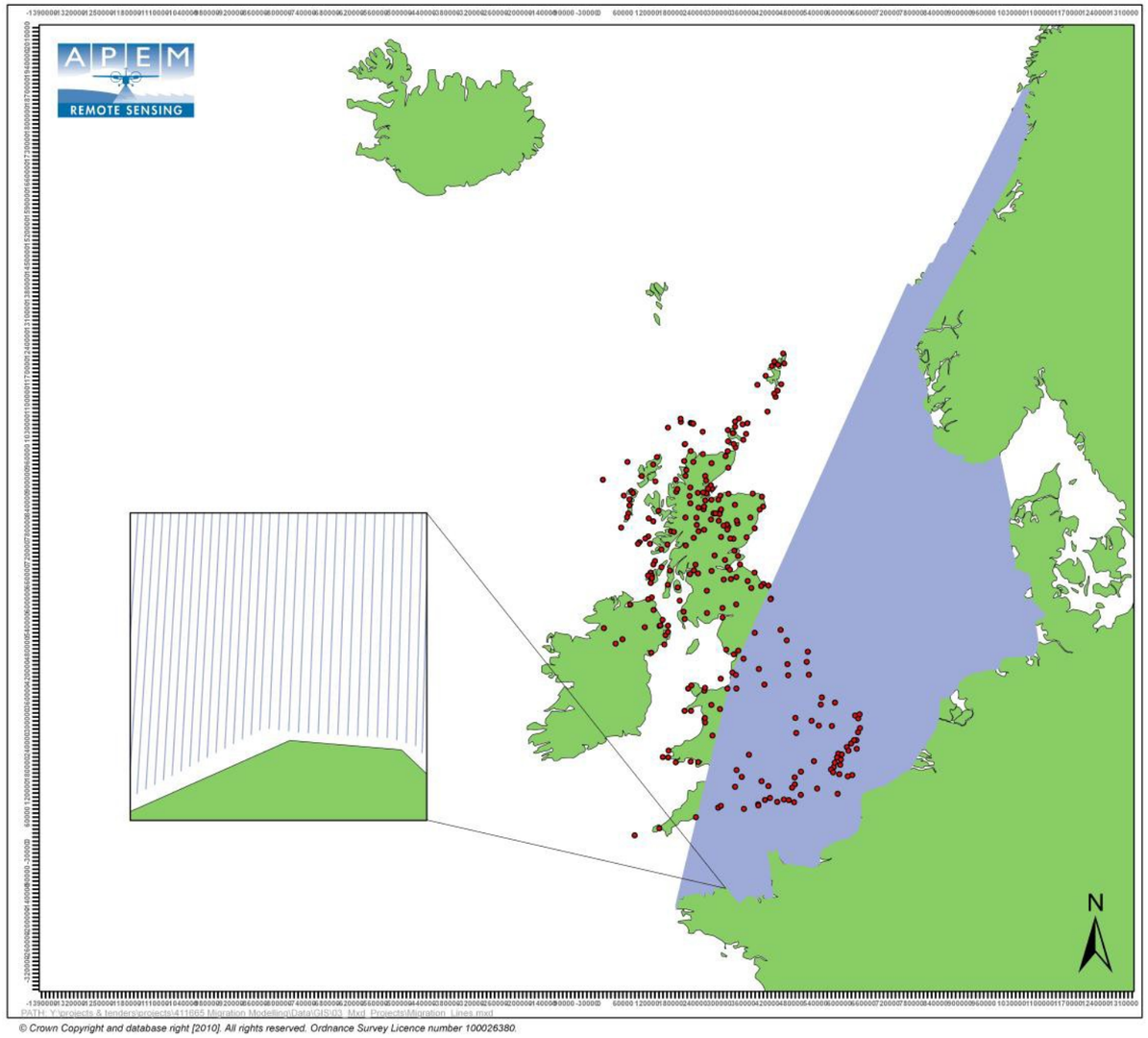


Figure D.1 Example migration lines from the European coast to Ribble and Alt Estuaries SPA. Red dots represent the centre of each SPA. The inset shows a section of the 1km spaced migration lines.

D.11 A list of SPAs that each of the species is associated with was collated (JNCC, 2011; Stroud *et al*., 2001). This information, along with the SPA line associations and migratory pathways, were then fed into R (R Development Core Team, 2012).

D.12 Within R, a list of SPAs associated with a species are extracted and the relevant data loaded. Data contained within the migratory pathway are then extracted and collated. A random percentage of birds are assigned to each migratory route, and percentages within each wind farm development area are summed to produce the output. Where sufficient information exists on staging areas, the percentage of the population utilising these areas are incorporated. The model output provides a sum of the percentage of birds passing through the wind farm development areas within one migration period (i.e. spring migration). For an estimate of the total number of birds passing through the areas within one year, these outputs would need to be multiplied by the relevant number of migration periods. Where staging areas are incorporated, percentages migrating to/from may vary with migration season. Therefore differing proportions of the population may pass through a particular wind farm on outward and return migration flights.

D.13 In addition, percentages passing through the wind farm development areas were converted to numbers of birds to feed into collision risk modelling. Estimates of the flyway population and GB & Ireland population were obtained from the SOSS-05 project (Wright *et al*., 2012).

Species

D.14 For the purposes of modelling, a list of 12 species (seven waders and five wildfowl) were selected based on a relatively high proportion of birds occurring within the regional SPAs close to the proposed Hornsea subzone 1 wind farm development area. To take a precautionary approach, the largest estimated population size was used to estimate likely maximum numbers passing through the wind farm development area.

