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Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters

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Authors of short note presented in Appendix 4: D Russell and M Carter

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This report presents the results of marine and freshwater work carried out for Marine Scotland under external commission.

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E L Hague[1], R R Sinclair[1] and C E Sparling[1,2]

Authors of short note presented in Appendix 3: C Lacey[2] and P S Hammond[2]
Authors of short note presented in Appendix 4: D Russell[2] and M Carter[2]

[1] SMRU Consulting, Scottish Oceans Institute, East Sands, St Andrews, Fife, KY16 8LB
[2] Sea Mammal Research Unit, University of St Andrews, St Andrews, Fife, KY16 8LB

Executive Summary

This report collates and provides up-to-date information on the abundance and distribution of marine mammal species in the Scottish Northern North Sea region and Scottish Atlantic waters, with a focus on Draft Plan Option (DPO) sites identified in the Draft Sectoral Marine Plan for Offshore Wind Energy for Scotland. These are sites which may be leased for commercial-scale offshore renewable development. Using the review of the current abundance and distribution data available for marine mammals in Scottish waters, the report then highlights areas where data are lacking, particularly for DPOs, and a number of recommendations are provided on potential future options for research at a strategic level to fill these gaps.

Summary tables are presented throughout the report which provide an overview of the large volume of information presented within the report, one of which collates the >40 data sources presented (Table 1), another the species expected to be sighted within each DPO region and site (Table 9), and two further summary tables summarise the gaps in knowledge by DPO region (Table 12) and by species (Table 13).

The report also provides a review of our current understanding of vital rates of marine mammals in Scottish waters, again highlighting any gaps in current knowledge. Separately commissioned short notes are available in the Appendices which provide information and advice on the utility and future status of the SCANS surveys and of seal at-sea usage maps.

The species reviewed are harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*), harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), white-beaked dolphin (*Lagenorhynchus albirostris*), minke whale (*Balaenoptera acutorostrata*), short-beaked common dolphin (*Delphinus delphis*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), fin whale (*Balaenoptera physalus*), and beaked whale spp including Northern bottlenose whale (*Hyperoodon ampullatus*), Sowerby's beaked whale (*Mesoplodon bidens*) and Cuvier's beaked whale (*Ziphius cavirostris*).

1. Introduction

The overall objective of this report is to collate and provide up-to-date information on the abundance and distribution of all marine mammal species in the Scottish Northern North Sea region and Scottish Atlantic waters, with a focus on the Regions and Draft Plan Option (DPO) sites (Figure 1) within the Draft Sectoral Marine Plan for Offshore Wind Energy (Scottish Government 2019b). The DPOs comprise 17 sites split across five regions within Scottish waters (Figure 1), all of which have the potential to produce several gigawatts of renewable energy. Final Plan Options, to be confirmed in the final Sectoral Marine Plan for Offshore Wind Energy (due for publication later in 2020), will be made available for lease for commercial-scale offshore wind developments by Crown Estate Scotland ('ScotWind'). The Strategic Environmental Assessment prepared for the draft Sectoral Marine Plan for Offshore Wind Energy recognises the data gaps and uncertainties with respect to marine mammals (Scottish Government 2019c).

To help support the planning, licensing and consenting assessments with respect to marine mammals within these DPO sites, and within Scottish waters as a whole, this report provides a review of the published and unpublished literature available to provide up to date information on baseline abundance and distribution of marine mammals species in these waters.

A summary table of the data sources of abundance and distribution data within Scottish waters used in this review is provided in Table 1, and a comprehensive description of each data source is provided in Appendix 1: Data Sources.

We provide dedicated reviews and up to date information for the baseline abundance and distribution within Scottish waters for the following species:

- Harbour seal *Phoca vitulina*
- Grey seal *Halichoerus grypus*
- Harbour porpoise *Phocoena phocoena*
- Bottlenose dolphin *Tursiops truncatus*
- Risso's dolphin *Grampus griseus*
- White-beaked dolphin *Lagenorhynchus albirostris*
- Minke whale *Balaenoptera acutorostrata*
- Short-beaked common dolphin *Delphinus delphis*
- Atlantic white-sided dolphin *Lagenorhynchus acutus*
- Long-finned pilot whale *Globicephala melas*
- Killer whale *Orcinus orca*
- Humpback whale *Megaptera novaeangliae*
- Sperm whale *Physeter macrocephalus*
- Fin whale *Balaenoptera physalus*
- Beaked whale spp.
    - Northern bottlenose whale *Hyperoodon ampullatus*
    - Sowerby's beaked whale *Mesoplodon bidens*
    - Cuvier's beaked whale *Ziphius cavirostris*

We have presented information on the species most likely to occur in Scottish waters, including only the species for which there are sufficient information for the purpose of this report. This is by no means an exhaustive list of all the marine mammal species in Scottish waters. Other species sightings or strandings tend to be rare, and as such there is little to no information on abundance or distribution within Scottish waters for many of those rarer species, and so for the purposes of this report these have not been included.

Following a thorough review for each species, we then highlight areas, with a particular focus on DPO sites, and species where knowledge is sparse, and provide recommendations where further knowledge is required. We also provide a review of our current knowledge of vital rates for each species (Appendix 2: Vital Rates), highlighting gaps in our current understanding.

Also provided as part of this report are two short notes separately commissioned to provide up to date recommendations on the utility and future of:

- The SCANS (Small Cetaceans in European Atlantic waters and the North Sea) surveys (Appendix 3: SCANS surveys)
- Harbour and grey seal at-sea distribution maps (Appendix 4: Seal Abundance and Distribution)

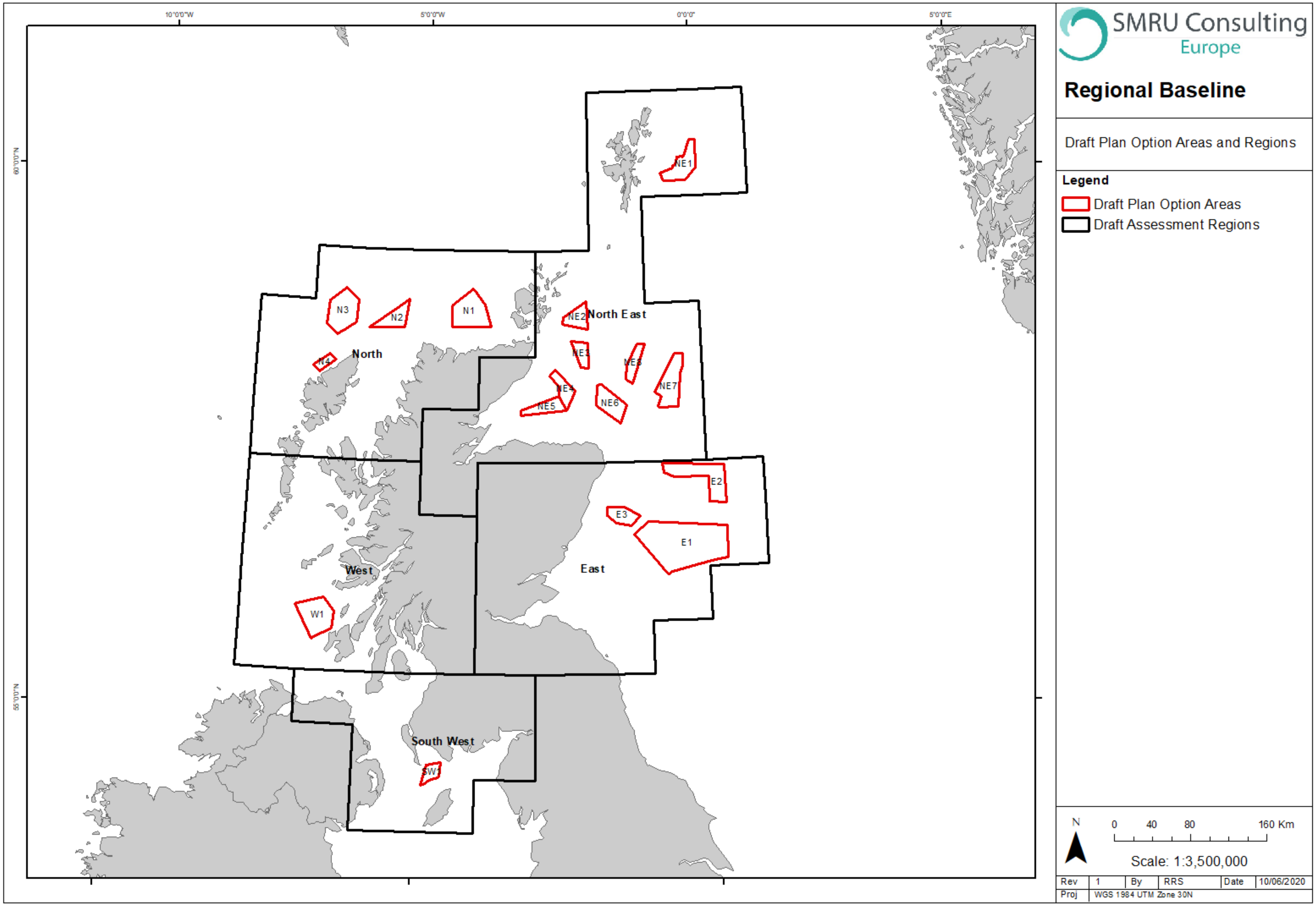

Figure 1: The Draft Plan Option sites and regions within Scottish waters presened in the Draft Sectoral Marine Plan for Offshore Wind Energy (Scottish Government 2019b).