Model Outputs

D.15 Species population size and the numbers estimated to be migrating through the proposed wind farm area are shown in Table D.1.

Collision Risk Modelling

D.16 The presence of the Hornsea subzone 1 site presents a potential collision risk to birds which fly through the wind turbine array when on migration. The risk to birds is from directly colliding with the wind turbine rotors and their associated structures at sea.

D.17 All collision risk assessments used the new 'Band' model adapted for migrants (Band *et al*., 2012) designed specifically for applications for offshore wind farm developments. To be precautionary, avoidance rates of 95%, 98%, 99% and 99.5% have been modelled. Species input data is shown in Table D.2, with turbine specification shown in Table D.3. Seasonal estimates for species collision on migration are detailed in Table D.4 – Table D.15.

Table D.1 Numbers estimated to be migrating through the proposed Hornsea subzone 1 wind farm development area.

Species	Flyway population	GB and Ireland population	Percentage of flyway population staging at the Wadden Sea	Migration season[2]	Migrant estimate	Lower confidence limit	Upper confidence limit	Percentage of flyway population within Hornsea Subzone 1	Percentage of GB and Ireland Population within Hornsea Subzone 1
Bewick's swan	20,000	7,380	-	Spring/ Autumn	106	101	112	0.53	1.44
Taiga bean goose	70,000- 90,000	410	-	Spring/ Autumn	57	56	58	0.06	13.91
Dark-bellied brent goose	200,000	91,000	99.8	Spring	1,498	1,432	1,573	0.75	1.65
			41.6	Autumn	1,063	1,007	1,114	0.53	1.17
Shelduck	300,000	75,610	43.8	Spring	6,026	5,965	6,083	2.01	7.97
			81.9	Autumn	4,617	4,544	4,677	1.54	6.11
Wigeon	1,500,000	522,370	-	Spring/Autumn	35,076	34,821	35,348	2.34	6.71
Golden Plover	1,070,000–1,140,000	566,700	-	Spring/Autumn	24,254	23,595	24,870	2.27	4.28
Grey plover	250,000	49,315	-	Spring/Autumn	3,972	3,943	4,005	1.59	8.06
Lapwing	5,500,000-9,500,000	827,700	-	Spring/Autumn	62,245	61,740	62,751	0.66	7.52
Knot	450,000	338,970	75.0	Spring	19,410	19,036	19,726	4.31	5.73
			79.7	Autumn	19,400	19,087	19,737	4.31	
Dunlin	1,330,000	438,480	71.2	Spring	16,742	16,441	17,020	1.26	3.82
			86.8	Autumn	16,715	16,407	17,098	1.26	3.81
Black-tailed godwit	57,000	56.880	-	Spring/Autumn	952	931	974	1.67	1.67
Bar-tailed godwit	120,000	54,280	58	Spring	3,011	2,962	3,055	2.51	5.55
			25.3	Autumn	3,292	3,251	3,330	2.74	6.07

[1]Wright *et al.,* 2012

[2]Laursen *et al.,* 2010.

Table D.2 Species Input Parameters for Collision Risk Modelling in the Hornsea Subzone 1 site.

Species	Proportion of flights at Potential Collision height (PCH)	Body Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Nocturnal Activity Rate (%)
Bewick's swan	38	1.21	1.96	18.5	100
Taiga bean goose	75	0.75	1.58	17.3	100
Dark-bellied brent goose	75	0.58	1.15	17.7	100
Shelduck	60	0.62	1.12	15.4	100
Wigeon	60	0.48	0.80	20.6	100
Golden plover	75	0.28	0.72	26.8	100
Grey plover	75	0.28	0.77	17.9	100
Lapwing	75	0.30	0.84	12.8	100
Knot	75	0.24	0.59	20.1	100
Dunlin	75	0.18	0.40	15.3	100
Black-tailed godwit	75	0.42	0.76	19.4	100
Bar-tailed godwit	75	0.38	0.75	18.3	100

Data obtained from the following sources: Alerstam (1990); Alerstam *et al.* (2007); Bruderer & Boldt (2001);

Garthe & Hüppop (2004); King *et al.* (2009); Larsen & Clausen (2002); Pennycuick (1997); Platteeuw (2005); Robinson (2005); Wright *et al.* (2012).

Table D.3 Collision Risk Modelling Turbine Specification for Hornsea Subzone 1.

Turbine Parameter	Worst Case Array
Turbine Model	SWT 3.6
Number of Turbines	332
Number of Blades	3
Rotation Speed (rpm)	13
Rotor Radius (m)	60
Hub Height (m)	95
Maximum Blade Width (m)	4.20
Pitch (degrees)	15

Table D.4 Summary of Seasonal Mortality Rates for Bewick's Swan.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Bewick's swan	95	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	98	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Table D.5 Summary of Seasonal Mortality Rates for Taiga Bean Goose.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Taiga bean goose	95	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	98	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Table D.6 Summary of Seasonal Mortality Rates for Dark-bellied Brent Goose.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Dark-bellied brent goose	95	Mean	2	1
		Minimum	1	1
		Maximum	2	1
	98	Mean	1	0
		Minimum	1	0
		Maximum	1	0
	99	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Table D.7 Summary of Seasonal Mortality Rates for Shelduck.

Species	AvoidanceRate (%)	Mortality Rate	Spring Migration	Autumn Migration
Shelduck	95	Mean	5	4
		Minimum	5	4
		Maximum	5	4
	98	Mean	2	2
		Minimum	2	2
		Maximum	2	2
	99	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	99.5	Mean	1	0
		Minimum	1	0
		Maximum	1	0

Table D.8 Summary of Seasonal Mortality Rates for Wigeon.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Wigeon	95	Mean	25	25
		Minimum	25	25
		Maximum	26	26
	98	Mean	10	10
		Minimum	10	10
		Maximum	10	10
	99	Mean	5	5
		Minimum	5	5
		Maximum	5	5
	99.5	Mean	3	3
		Minimum	3	3
		Maximum	3	3

Table D.9 Summary of Seasonal Mortality Rates for Golden Plover.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Golden plover	95	Mean	20	20
		Minimum	19	19
		Maximum	20	20
	98	Mean	8	8
		Minimum	8	8
		Maximum	8	8
	99	Mean	4	4
		Minimum	4	4
		Maximum	4	4
	99.5	Mean	2	2
		Minimum	2	2
		Maximum	2	2

Table D.10 Summary of Seasonal Mortality Rates for Grey Plover.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Grey plover	95	Mean	3	3
		Minimum	3	3
		Maximum	3	3
	98	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	99	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Table D.11 Summary of Seasonal Mortality Rates for Lapwing.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Lapwing	95	Mean	60	60
		Minimum	59	59
		Maximum	60	60
	98	Mean	24	24
		Minimum	24	24
		Maximum	24	24
	99	Mean	12	12
		Minimum	12	12
		Maximum	12	12
	99.5	Mean	6	6
		Minimum	6	6
		Maximum	6	6

Table D.12 Summary of Seasonal Mortality Rates for Knot.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Knot	95	Mean	15	15
		Minimum	15	15
		Maximum	10	10
	98	Mean	6	6
		Minimum	6	6
		Maximum	4	4
	99	Mean	3	3
		Minimum	3	3
		Maximum	2	2
	99.5	Mean	2	2
		Minimum	2	2
		Maximum	1	1

Table D.13 Summary of Seasonal Mortality Rates for Dunlin.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Dunlin	95	Mean	13	13
		Minimum	13	13
		Maximum	13	14
	98	Mean	5	5
		Minimum	5	5
		Maximum	5	5
	99	Mean	3	3
		Minimum	3	3
		Maximum	3	3
	99.5	Mean	1	1
		Minimum	1	1
		Maximum	1	1

Table D.14 Summary of Seasonal Mortality Rates for Black-tailed Godwit.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Black-tailed godwit	95	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	98	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99	Mean	0	0
		Minimum	0	0
		Maximum	0	0
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Table D.15 Summary of Seasonal Mortality Rates for Bar-tailed Godwit.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Bar-tailed godwit	95	Mean	3	3
		Minimum	3	3
		Maximum	3	3
	98	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	99	Mean	1	1
		Minimum	1	1
		Maximum	1	1
	99.5	Mean	0	0
		Minimum	0	0
		Maximum	0	0

Discussion

D.18 For each of the twelve species assessed within this report, the migration model, Migropath, has predicted that a proportion of the population is likely to pass through the Hornsea subzone 1 wind farm development site.

D.19 Of the species assessed, the greatest percentage of the GB and Ireland population predicted to pass through the site is that of the taiga bean goose. Despite 13.9 percent of the GB and Ireland population estimated to pass through the site, due to the species biometrics and flight speed, there is predicted to be little risk of collision with the proposed turbines.

D.20 The remaining eleven species are all estimated to have less than 10% of the GB and Ireland population passing through the Hornsea subzone 1 development site.

D.21 Bewick's swan, dark- bellied brent goose and black-tailed godwit are all predicted to have less than 2% of the GB and Ireland population passing though the area.

D.22 The collision risk modelling has predicted low numbers of collisions with the proposed turbines for most of the species assessed, however higher numbers of wigeon and lapwing are predicted to collide with the proposed turbines. Further assessment against regional thresholds will be necessary for species with predicted collisions.

References

Alerstam, T. (1990) Bird Migration. Cambridge University Press, Cambridge.

Alerstam, T., Rosen, M., Backman, J., Ericson, P.G.P., & Hellgren, O. (2007) Flight speeds among bird species: Allometric and Phylogenetic Effects. Plos Biology 5(8): e197. Doi:10.1371/journal.pbio.0050197.

Band, W (2012). Using a collision risk model to assess bird collision risks for offshore windfarms. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. SOSS Website. Original published Sept 2011, extended to deal with flight height distribution data March 2012.

Bruderer, B. & Boldt, A. (2001) Flight characteristics of birds: I radar measurements of speeds. Ibis 143: 178-204.

Garthe, S & Hüppop, O. (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41: 724-

734.

JNCC. 2011. Spatial and Summary Data for UK SPAs [online]. Available from http://jncc.defra.gov.uk/page-1409 [Accessed 13th December 2011).

King, S., Maclean, I.M.D., Norman, T., & Prior, A. (2009) Developing guidance on ornithological cumulative impact assessment for offshore wind developers. COWRIE.

Larsen, J.K. & Clausen, P. (2002) Potential Wind Park Impacts on Whooper Swans in Winter: The Risk of Collision. Waterbirds: The International Journal of Waterbird Biology, Vol. 25, SpecialPublication 1: Proceedings of the Fourth International Swan Symposium

2001 (2002), pp. 327-330.