2. Data sources

In order to provide a collation and review of regional baseline information on abundance and distribution of marine mammals in Scottish waters, we performed a thorough review of potential data sources. The review covered published and un-published data, and explored the availability of industry data e.g. data from baseline monitoring of wet renewables sites. Unlike other similar aggregations of marine mammal survey data (Kaschner et al. 2012, Mannocci et al. 2018), we have not only focused on surveys that use distance sampling methodology (i.e. methodology that allows for the calculation of perpendicular distances to observed groups and thus the estimation of absolute abundance), and instead have collated any available data covering the abundance and distribution of marine mammals in Scottish waters, regardless of sampling methodology. There have been both large-scale surveys of the area, recurrent small-scale surveys, as well as sporadic or stand-alone surveys or data collection.

Table 1 provides an overview of all data sources that were identified and explored as part of this review, with more thorough information on the coverage and limitations of each source provided in Appendix 1: Data Sources. Where possible, information is provided on the species, location and time-frame covered within the data-sets, and advice on the utility, interpretation and the limitations of each dataset are discussed. Datasets that were made available to the project as part of this work are, where permissions were approved, provided in the Supplementary Materials as shapefiles and are listed in the MEDIN database and available on Marine Scotland Maps.

Table 1

Data sources of marine mammal abundance and distribution data within Scottish waters
Species: AWSD Atlantic white-sided dolphin, BND Bottlenose dolphin, BW Blue whale, BWS Beaked whale spp., CBW Cuvier's beaked whale, FKW False killer whale, FW Fin whale, HP Harbour porpoise, HW Humpback whale, KW Killer whale, LFPW Long-finned pilot whale, MS Mesoplodon spp, MW Minke whale, NBNW Northern bottlenose whale, NRW Northern right whale, PSW Pygmy sperm whale, RD Risso's dolphin, SBCD Short-beaked common dolphin, SBW Sowerby's beaked whale, SD Striped dolphin, SW Sperm whale, SeW Sei Whale, WBD White-beaked dolphin. † data included in JCP database, superscript are the years of data included in the JCP database (Paxton et al. 2016). ‡ data included in the MERP database (Waggitt et al. 2020).

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
Anderwald and Evans (2010)	Visual and land based survey	BND, HP, WBD, MW, RD, KW, AWSD, SBCD, LWPW, HW, FW, NBNW, SD, SW	Region: North, North East. DPO: E3	East Grampian coastline	1973-2010	All	Sightings maps	• Sightings data over long time period • Cover coastal sightings that larger scale surveys may miss	• Most effort coastal so little overlap with DPO
APEM	Aerial surveys	Unknown	Region: North East, East	East coast Scotland	2020-present	Unknown	Digital stills	Unknown – data unavailable for this report	
Atlas of Cetacean Distribution (Reid et al. 2003) † ‡	Collation and analysis of data from European Seabirds at Sea (ESAS), Sea Watch Foundation and the Small Cetaceans in European Atlantic waters and the North Sea surveys (SCANS)	HW, MW, SeW, FW, SBCD, WBD, AWSD, RD, LFPW, HP, SW, NBW, BWS, MS, BND, SD, KW, NRW, BW, PSW, CBW, SBW, FKW.	All	Whole UK	1979-1997	All	Relative densities at regional level, where possible. If data is limited, maps of sightings rate per unit search time.	• Data available online • Long time series of data	• Data >23 years old • Collation of 18yrs data so no reflection of inter-annual shifts or seasonal differences
Booth et al. (2013) † ‡	Visual and acoustic vessel-based surveys (data from Hebridean Whale and Dolphin Trust (HWDT))	HP	Region: North and West. DPO: W1, N4	Hebrides	2003-2010	Apr-Sep	Habitat preference maps	• Overlap with DPOs	• Little overlap with DPO sites
Cetaceans of the Atlantic Frontier (Pollock et al. 2000, Weir et al. 2001) † ‡	Data from ESAS and Seabirds at Sea Team (SAST) surveys	FW, SeW, MW, HW, SW, NBNW, SBW, KW, LFPW, AWSD, WBD,	Region: North, North East, West, South West. No overlap with DPO	West and North Scotland	1979-1998	All	Abundance and distribution data presented in 1 of 3 ways dependent on number of sightings per species:	• Long time series of data	• Effort varied monthly, seasonally and yearly. ~Double coverage in summer months

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
		RD, BND, SBCD, HP					Abundance estimates (as number of animals sighted per km trackline) OR sighting location OR number of individuals sighted		• Coverage varied geographically with respect to season • SAST surveys primary goal to collect seabird data, marine mammal data secondary objective • No overlap with DPOs
Clyde Porpoise	Boat based visual and acoustic surveys	HP	Region: West and South West. No overlap with DPO	Firth of Clyde	Unknown	Unknown	Unknown – data unavailable for this report		• No overlap with DPOs
Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) (Hammond et al. 2009) [† ‡]	Ship based surveys	SBCD, SD, BND, LFPW, SW, MW, FW and BWS.	Region: North. No overlap with DPO	West coast offshore, beyond the continental shelf	2007	Jul	Estimates of abundance and distribution of cetaceans beyond the continental shelf: density surface maps.	• Design-based estimates and density surfaces provided	• Very offshore, so no coverage of DPOs
Collaborative Oceanography and Monitoring for Protected Areas and Species (COMPASS) project	Acoustic monitoring	HP, Dolphin species	Region: North, West, South West No overlap with DPO	West Scotland	2017-present	All	Dolphin species and porpoise detection positive days and hours	• Data provided free of charge	• Only detects vocalising marine mammals • No overlap with DPOs
Cetacean Research & Rescue Unit (CRRU) [‡]	Vessel based data collection	Record all marine mammal species	Region: North East. No overlap with DPO	Southern Moray Firth	1997-present	Summer	Sightings data		• Not responsive to data requests
East Coast Marine Mammal Acoustic Study (ECOMMAS)	Passive acoustic monitoring	HP, Dolphin species	Region: North East and East No overlap with DPO	Coastal east Scotland	2013-present	All (2013 summer only)	Dolphin species and porpoise detection positive days and hours	• 2013-2016 data available on MSS website. • Recent data provided free of charge	• Only detects vocalising marine mammals • No overlap with DPOs
Embling (2007)	Acoustic survey data and analysis	HP, SW and delphinids (not classified to species level)	Region: North, West, North East. DPO: N1, N2, N3, N4, W1	North and West Scotland	2003-2005	May, Jul, Sep, Oct	Sightings distribution maps	• Large area of coverage	• Dolphin detections not identified to species level • Only detects vocalising marine mammals
Evans et al. (2011)	Collation of data sources	All cetaceans	Region: North, North East. DPO: N1, NE2 and NE3.	Pentland Firth and Orkney Isles	1980-2010	All	Sightings maps	• Long time series of data	• Some data sources had no effort data, preventing calculation of density estimates
Hebridean Whale and Dolphin Trust (HWDT) [2003-2010†, 2002-2015‡]	Visual and acoustic surveys	BND, SBCD, HP, HW, KW, MW, RD, WBD	Region: North, West and South West DPO: N4 and W1	Hebrides	2003 – 2017 (surveys ongoing)	Apr-Oct	Sightings per unit effort	• Collate sightings data from other sources	• Subset of HWDT data provided at cost for this report.