Laursen, K., Blew, J., Eskildsen, K., Gunther, K., Halterlein, B., Kleefstra, R., Luersen, G., Potel, P. & Schrader, S. (2010) Migratory Waterbirds in the Wadden Sea 1987- 2008. Wadden Sea Ecosystem No.30. Common Wadden Sea Secretariat, Joint Monitoring Group of Migratory Birds in the Wadden Sea, Wilhelmshaven, Germany.

Pennycuick, C.J. (1997) Actual and 'optimum' flight speeds: field data reassessed. Journal of

Experimental Biology 200: 2355-2361.

Platteeuw, M. (2005) Could ecological flood defences be used as functional stepping-stones along migration routes of wetland birds? Ecohydrology & Hydrobiology, 5, 87-93.

R Development Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

Robinson, R.A. (2005) BirdFacts: profiles of birds occurring in Britain & Ireland (v1.1, Jan

2006). BTO Research Report 407, BTO, Thetford (http://www.bto.org/birdfacts).

Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H & Whitehead, S (eds). 2001. The UK SPA network: its scope and content. JNCC, Peterborough. Volume 1: Rationale for the selection of sites. 90 pp. Volume 2: Species accounts. 438 pp. Volume 3: Site accounts. 392 pp

Willis, J. & O'Keeffe, N. In prep. Modelling fish in hydrodynamic models – an example using the Severn Barrage SEA.

Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. & Burton, N.H.K. (2012) Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex I species). Strategic Ornithological Support Services. Project SOSS-05. BTO Research Report No. 592.

Migration Modelling and Collision Risk Modelling in Relation to Hornsea Subzone 1 Development – DRAFT FINAL

Draft Final

May 2013

APEM REF: 412552

APEM LTD
Riverview, A17 Embankment Business Park, Heaton Mersey, Stockport SK4 3GN
Tel: 0161 442 8938 Fax: 0161 432 6083
Registered in England No. 2530851
Website: http://www.apemltd.co.uk

PROJECT DIRECTOR: Dr Mark Rehfisch

PROJECT MANAGER: Dr Stephanie McGovern

WRITTEN BY: Dr Stephanie McGovern, Helen Rowell & Sean Sweeney

This report is draft and should not be cited.

Introduction

Background

D.23 Offshore wind development is underway around the coast of the UK, and Round 3 developments will deliver more turbines across a wide area of sea, extending further offshore. An integral part of gaining consent is the ability of the competent authority to make an Appropriate Assessment as part of the Habitats Regulations Assessment, particularly for waterbirds and seabirds. To provide confidence in their assessment, it is important to provide information to the competent authority on the likely origins of migratory birds and numbers which may pass though offshore wind developments. Whilst monthly field surveys can provide information on the presence of species, due to a combination of the rapid turnover of migratory species through sites, the difficulty of predicting precisely when they will pass through sites and the tendency for many migrants to move at night, the survey effort required to adequately assess magnitude and frequency of these events is not realistically possible for developments that are larger and further offshore. Moreover, failure to detect any given species during field surveys does not necessarily lead to a conclusion that the species in question will never interact with the proposed development. Therefore, during migration windows there remain questions about the potential number of birds passing through proposed wind farm footprints.

D.24 One solution is to model migratory bird movements theoretically. APEM have developed a simple approach to estimating the number of migrating birds passing through the wind farm development sites. This report describes the use of this modelling method to quantify bird migration through the proposed Hornsea subzone 1 wind farm.