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
								• Long time series of data	
HiDef Ltd (2015)	Aerial surveys	HP, MW, WBD, BND, harbour and grey seal	Region: North East and East. DPO: NE5 and E3.	Coastal east Scotland, Orkney	2014	Aug-Nov	Sightings data	• Data available online	• Coastal so little overlap with DPOs. • Short span of data collection
Heinänen and Skov (2015)	Analysis of a collation of data sources (Joint Cetacean Protocol (JCP))	HP	All	Whole UK	1994-2011	Summer (Apr-Sep) and Winter (Oct-Mar)	Density surface maps	• Long time series of data • Summer and winter estimates available	• Uncertainty in distributions due to uneven survey effort • Uncertainty particularly high in winter
Inter-Agency Marine Mammal Working Group (IAMMWG 2015c)	Analysis of a collation of data sources	HP	All	Whole UK	1965-2014	Summer and Winter	Modelled occurrence of harbour porpoise	• Fine scale (5x5km) • Long time series	
Irish Whale and Dolphin Group (IWDG) 2001-2010†, 2001-2016‡	Line transect surveys on ferry's	Unknown	Region: Southwest DPO: SW1	Belfast-Cairnryan ferry route	2013-unknown	Unknown	Sightings data, photo-ID for some species	• Sightings of interest submitted to HWDT	• Not much data for Scottish waters (S. Berrow, personal communication)
Joint Cetacean Protocol (JCP) Data Analysis (Paxton et al. 2016)	Analysis of a collation of data sources (JCP)	HP, MW, BND, SBCD, RD, WBD, AWSD	All	Whole UK	1994-2010	Summer	Estimate spatial and temporal patterns of abundance	• Indictive illustration of species distribution • Density/abundance estimates can be used in impact assessments when scaled to total abundance of reference populations • Long time series of data	• Data >10yrs old • Due to patchy distribution of data, estimates are less reliable than SCANS. • Should not be used to provide baseline data or to infer fine scale abundance (ie less than 1000km^2) • Only summer • Abundance estimates not suitable for EIAs • Not suitable for detecting small changes in population size
Lighthouse Field Station (University of Aberdeen)	Vessel based surveys	BND, but will also opportunistically record other cetacean species	Region: North East. No overlap with DPO	Moray Firth SAC	2002-2016 (surveys ongoing)	May-Sep	Effort and sightings data, photo-ID data	• Data provided free of charge	• Little overlap with DPO. • Only summer
Macleod et al. (2003)	Ship based survey	AWSD, FW, SeW, LFPW, SW, SBCD, HP, WBD, RD	Region: North Area: N3 and N4	Outer Hebrides; west of the Shetland Islands and the Faroe-Shetland Channel	1998	Jul and Aug	Maps of distribution of sightings and group sizes		• >20 yrs old • 304 marine mammal sightings but only 184 to species level, as the vessel did not approach any marine mammals for species

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
									ID or for estimation of group size. • Only summer
MacLeod et al. (2008)	Vessel based survey (using SAST survey data)	SBCD, WBD	All	Whole UK	1983-1998	May-Oct	Sightings maps	• Long time series of data • Overlap with DPOs	• SAST surveys primary goal to collect seabird data, marine mammal data secondary objective
MARINElife 1995-2010†, 2008-2014‡	Vessel based survey	AWSD, BND, SBCD, HP, MW, RD, grey seal, harbour seal, cetacean sp, dolphin sp., whale sp, seal sp.	Region: All Area: SW1, E1, NE7	Ferry routes: Belfast – Glasgow, Belfast – Liverpool, Belfast – Heysham, Heysham-Warrenpoint, Rosyth-Zeebrugge	2008-2019	All	Sightings and effort records	• Routes and sightings overlap some DPO areas. • Data covering all months	• Data provided at (small) cost
Marine Protected Area Management and Monitoring (MarPAMM)	Acoustic	HP, dolphin species	Region: West DPO: W1	Hebrides	2019-present	May-Nov	Tables of detection-positive hours (DPH)	• Data provided free of charge • One PAM device within DPO area	• Only detects vocalising marine mammals
Marine Ecosystems Research Project (MERP) (Waggitt et al. 2020)	Collation of data sources, and analysis of collated data	AWSD, FW, BND, MW, HP, KW, LFPW, RD, SBCD, SW, SD, WBD.	All	Whole UK	1980-2018	All	Species distribution maps available at monthly and 10km^2 density (animals/km^2) scale	• Data available online • Density maps can be generated at a monthly time scale	• Unclear whether predictions are weighted to more recent data, or if all data regardless of age treated the same • Does not reflect shifts in species distribution • The collated data is not available for commercial projects, and so cannot be used to inform commercial scale renewables planning • Not a good reflection of small or sub-populations • Outputs represent data gathered over long time period, so uncertain how much these surfaces can be used to indicate contemporary relative abundance.

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
North Atlantic Sightings Surveys (NASS)	Ship and aerial surveys	Focus on FW, MW, SeW and LFPW, but sightings of all cetacean species recorded.	Region: North and North East DPO: N1, NE1, NE2, NE3, NE4, NE5, NE6, NE7. NE8, E1, E2 and E3.	North Atlantic and northern North Sea	1987, 1989, 1995, 2001, 2007 and 2015.	All late June to first week of Aug, except 1989 July-Aug	Sightings data used to assess abundance and distribution over a large area.	• Data provided free of charge • Large spatial coverage	• Survey methodology and spatial and temporal extent of surveys optimised to suit target species. • Variation in methodology • Only summer
Northern North Sea Cetacean Ferry Surveys (NORCET) 2004-2009†, 2004-2015‡	Visual surveys from ferry platforms	HP, BND, WBD, MW, AWSD, RD, SBCD, HW, LFPW, KW	Region: North East and East. DPO: close to NE1 NE2 NE3, NE4, NE6, NE8, E3.	Ferry route between Aberdeen-Orkney-Shetland	2002-2007, unable to confirm	May-Sep	Effort and sightings data	Unknown	
Offshore Renewable Energy developments†	Ship and aerial surveys Passive Acoustic Monitoring (PAM)	HP, BND, WBD, MW, KW, SBCD, AWSD, LFPW, RD, HW, grey seal, harbour seal	Region: North East (Moray Firth developments), North (EMEC) and East (Forth and Tay developments) DPO: NE3, NE4, NE5, NE6, N1.	Forth and Tay region, Moray Firth, Orkney	Varied by project	Varied by project but mostly year-round	Various e.g. sightings maps, density surfaces	• Good fine scale and year-round sightings data for most sites	• Can be very specific to project, so unlikely to cover DPOs • Usually relatively short term data collection
ORCA 2009-2010†, 2006-2015‡	Visual surveys from ferry platforms	HP, BND, SBCD, RD, WBD, KW, MW, FW, SeW,, harbour and grey seal	Region: West, North, North East and East. DPO: close to NE1 NE2 NE3, NE4, NE6, NE8, E3.	Ferry routes between Aberdeen-Orkney-Shetland, and around the Hebrides and west Scotland.	2016-2019	Mar-Oct	Effort and sightings data	• Data provided free of charge	• Effort varies monthly and yearly and across ferry routes.
Paxton et al. (2014)	Analysis of a collation of data sources (JCP and Scottish Natural Heritage (SNH))	MW, RD and WBD	All Regions, DPO areas dependent on species	Scottish territorial waters	1994-2012	All	Estimate of relative density in Scottish waters to inform MPA designation	• Overlap with DPOs • Long time series of data	• Limited data in autumn and winter months • Uncertainty in models
Rogan et al. (2017)	Collation of data sources: Vessel surveys from SCANS II, Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) & Trans North	CBW, LFPW, NBNW, SBW, SW	None	Offshore off North-west Scotland	2005, 2007	July	Surface maps of smoothed predicted abundance	• Large spatial coverage	• Only data from July • Doesn't cover any DPO region or areas • Only one month of the year (July)

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
	Atlantic Sightings Survey (T-NASS)								
Russell et al. (2017)	Products of seal telemetry and haulout count data analysis	Harbour and grey seal	All	Whole UK	1991-2015	All	Average seal at-sea distribution estimates at a 5km grid resolution	• Data available online • Small resolution	• >5yrs old
Small Cetaceans in European Atlantic waters and the North Sea (SCANS) (Hammond et al. 2002, Hammond et al. 2006, Hammond et al. 2013, Hammond et al. 2017) [SCANS I & II † and ‡]	Ship and aerial surveys	Small cetaceans	All	Whole UK	1994, 2005 and 2016	July	Estimates of abundance for small cetacean population	• Data available online	• Infrequent • Only one month of the year • SCANS I and II data >15 yrs old
Scotland's Marine Atlas (Baxter et al. 2011)	Analysis of data	Harbour and grey seal, HP, BND, MW, WBD, FW, SBCD, AWSD, RD, KW, SW, LFPW, NBW, SBW	All	All Scottish waters	Not reported	Not reported	Encounter rate maps	• Updated version should be available in near future	• Source of cetacean data not stated • Seal count and density data from 2007-2009, so >11 yrs old.
Sea Watch Foundation [1994-2008†, 1978-2016‡]	Land and vessel-based sightings	All cetacean species	Unknown	Unknown	mid 1960s-present	All	Sightings data, with some effort data	• Some data shared or collated via biological centres e.g. for regional marine plans, which may also use data for commercial developments	• Effort data not consistent • Data not available to commercial companies, so cannot inform commercial renewables development projects
Sea Mammal Research Unit (SMRU) BND photo-ID surveys	Vessel based surveys	BND, but will also opportunistically record other cetacean species	Region: East. No overlap with DPO.	Tay and St Andrews Bay, some years include Firth of Forth	2009-present	May-Sept	Effort and sightings data, photo-ID data		• No overlap with DPO, but surveys allow estimation of BND movement between Moray Firth and St Andrews Bay, past DPO NE5, NE6 and E3.
SMRU seal telemetry data	Telemetry data	Harbour and grey seal	All	Whole UK	1988-2018	All	Information on GPS location, dive data and tracks, which is	• Extensive coverage of UK waters	• Limited coverage in some areas

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
							fed into at-sea usage maps		
SMRU seal haulout data	Mostly aerial survey data, some ground counts	Harbour and grey seal	All	Whole UK	August counts: 1996-current, Grey seal pup counts: 1989-current	August haulout count (harbour and grey seals), autumn pup count (grey seals)	Haulout count data for population estimates	• Regularly collected data source	• Land based surveys – no information on at-sea densities • Only provides snapshot of certain times of year
Social Media	Sightings information	All species	Varies	Varies	Around 2015-present	All	Presence only sightings data	• Useful source of sightings information where no dedicated surveys occur • Can provide information on population from photo ID and observed behaviour • Some information collated and submitted to other datasets (e.g. to Sea Watch Foundation)	• Species identification not always by trained observers • Usually coastal sightings so unlikely to overlap with DPOs
Stone (2015)	Visual observations and PAM recorded during seismic surveys	All cetacean species	All	Whole UK	1994-2010	All	Species distribution plots	• Sightings data covering areas that have not otherwise been covered by vessel-based surveys • Long time series of data	• Effort varies monthly and yearly
Whale and Dolphin Conservation (WDC): Shorewatch 1999-2009‡	Land based sightings data	All marine mammals	All	Coastal mainland Scotland and Hebrides	2005-2019	All	Effort and sightings	• Data provided free of charge	• Coastal land-based watches, no coverage of DPO areas
Webb et al. (2018)	Aerial	MW (also harbour and grey seal, HP, WBD, RD)	Region: West DPO: W1	Hebrides	2016	Aug-Sep	Relative density and relative abundance estimates, sightings		• Method may be unsuitable for MW • Low sightings rates

Data Source	Data Type (e.g. survey, products of data analysis, database)	Species	Relevant DPO: Region and Area	Area	Year (s)	Month (s)	Outputs	Pros	Cons
							and spatial distribution maps		

3. Scottish marine mammal abundance and distribution

3.1. Management units

The Inter-Agency Marine Mammal Working Group (2013) drafted management units (MUs) for marine mammals in UK waters. The MUs for cetaceans were then confirmed in IAMMWG (2015a), however, defined MUs for seals were not part of the final document.

There are Seal Management Units (SMUs) provided by SCOS, which are currently used as the relevant MUs in the absence of defined seal MUs from the IAMMWG. There are seven SMUs in Scottish waters. For harbour seals, the abundance estimate for each SMU can be estimated by scaling the August haulout count data with data from tagged seals to correct for the proportion of seals hauled-out at the time of the count (0.34; 95% CI: 0.30-0.37) (Lonergan et al. 2013). Grey seal abundance can be estimated in one of two ways: modelling pup production estimates or scaling August haulout counts. SCOS (2019) uses the pup production estimates obtained during the autumn breeding season, which are converted to estimate of total population size (aged 1+ population) using a mathematical model and projected forward (see detail in Russell et al. 2019, Thomas et al. 2019). It is important to note (and is highlighted in the SCOS reports) that this is representative of grey seal abundance during the breeding season only, and since grey seals re-distribute outside of the breeding season, the breeding season abundance estimates for each area may not be representative of abundance estimates at other time of the year. Therefore, an alternative approach to estimating grey seal abundance is to use the August haulout counts of grey seals and scale to account for the proportion of seals hauled-out at the time of the count (0.34; 95% CI: 0.30-0.37) (Lonergan et al. 2011). Harbour and grey seal SMU abundance estimates are provided in Table 2.

The most up-to-date abundance estimates with associated MUs for cetaceans present in Scottish waters are presented in Table 3. While there are MUs identified and abundance estimates available for the more common species in Scottish waters, for many cetacean species these estimates are based on old data and may not be reflective of current abundance levels. The abundance estimates for cetaceans, outlined in IAMMWG (2015b) are largely based on the results of the SCANS II and CODA surveys. Distribution modelling of the combined SCANS-III and ObSERVE datasets is ongoing and results will be compared with those from modelling the combined data from

SCANS-II and CODA in 2005/07. Results of this work should be available later in 2020 when the SCANS-III project is completed (P. Hammond, personal communications).

There is therefore a gap in our understanding of appropriate population MUs for many species which will potentially limit the ability of quantitative impact assessments to assess population levels effects of future developments within DPOs sites.

The MU abundance estimates are currently being updated by JNCC (J. Sutherland, personal communications), however the MU boundaries are not currently being revised. There are currently MU boundaries provided by the IAMMWG (2015a) for harbour porpoise, bottlenose dolphin, Risso's dolphin, minke whale, white-beaked dolphin, short-beaked common dolphin and Atlantic white-sided dolphin. However, there is currently no guidance on recommended MUs boundaries for other species, including harbour and grey seals, and other cetacean species such as pilot whales and killer whales. Additionally, some of the MU boundaries are too large to effectively manage and predict potential impacts on populations and are not reflective of sub-populations within MU boundaries. For example, the MU for white-beaked dolphins is the entire Celtic and Greater North Sea, with this area very large when assessing development specific impacts against the whole MU population. At the time of writing, MU boundaries are still in discussion and any revision of species MU boundaries are unlikely to be available until later this year (J. Sutherland, personal communications).

Table 2

Harbour and grey seal abundance estimates for SMUs of relevance in Scottish waters.

	Harbour Seal – Aug Count		
SMU	**Aug Count (2015-17)**	**Abundance Est (95% CI)**	**Reference**
SW Scotland	1,200	1667 (1364 – 2222)	SCOS (2019)
West Scotland	15,889	22068 (18056 – 29424)	SCOS (2019)
Western Isles	3,533	4907 (1015 – 6543)	SCOS (2019)
N Coast & Orkney	1,349	1874 (1533 – 2498)	SCOS (2019)
Shetland	3,369	4679 (3828 – 6239)	SCOS (2019)
Moray Firth	879	1221 (999 – 1628)	SCOS (2019)
E Scotland	346	481 (393 – 641)	SCOS (2019)
		Grey Seal – Aug Count	
SMU	**Aug Count (2008-17)**	**Abundance Est (95% CI)**	**Reference**

SW Scotland	374	1100 (1011 – 1247)	SCOS (2019)
West Scotland	5,267	15491 (14235 – 17557)	SCOS (2019)
Western Isles	5,772	16976 (15600 – 19240)	SCOS (2019)
N Coast & Orkney	9,714	28571 (26254 – 32380)	SCOS (2019)
Shetland	1,558	4582 (4211 – 5193)	SCOS (2019)
Moray Firth	1,189	3497 (3214 – 3963)	SCOS (2019)
E Scotland	3,652	10741 (9870 – 12173)	SCOS (2019)
Grey Seal – Pup Production			
Breeding Region	**Pup Production Est (2016)**	**Abundance Est at the start of 2017 breeding season in (95% CI)**	**Reference**
North Sea (includes Firth of Forth)	14,583	41,800 (32,100 – 51,400)	SCOS (2019)
Inner Hebrides	4,541	8,900 (7,400 – 10,900)	SCOS (2019)
Outer Hebrides	15,732	30,500 (26,400 – 36,500)	SCOS (2019)
Orkney	23,849	54,500 (45,100 – 67,400)	SCOS (2019)

Table 3

Cetacean abundance estimates for MUs of relevance in Scottish waters.