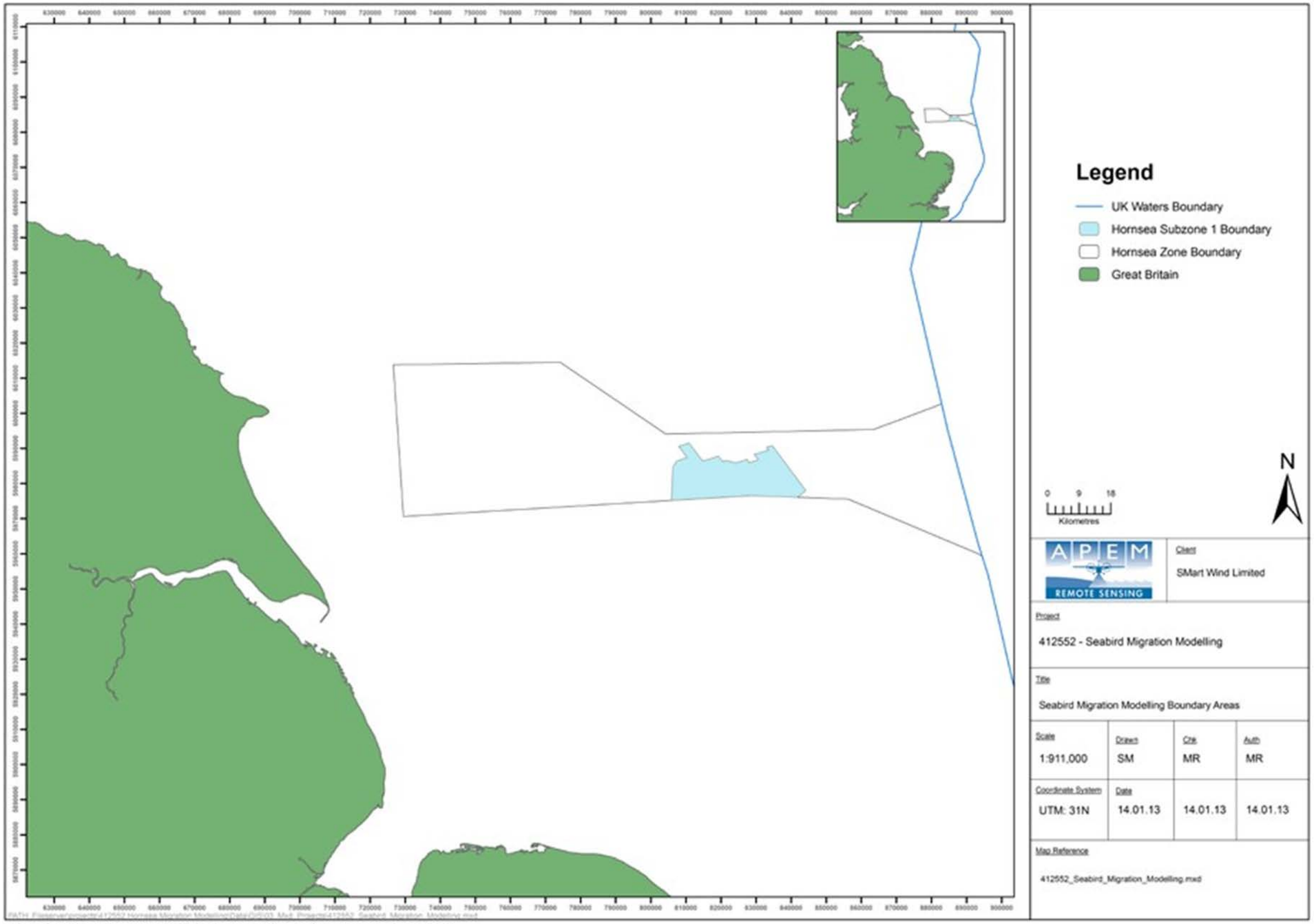
Methodology

Approach

D.25 APEM have devised a simple method to estimate the numbers of migrants passing through the Hornsea subzone 1 wind farm site. The method is based on a basic calculation utilising species specific information on population estimates and migration behaviour.

Migration Route

D.26 To ensure the estimates are precautionary, the migration route is assumed to extend to the edge of the UK waters boundary and the entire population will pass between the coast and this boundary. The width of the Hornsea Subzone 1 proposed wind farm is assumed to be 39 km (Figure D.2). This is the widest point across the subzone and therefore represents the worst case scenario.



© Crown Copyright and database right [2011]. All rights reserved. Ordnance Survey Licence number 100026380.

Figure D.2 Map indicating the location and extent of the Hornsea Subzone 1 Wind farm Development Area.

Species

D.27 For the purposes of modelling, a list of five species of seabird were selected based on a relatively high proportion of birds occurring within the regional SPAs close to the proposed Hornsea subzone 1 wind farm development area. Recommendations from the phase 3 consultation response from the Joint Nature Conservation Committee (JNCC) and Natural England (NE) were also incorporated into the species selection. Estimates of both the GB and Ireland population and the flyway population passing through the Hornsea Subzone 1 site have been undertaken. Due to a lack of detailed information regarding migration routes of offshore species, it is difficult to refine the species specific assumptions further than those listed below.

Artic Skua

D.28 Arctic skuas tend to migrate and winter along coasts, often lingering for some time where there are aggregations of terns and small gulls such as in estuaries (Taylor 1979). The birds that migrate along the coasts of Britain and Ireland comprise both UK-breeding birds and those that breed in the north of Europe (Furness 1987).

D.29 Arctic skuas occur in two plumage phases: dark and light. In Scotland, dark birds predominate, in southern Scandinavia up to 95% of birds may be dark-phase, but at high latitudes nearly all birds are light-phase. The migrations of these birds differ in timing and so the proportions of light and dark birds on coasts change through the migration seasons (Arcos 1997). Most birds seen at sea in the North Sea in autumn were classified as dark-phase (Tasker *et al*. 1987), suggesting that few Arctic breeders pass through the North Sea in autumn. Scottish birds leave their breeding sites largely in August and birds then probably follow a migration route through the North Sea (where migration peaks in August and September) and English Channel and then down the coasts of Europe and Africa, though some may cross the Atlantic to South American wintering grounds (Tasker *et al*. 1987; Wernham *et al*. 2002).

D.30 Scottish adult Arctic skuas return to colonies during late April, but birds breeding in the Arctic may not occupy breeding grounds until June, and some of these may occur along both British and Irish coasts in May. This is the month when the percentage of dark-phase birds is lowest in the North Sea (Tasker *et al*. 1987). In Sussex it has been observed that the proportion of light-phase birds increases during the spring, as later migrating birds head for progressively more northerly breeding grounds (Newnham 1984).

Great Skau

D.31 Great skuas on migration generally avoid coasts, with birds tending to remain at least 2-5 km from the shore, except during periods of bad weather. Equally, great skuas only rarely travel into pelagic waters, tending to remain over the shallow seas of the continental shelf (Wernham *et al*. 2002). The great skua is listed in Stienen *et al*. (2007) as an offshore species that is rarely observed within 20 km from the shoreline. The analysis of the latitudes of recoveries in different months shows a tendency for autumn migration to be slow and ill- defined, whilst in contrast; the spring migration is more clearly defined. Rapid spring migration is to be expected, as the earlier birds lay in May, the higher their breeding productivity (Catry *et al*, 1998). One of the greatest uncertainties regarding great skua migrations is the extent to which patterns are determined by the distribution and behaviour of commercial fisheries, as studies in wintering areas and on migration suggest that birds associate strongly with fishing fleets to feed on discards (Furness 1987; Tasker *et al*. 1987).