Species	MUs	Abundance	Reference
Harbour porpoise	North Sea	345,373 CV=0.18 CI=246,526-495,752	SCANS III (Hammond et al. 2017)
	West Scotland	24,370 CV=0.23 CI=15,074-37,858	SCANS III (Hammond et al. 2017)
	Celtic and Irish Seas	104,695 CV=0.32 CI=2,5611-8,7094	IAMMWG (2015b) sourced from SCANS II (Hammond et al. 2013) and CODA (Macleod et al. 2009)
Bottlenose dolphin	Coastal West Scotland and the Hebrides	45 CI=33-66	IAMMWG (2015b) sourced from Cheney et al. (2013)
	Coastal East Scotland	195 CI=162-253	IAMMWG (2015b) sourced from Cheney et al. (2013)
	Irish Sea	397 CV=0.23 CI=362-414	IAMMWG (2015b) sourced from Evans (2012)
	Greater North Sea	0	IAMMWG (2015b)
Risso's dolphin	Marine Atlantic	None available	IAMMWG (2015b)
White-beaked dolphin	Celtic and Greater North Seas	15,895 CV=0.29 CI=9,107-27,743	IAMMWG (2015b) sourced from SCANS II (Hammond et al. 2013)
	North Sea	20,453 CV=0.36	SCANS III as reported in NAMMCO (2019)
Minke whale	Celtic and Greater North Seas	23,528 CV=0.27 CI=13,989-39,572	IAMMWG (2015b) sourced from SCANS II (Hammond et al. 2013) and CODA (Macleod et al. 2009)
Common dolphin	Celtic and Greater North Seas	56,556 CV=0.28 CI=33,014-96,920	IAMMWG (2015b) sourced from SCANS II (Hammond et al. 2013) and CODA (Macleod et al. 2009)
White-sided dolphin	Celtic and Greater North Seas	69,293 CV=0.37 CI=34,339-139,828	IAMMWG (2015b) sourced from SCANS II (Hammond et al. 2013), CODA (Macleod et al. 2009) and T-NASS data
Long-finned Pilot whale	Northeast and Central Atlantic	up to 560,000	NAMMCO[1]
	North-eastern Atlantic	778,000	Buckland et al. (1991)
Killer whale	North Atlantic	15,000	NAMMCO[2]
Humpback whale	North Atlantic	at least 35,000	NAMMCO[3]
Sperm whale	Northeast Atlantic	30,000	NAMMCO[4]
Fin whale	North Atlantic	Over 50,000	NAMMCO[5]

1 https://nammco.no/topics/long-finned-pilot-whale/
2 https://nammco.no/topics/killer-whale/
3 https://nammco.no/topics/humpback-whale/
4 https://nammco.no/topics/sperm-whale/
5 https://nammco.no/topics/fin-whale/

3.2. SACs, MPAs and designated haulout sites

All cetaceans in Northern European waters are listed under Annex IV of the EU Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive) as European Protected Species (EPS) of Community Interest and in need of strict protection. The harbour porpoise, bottlenose dolphin, harbour seal and grey seal have protection under Annex II as species of Community Interest whose conservation requires the designation of Special Areas of Conservation (SACs). There are several SACs for marine mammals in Scottish waters; these include one SAC of harbour porpoise, one for bottlenose dolphins, eight harbour seal SACs and six grey seal SACs. In addition, there are now three possible Marine Protected Areas (pMPAs)[6] [7] in Scottish waters for cetacean species: one for Risso's dolphins, and two for minke whales, which are legislated under the Marine (Scotland) Act 2010. All SACs and pMPAs for marine mammals in Scottish waters are listed in Table 4 and shown in Figure 2.

In addition to these, under Section 117 of the Marine (Scotland) Act 2010, the Scottish Government identified and designated 194 haulout sites for harbour and grey seals, where seals come ashore to rest, moult or breed. The designated haulout sites were chosen with a focus on implementing legislation to protect seals from harassment at those sites, rather than direct use for marine spatial planning. It is an offence to intentionally or recklessly harass a seal at a haulout site. The locations of the designated haulout sites are presented in Figure 3; full details and shapefiles can be obtained from the Marine Scotland website[8]. While these sites are all land-based haulouts, and therefore do not overlap DPO areas, their location should be considered when choosing export cable landfall locations and any associated onshore works.

[6] Information on the pMPAs can be found here: Scottish Government (2019a)
[7] https://www2.gov.scot/Topics/marine/marine-environment/mpanetwork/developing/consultation
[8] http://marine.gov.scot/information/seal-haulout-sites

Table 4

Marine mammal SACs and pMPAs in Scottish waters.

Species	Protected Area	Region
Harbour porpoise	Inner Hebrides and the Minches SAC	North, West
	North Channel SAC (Northern Ireland)*	Relevant to South West
Bottlenose dolphin	Moray Firth SAC	North East
Minke whale	Southern Trench pMPA	North East
	Sea of Hebrides pMPA	North, West
Risso's dolphin	North-east Lewis pMPA	North
Harbour seal	Ascrib, Isay and Dunvegan SAC	North
	Dornoch Firth and Morrich More SAC	North East
	Eileanan agus Sgeiran Lios mor SAC	West
	Firth of Tay and Eden Estuary SAC	East
	Mousa SAC	North East
	Sanday SAC	North East
	South-East Islay Skerries SAC	West
	Yell Sound Coast SAC	North East
Grey seal	Berwickshire and North Northumberland Coast SAC	East
	Faray and Holm of Faray SAC	North East
	Isle of May SAC	East
	Monach Islands SAC	North East
	North Rona SAC	North
	Treshnish Isles SAC	West

* The North Channel SAC is a designated SAC within Northern Irish waters, however, the eastern SAC boundary is within 2 km of the SW1 DPO area boundary and is therefore important to include.

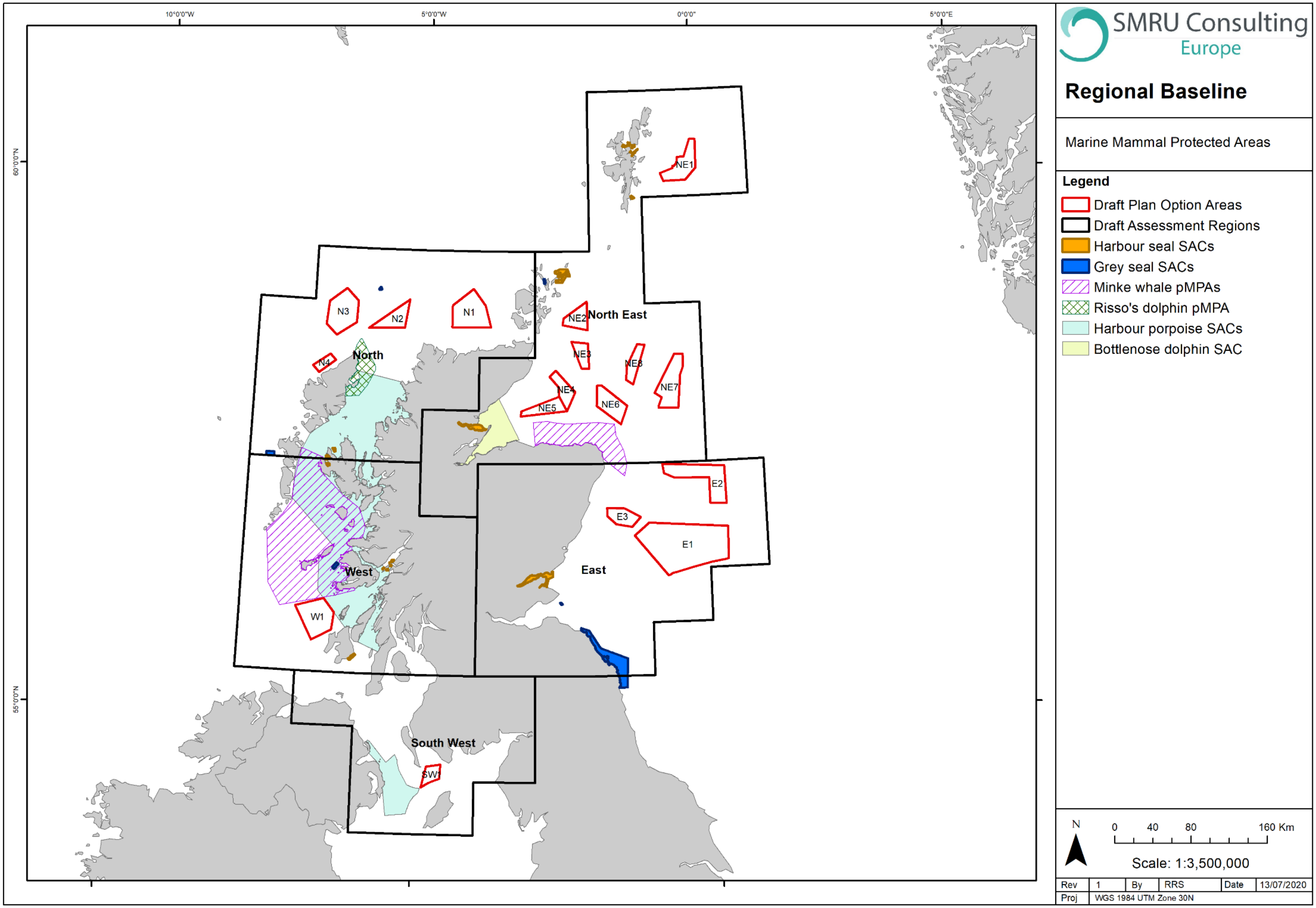

Figure 2: Marine mammal SACs and MPAs in Scottish waters. The DPO regions and sites are overlaid for reference.