D.32 The great majority (40-100%) of the flyway population of great skua use the English Channel to leave the North Sea (Stienen *et al*. 2007). Great skuas from breeding colonies on the west coast of Scotland may migrate south directly down the Atlantic coast of Europe, whereas many from colonies on the northern isles migrate into the North Sea before moving from there into the Atlantic. Immature birds that have visited colonies but not bred tend to migrate away from colonies first in June and July, while breeding adults and juvenile birds leave colonies mainly in August, but with some remaining until October (Wernham *et al*. 2002). Peak numbers on migration are in September in the North Sea (Tasker *et al*. 1987) and October to the west of Britain and Ireland (Webb *et al*. 1990). Spring migration occurs during late March and April, with established breeders arriving at colonies from late March, with newly recruiting birds arriving later, and immatures last of all (Wernham *et al*. 2002).

Little Gull

D.33 Little gulls are primarily passage migrants to Britain and Ireland, occurring in both spring and autumn (Stone *et al*. 1995). The numbers of little gulls on passage through Britain and Ireland, and passing Helgoland Bight, have increased dramatically since the 1970s. This increase matches a documented westward expansion in breeding range that has taken place over a similar time period. There has also been a recent northerly extension to the wintering range (Hagemeijer & Blair 1997). Passage during migration is usually rapid and judging from observations at sea, most gulls remain close inshore (Skov *et al*. 1995). The little gull is listed in Stienen *et al*. (2007) as an inshore species that is most abundant within 20 km from the shoreline.

D.34 The great majority (40-100%) of the flyway population of little gull use the English Channel to leave the North Sea (Stienen *et al*. 2007). Movements of little gulls out of the North Sea take place in October, with birds moving to wintering areas in the western Mediterranean, with seemingly smaller numbers in the Irish Sea, the English Channel and off northwest Africa. Relatively large numbers cross the North Sea in autumn and internationally important numbers occur near the River Tees (Skov *et al*. 1995). Within the Irish Sea, the largest numbers are associated with the County Wicklow coast (Wernham *et al*. 2002). There is also a well-documented spring passage through the English Channel and the southern North Sea from April and May (Woutersen 1980).

Common Tern

D.35 Common terns breeding in the UK migrate via the western coasts of Europe to wintering grounds on the west coast of Africa. In addition to the UK breeding population, many common terns from populations breeding in northern mainland Europe also migrate via the UK on passage. Many of the recoveries of common terns from northern European populations have come from the western parts of Britain, suggesting a substantial passage directly across the country (Wernham *et al*. 2002). The common tern is listed in Stienen *et al*. (2007) as an inshore species that is most abundant within 20 km from the shoreline.

D.36 Between 30-70% of the summer resident terns use the English Channel to leave the North Sea (Stienen *et al*. 2007). Post-fledging dispersal of juveniles occurs between July and October, with adults migrating mainly between August and October. Much of the movement of these coastal birds within Britain may be overland (Ward 2000; Wernham *et al*. 2002). During September, and especially October, there is a strong southward movement of common terns along the coast of southwest Europe and away from Britain and Ireland, with migration following the coasts (Wernham *et al*. 2002). Many UK breeding birds are back at their breeding areas by April. The lack of records at west coast observatories implies that there is little movement through the Irish Sea to the Scottish colonies, and the frequency of inland sightings suggests that much of the spring passage takes place directly overland to the breeding sites. In fact, the only British observatories to record substantial numbers in spring are Dungeness and Portland Bill. At both sites, spring passage peaks in late April and early May and is mainly eastward, suggesting that these birds are most likely to be on their way to breeding areas elsewhere in northern Europe (Wernham *et al*. 2002).

Artic Tern

D.37 Britain and Ireland is at the southern edge of the breeding range of the Arctic tern, and colonies are concentrated in the north of the country (Wright *et al*. 2012). At the end of the breeding season, the main post-breeding movement of adult birds is southwards. Movements through Britain and Ireland are thought to occur mainly offshore (Wernham *et al*. 2002). The migration continues southwards via the coast of western and southern Africa to wintering sites around the Antarctic along the West African coast (Wright *et al*. 2012). The return passage begins in March, with birds heading for European colonies heading northwards through the eastern Atlantic, with a similar route to that undertaken in autumn taken in spring (Wernham et al. 2002). In Britain, overland northward movements of Arctic terns are indicated by observations of hundreds or even thousands of birds during some spring months at reservoirs in central England. These observations may be the result of poor flying conditions at sea or at high altitudes over land (Kramer 1995).

Modelling assumptions

D.38 For each of the individual species to be modelled, model assumptions are presented in Table D.16.

Table D.16 Individual species modelling assumptions.

Species	Percentage ofpopulation passing through the North Sea on Migration	Inshore or offshore species	Percentage of population that migrate within 20 km from shore	Percentage of population that migrate outside of 20 km from shore
Arctic skua	100	Both	100	
Great skua	100	Offshore	0	100
Little gull	100	Inshore	50	50
Common tern	100	Inshore	50	50
Arctic tern	100	Offshore	0	100

Model Outputs

D.39 The proposed Hornsea subzone 1 development may present possible barrier effects to migrating species. As such utilising information on the species population and relevant migration behaviour can allow calculation of the number of a species that may pass through a given area. This can be calculated utilising the following formula:

D.40 Width of development area / width of migration route (altered for species specific behaviour)* species population.