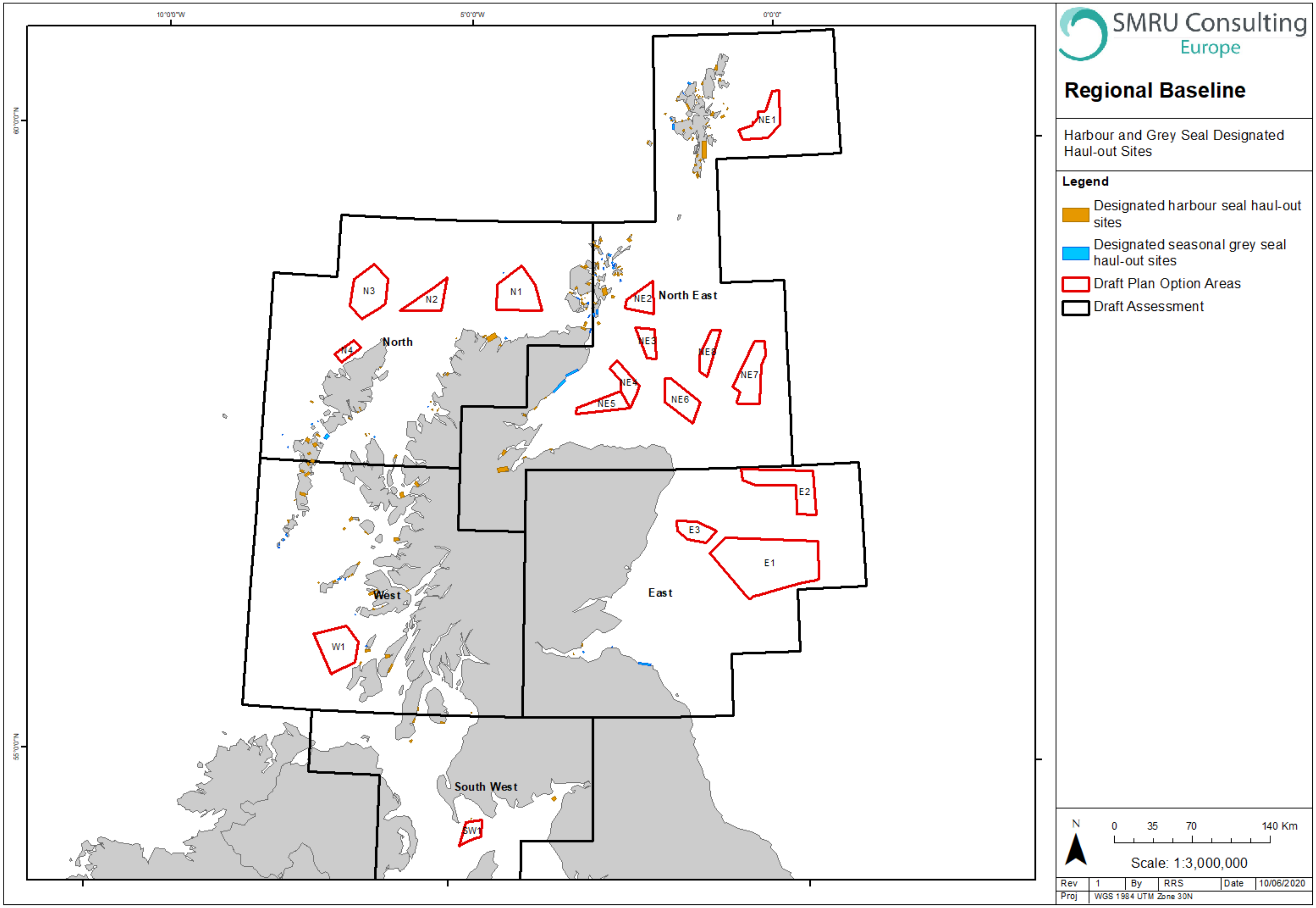

Figure 3: Designated grey and harbour seal haulout sites (orange) and seal breeding colonies and haulouts (blue). The DPO regions and sites are overlaid for reference.

3.3. Species accounts

The following section includes specific discussion of the abundance and distribution data available for each marine mammal species within Scottish waters, with special reference to the DPOs sites. A summary table of this evidence, including frequency of species presence within DPO sites is presented in Section 3.4 DPO Species Summary (Table 9).

3.3.1. Harbour seal

Based on the information presented below, harbour seals are resident year-round in Scottish waters, but their distribution is primarily limited to coastal waters with little expected overlap with DPO areas. This species is more likely to be important when considering coastal activities related to development, such as cable landfall location or vessel activity, given their coastal distribution and haulout locations.

Harbour seals haulout on land to rest, moult and breed (Thompson et al. 1997), and will disperse from these sites and forage at sea, where they will primarily stay within 30-50 km of the coastline, in waters <50 m deep (Thompson et al. 1994, Bailey et al. 2014, Jones et al. 2015). However, harbour seal movements are highly variable among individuals, with foraging strategy potentially specialised within particular regions, and so movements overall can show a high degree of inter-individual variation (Sharples et al. 2012). In June and July females will haulout to give birth (SCOS 2019), and will then lactate and care for the pup for approximately 21 days before weaning (Thompson and Wheeler 2008). During this time the female will continue to forage at sea, though the requirement to regularly return to their pup may limit the distance females travel to forage, and so at-sea distribution may vary during these months (Thompson et al. 1994, Bailey et al. 2014).

The majority of our current knowledge on overall harbour seal abundance in Scottish waters is derived from annual aerial surveys. Temporal shifts in haulout distribution have been detected in some areas of Scotland, likely due to localised variation (Cordes et al. 2011). Such shifts must be considered when interpreting haulout locations and site use over long time scales.

The most recent assessment of harbour seals in UK waters concluded that the overall trend in Conservation Status was Unfavourable – Inadequate due to the fact that declines are still observed in some areas, leading to the current population size being less than the favourable reference population, and the future prospects of the population being poor (JNCC 2019f). Detailed information on harbour seal counts and population trends are reported annually in the SCOS reports (Special Committee on Seals)[9]. The most recent UK wide count (2008-2017) gives a total of 32,600 harbour seals, which scales to a UK abundance estimate of 45,100 to account for seals at sea at the time of the count (SCOS 2019). A total of 81% of these seals were counted in Scotland. For some Scottish SMUs, the population is declining e.g. in the North Coast and Orkney unit (2006-2015 decline of 10.41% p.a), but is either stable or increasing in other areas (Figure 4). The main concentration of harbour seal haulouts are in West Scotland, including the Inner Hebrides, where 60% of all Scottish harbour seals were counted. While the most recent count data suggests that the east Scotland SMU is stabilising, there has been a drastic decline in the Firth of Tay and Eden Estuary SAC population size (1990-2002 count of 641, 2016 count of 51). Population modelling work conducted for the Firth of Tay and Eden Estuary population has concluded that if this declining trend continues, the population will effectively become extinct within the next 20 years (Hanson et al. 2015).