D.41 Using the above formula, an estimation of the number of each species passing through the Hornsea subzone 1 development area is shown in Table 3.1. Estimations of both the Flyway population (deemed to be the biogeographical population) and the GB and Ireland population (deemed to be the breeding population) have been undertaken. Estimates are presented for one migration passage, so to enable a full assessment of the number of individuals passing through the development area within a year, the number presented will need to be multiplied by two. For assessment purposes the percentage of the GB and Ireland population estimated to be passing through the area is also shown in Table D.17.

Collision Risk Modelling

D.42 The presence of the Hornsea subzone 1 site presents a potential collision risk to birds which fly through the wind turbine array when on migration. The risk to birds is from directly colliding with the wind turbine rotors and their associated structures at sea.

D.43 All collision risk assessments used the new 'Band' model adapted for migrants (Band *et al*., 2012) designed specifically for applications for offshore wind farm developments. To be precautionary, avoidance rates of 95%, 98%, 99% and 99.5% have been modelled. Species input data is shown in Table D.18, with turbine specification shown in Table D.19. Seasonal estimates for species collision on migration are detailed in Table D.20 - Table D.24.

Table D.17 Numbers estimated to be migrating through the proposed Hornsea subzone 1 wind farm development area. Estimates are for one migration passage.

Species	Flyway population[1]	GB and Ireland Population[2]	Migrant estimate of GB and Ireland Population within Hornsea Subzone 1	Migrant estimate of Flyway Population within Hornsea Subzone 1	Percentage of Population within Hornsea Subzone 1
Arctic skua	120,000- 420,000	6,408	1,922	126,000	30
Great skua	48,000	28,902	9,538	8,976	33
Little gull	75,000	Unknown*	-	12,375	16.5
Common tern	160,000- 200,000	35,514	5,860	33,000	16.5
Arctic tern	1,500,000- 2,700,000	160,164	52,854	891,000	33

* This species lacks an accurate British or UK population estimate (Baker *et al*. 2006; Holt *et al*. 2012); [1] From Wright *et al*. (2012); [2] From Baker *et al*. (2006)

Table D.18 Species Input Parameters for Collision Risk Modelling in the Hornsea Subzone 1 site.

Species	Proportion of flights at potential collision height	Body length (m)[2]	Windspan (m)[2]	Flight speed (ms^{-1})	Nocturnal Activity Rate (%)[7]
Arctic skua	3.8	0.44	1.18	13.3 [3]	0
Great skua	4.3	0.56	1.36	16.0 [4]	0
Little gull	5.5	0.26	0.78	11.5 [5]	25
Common tern	12.7	0.33	0.88	10.5 [6]	0
Arctic tern	2.8	0.34	0.80	10.9 [5]	0

[1] From Cook *et al*. (2011); [2] From Robinson (2005); [3] From Pennycuick (1997); [4] From Mateos-Rodriguez & Bruderer (2012); [5] From Alerstam *et al*., (2007); [6] From Alerstam (1985); [7] From Garthe & Hüppop (2004).

Table D.19 Collision Risk Modelling Turbine Specification for Hornsea Subzone 1.

Turbine Parameter	Worst Case Array
Turbine Model	SWT 3.6
Number of Turbines	332
Number of Blades	3
Rotation Speed (rpm)	13
Rotor Radius (m)	60
Hub Height (m)	95
Maximum Blade Width (m)	4.20
Pitch (degrees)	15

Table D.20 Summary of Seasonal Mortality Rates for Arctic Skua.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Arctic Skua	98	GB and Ireland population	0.07	0.07
		Flyway population	4.53	4.53
	99	GB and Ireland population	0.03	0.03
		Flyway population	2.26	2.26
	99.5	GB and Ireland population	0.02	0.02
		Flyway population	1.13	1.13

Table D.21 Summary of Seasonal Mortality Rates for Great Skua.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Great Skua	98	GB and Ireland population	0.39	0.39
		Flyway population	0.37	0.37
	99	GB and Ireland population	0.20	0.20
		Flyway population	0.18	0.18
	99.5	GB and Ireland population	0.10	0.10
		Flyway population	0.09	0.09

Table D.22 Summary of Seasonal Mortality Rates for Little Gull.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Little Gull	98	GB and Ireland population	-	-
		Flyway population	0.59	0.59
	99	GB and Ireland population	-	-
		Flyway population	0.29	0.29
	99.5	GB and Ireland population	-	-
		Flyway population	0.15	0.15

Table D.23 Summary of Seasonal Mortality Rates for Common Tern.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Common Tern	98	GB and Ireland population	0.72	0.72
		Flyway population	4.04	4.04
	99	GB and Ireland population	0.36	0.36
		Flyway population	2.02	2.02
	99.5	GB and Ireland population	0.18	0.18
		Flyway population	1.01	1.01

Table D.24 Summary of Seasonal Mortality Rates for Arctic Tern.

Species	Avoidance Rate (%)	Mortality Rate	Spring Migration	Autumn Migration
Arctic Tern	98	GB and Ireland population	1.40	1.40
		Flyway population	23.61	23.61
	99	GB and Ireland population	0.70	0.70
		Flyway population	11.81	11.81
	99.5	GB and Ireland population	0.35	0.35
		Flyway population	5.90	5.90

Discussion

D.44 For each of the five species assessed within this report, the migration modelling has predicted that a proportion of the population is likely to pass through the Hornsea subzone 1 wind farm development site.

D.45 Of the species assessed, the greatest percentage of the population predicted to pass through the site is that of the great skua and arctic tern. Despite 33 percent of the population estimated to pass through the site, due to the biometrics and flight speed of both species, there is predicted to be relatively few individuals at risk of collision with the proposed turbines.

D.46 Of the remaining species arctic skua is estimated to have the greatest number of individuals passing through the wind farm, with 30 percent of its population passing estimated to pass though the site. Arctic skua, common tern and little gull are all estimated to have relatively low levels of collision with the proposed turbines.

D.47 The collision risk modelling has predicted low numbers of collisions with the proposed turbines for the species assessed. Estimated densities for all species are higher than those observed during site specific surveys, as would be expected due to rapid turnover of species during migration. Collision risk analysis run on data collected through site specific surveys has predicted higher collision for some species however. Whilst this may seem counterintuitive species detected on survey are likely to fly at a lower flight height than those on migration, increasing the risk of collision. In addition, the current Band *et al*. (2012) model calculates the flux of birds passing through the site differently for individuals detected on site specific surveys and those on migration, which may also reduce the numbers estimated to collide with the proposed turbines.

D.48 Further assessment against regional thresholds will be necessary for species with predicted collisions.

References

Alerstam, T. (1990) *Bird Migration.* Cambridge University Press, Cambridge.

Alerstam, T., Rosen, M., Backman, J., Ericson, P.G.P., & Hellgren, O. (2007) *Flight speeds among bird species: Allometric and Phylogenetic Effects*. Plos Biology 5(8): e197. Doi:10.1371/journal.pbio.0050197.

Arcos, J.M. (1997) *Kleptoparastic behaviour of Arctic skuas Stercorarius parasiticus migrating through the northwestern Mediterranean*. Thesis, University of Barcelona. 31 pp.

Band, W (2012). *Using a collision risk model to assess bird collision risks for offshore windfarms*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. SOSS Website. Original published Sept 2011, extended to deal with flight height distribution data March 2012.

Bruderer, B. & Boldt, A. (2001) *Flight characteristics of birds: I radar measurements of speeds.* Ibis 143: 178-204.

Catry, P., Ratcliffe, N. & Furness, R.W. (1998) *The influence of hatching date on different life-history stages of Great Skuas Catharacta skua.* Journal of Avian Biology 29: 229-304.

Furness, R.W. (1987) *Movements and mortality rates of Great Skuas ringed in Scotland*. Bird

Study 25: 229-238.

Garthe, S & Hüppop, O. (2004) *Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index.* Journal of Applied Ecology 41: 724-

734.

Hagemeijer, W.J.M. & Blair, M.J. (eds.) (1997) *The EBCC Atlas of European Breeding Birds: their distribution and abundance.* T. & A.D. Poyser.

Kramer, D. (1995) *Inland spring passage of Arctic Terns in southern Britain*. British Birds 88: 211-217.

Mateos-Rodriguez, M. & Bruderer, B. (2012). *Flight speeds of migrating seabirds in the Strait of Gibraltar and their relation to wind*. Journal of Ornithology 153: 881-889.

Newnham, J.A. (1984) *Some aspects of the sea-bird movements observed from the Sussex coast during the spring 1983*. Sussex Bird Report 36: 60-63.

Pennycuick, C.J. (1997) *Actual and 'optimum' flight speeds: field data reassessed*. Journal of Experimental Biology 200: 2355-2361.

Robinson, R.A. (2005) BirdFacts: profiles of birds occurring in Britain & Ireland (v1.1, Jan 2006). BTO Research Report 407, BTO, Thetford (http://www.bto.org/birdfacts).

Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L. (1995) I*mportant Bird Areas for Seabirds in the North Sea.* BirdLife International, Cambridge.

Stienen, E.W.M., Waeyenberge, V., Kuijken, E. & Seys, J. (2007) *Trapped Within the Corridor of the Southern North Sea: Potential Impact of Offshore Wind Farms on Seabirds.* INC & FMI, Belgium.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J.& Pienkowski, M.W. (1995) *An atlas of seabird distribution in north-west European waters*. Joint Nature Conservation Committee and Nederlands Instituut vor Onderzoek der Zee, Peterborough.

Tasker, M.L., Webb, A., Hall, A.J., Pienkowski, M.W. & Langslow, D.R. (1987) *Seabirds in the North Sea.* Nature Conservancy Council, Peterborough.

Taylor, I.R. (1979) *The kleptoparasitic behaviour of the Arctic Skua Stercorarius parasiticus with three species of tern*. Ibis 121: 274-282.

Ward, R.M. (2000) *Migration patterns and moult of Common Terns Sterna hirundo and Sandwich Terns Sterna sandvicensis using Teesmouth in the late summer*. Ringing & Migration 20: 19-28.

Wernham, C., Siriwardena, G.M., Toms, M., Marchant, J., Clark, J.A. & Ballie, S. (eds.) (2002) *The Migration Atlas: Movements of the Birds of Britain and Ireland.* T & AD Poyser, London.

Woutersen, K. (1980) *Migrating Little Gulls in the Netherlands.* British Birds 73: 192-193.

Wright, L.J, Ross-Smith, V.H., Cook, A.S.C.P., Massimino, D. & Burton, N.H.K. (2012). Project SOSS-05 – Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species). BTO Report Commissioned by the Crown Estate.