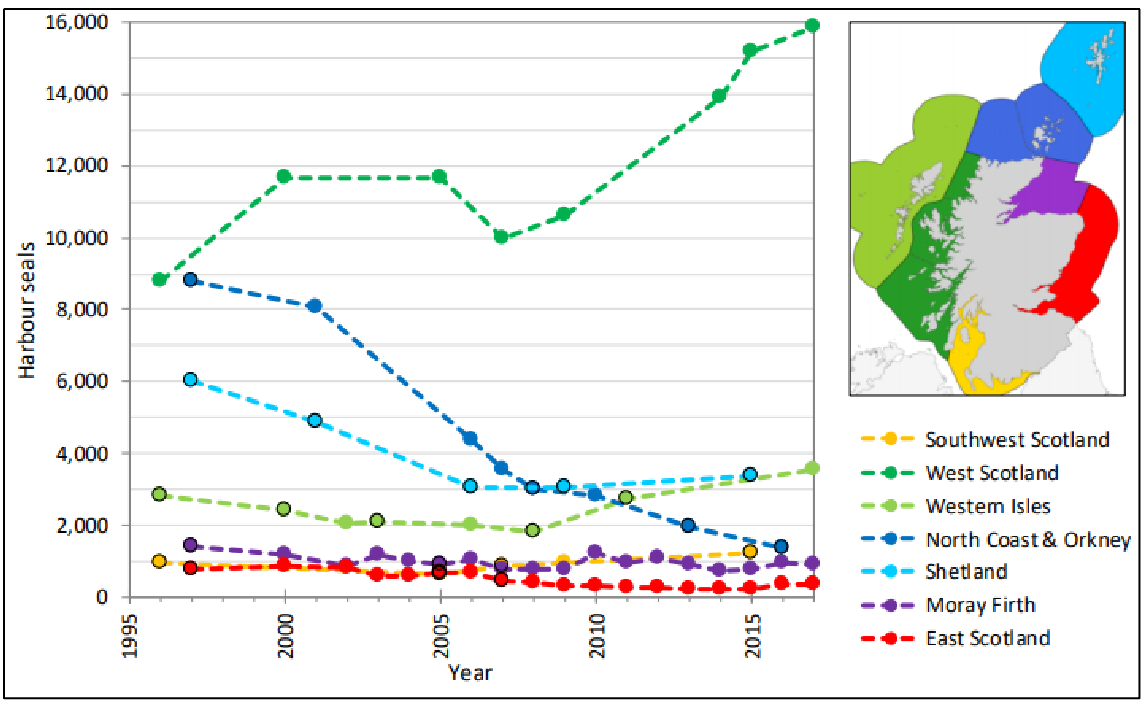

Figure 4: Harbour seal counts in Seal Management Units around Scotland, 1996-2017 (black circled points indicate a single count in that year, plain points represent means of multiple counts) (SCOS 2019).

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9 http://www.smru.st-andrews.ac.uk/research-policy/scos/

Of the 461 harbour seals tagged within UK waters since 2001, 420 of them recorded tracks within the DPO Regions in Scottish waters. These data show a primarily coastal distribution, with some overlap with the more coastal DPO areas, especially W1 and NE5 (Figure 5). Modelling of seal at-sea usage shows that usage is concentrated in the Hebrides, the Moray Firth, Orkney and Shetland (Figure 6) (Russell et al. 2017). Again, modeled at sea-usage shows that distribution is primarily coastal, with little utilisation of the DPO areas. Data from the Orkney Isles and the north coast of Scotland maps show relatively low predicted usage of DPO areas NE2 and NE3 (Figure 7).

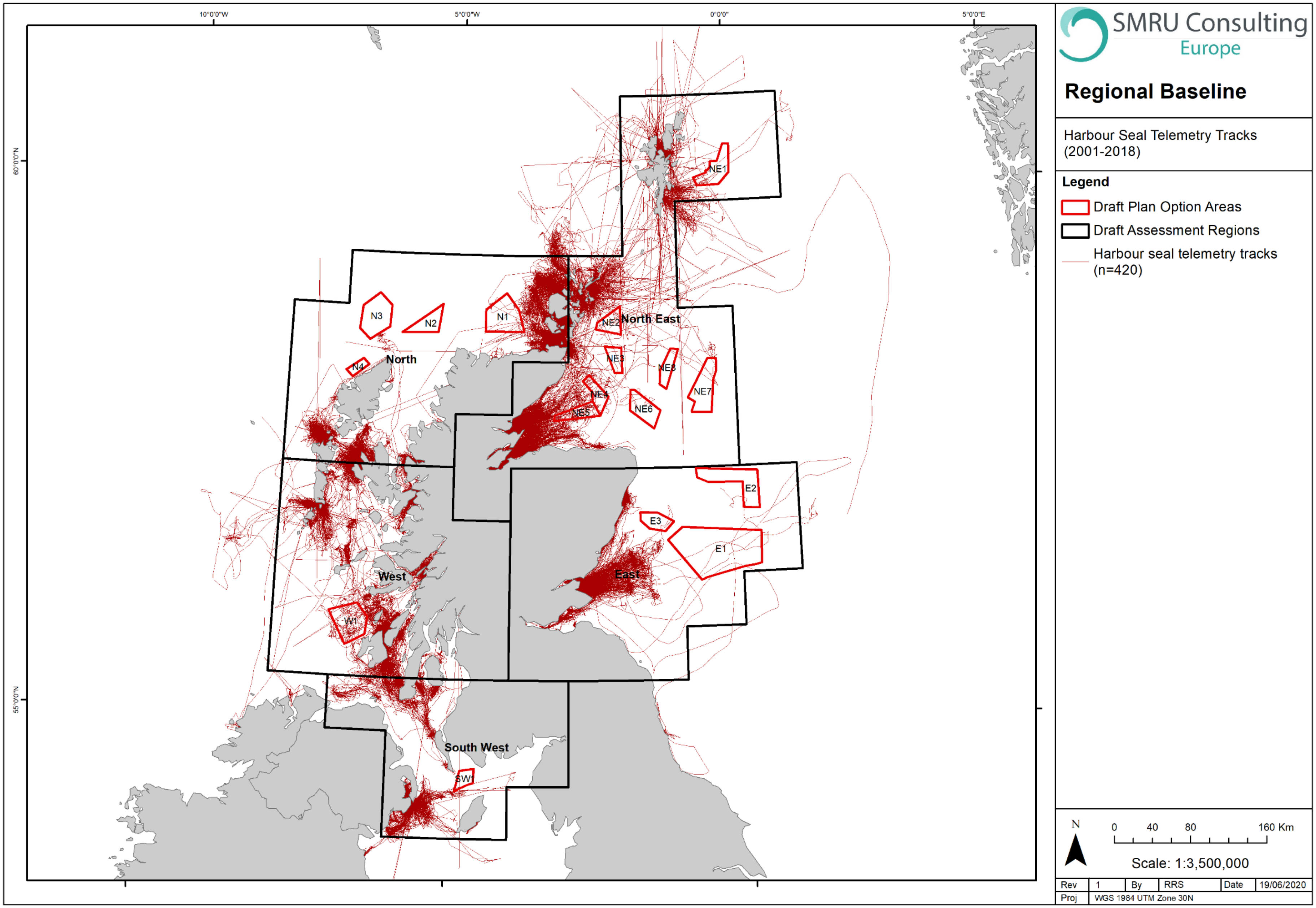


Figure 5: Telemetry tracks for harbour seals tagged between 2001 and 2018 (n=420) (data provided by SMRU). The DPO regions and sites are overlaid for reference.

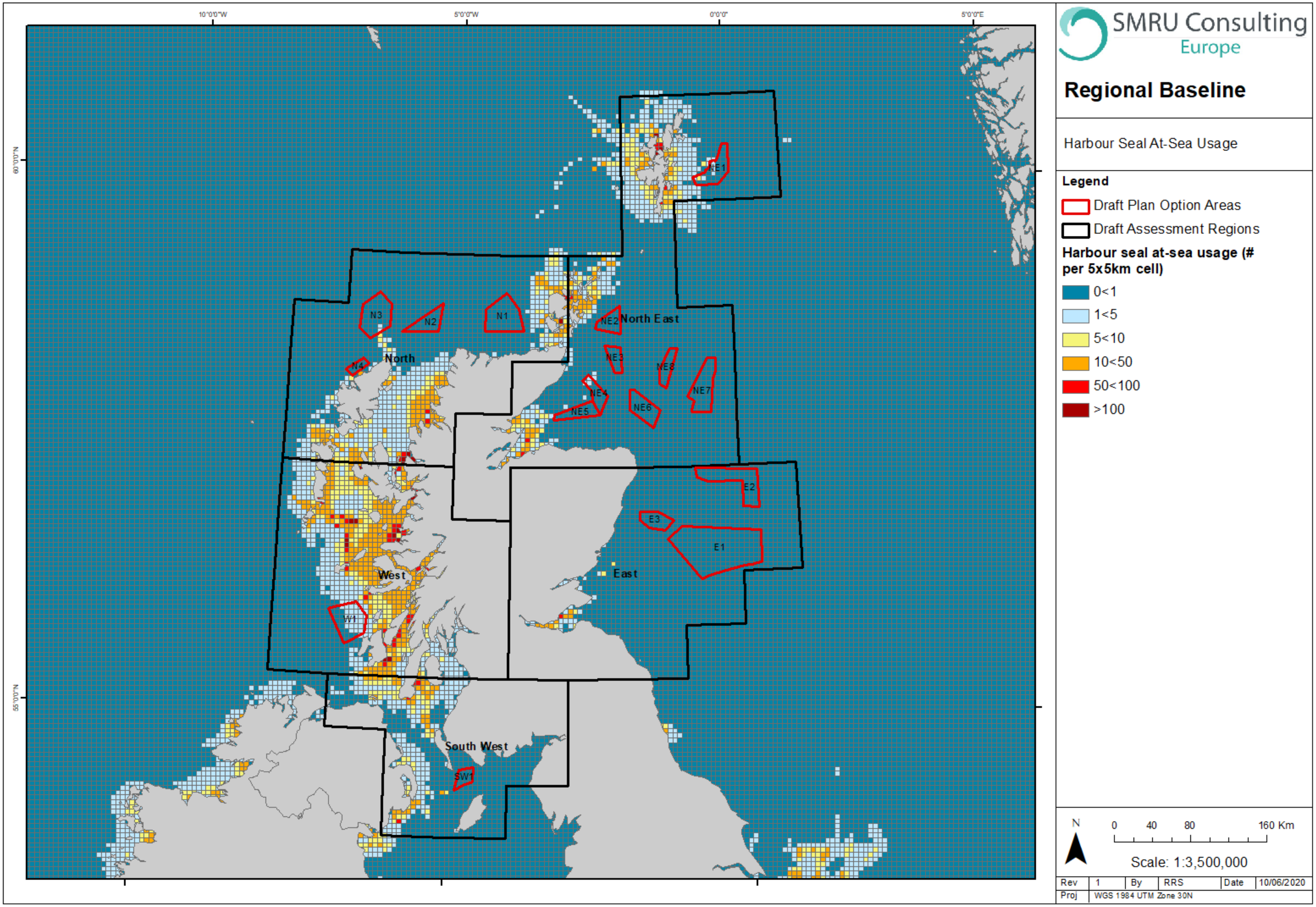


Figure 6: Harbour seal estimated at-sea usage (Russell et al. 2017).The DPO regions and sites are overlaid for reference.

In an on-going project based at SMRU, part funded by the Department for Business, Energy and Industrial Strategy (BEIS), the telemetry data that contributed to the maps presented in Figure 5 and Figure 6 are now being combined with more recent telemetry data and environmental data to produce models that describe the habitat preference of seals. These models are then used to predict how harbour seals use Scottish waters based on the availability of their preferred habitat. The final results of this report will be available in autumn 2020. For harbour seals, the outcomes of both the at-sea usage maps and the habitat preference model approach lead to largely similar predictions of at-sea distribution within the DPO sites (Table 5). Currently, the habitat preference modelling is the approach preferred by SMRU over the previous at-sea usage approach. A short note covering the utility of the seal usage and habitat preference maps was compiled for this report by Dr Debbie Russell and Dr Matt Carter (Appendix 4: Seal Abundance and Distribution).

Table 5

Predicted by-cell seal density rating (from habitat preference modelling; (Carter and al. In Prep), and from at-sea usage maps (Russell et al. 2017)) within DPO sites. For an idea of total abundance within DPO sites the size of area should also be considered; number of cells refers to the total number of complete and partial cells. Usage is presented as the number of harbour seals expected to be using a cell at any one time: very low: <2 low: <4 med: <20 high: <200 harbour seals. Bold indicates density ratings where the newer habitat preference model density ratings differ to previous density ratings available from the at-sea usage maps.

DPO	Number of cells (complete)	Harbour seals	
		Habitat Preference Model: by-cell density rating	At-sea usage: by-cell density rating
E1	187 (127)	Very low	Very low
E2	78 (34)	Very low	Very low
E3	30 (9)	Very low	Very low
N1	63 (31)	Very low	Very low
N2	35 (9)	Very low	Very low
N3	62 (30)	Very low-low	Very low - **med**
N4	17 (2)	Very low-med	Very low - med
NE1	46 (17)	Very low-med	Very low - med
NE2	31 (7)	Very low-**low**	Very low
NE3	27 (6)	Very low	Very low
NE4	32 (6)	Very low	Very low - **med**
NE5	34 (9)	Very low**-low**	Very low
NE6	45 (15)	Very low	Very low
NE7	61 (25)	Very low	Very low
NE8	27 (4)	Very low	Very low
SW1	23 (3)	Very low	Very low
W1	63 (29)	**Med**	**Low** - med

Jones et al. (2017) modelled harbour seal at-sea usage around the Pentland Firth and Orkney Isles, and found distribution to be very coastal in these areas. There was no overlap with the nearby DPOs sites (Figure 7).

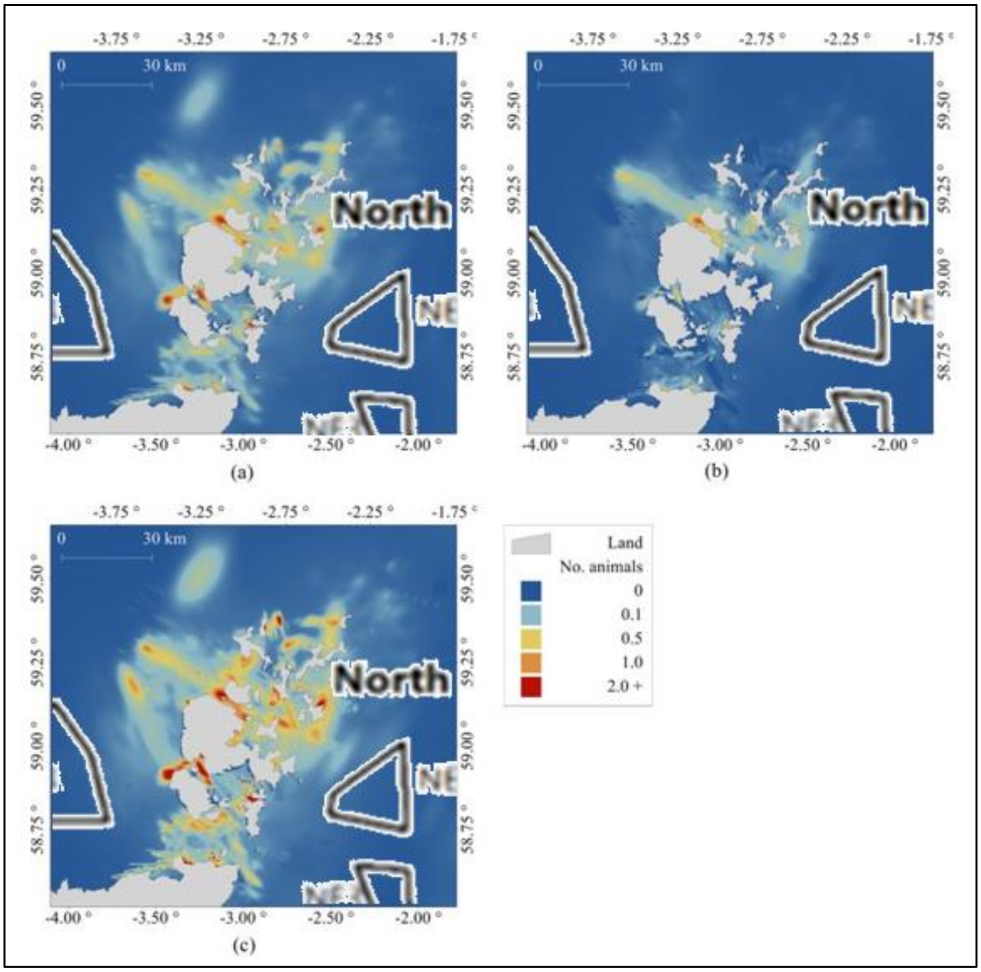


Figure 7: At-sea harbour seal usage in Orkney and the Pentland Firth (a) mean, (b) lower 95% confidence interval, (c) upper 95% confidence interval (Jones et al. 2017). Overlaid for reference are the approximate regional and DPO areas.

Tagging data makes up the bulk of our current knowledge on abundance and distribution of seals at sea, however there are also various vessel-based surveys that have recorded seal species. For example, Pollock et al. (2000) recorded harbour seals in inshore waters throughout their study area off the north-west of Scotland, with fewer records further offshore and only one record in water deeper than 200 m, and only one record that overlapped a DPO site (site W1) (Figure 8). Boat-based data has different limitations than tagging data, for example tagging data is very dependent on the behaviours of the individuals that are caught and tagged. Boat-based data is completely independent of tagging effort, however, there are other limitations associated with such data, for example it may be difficult to confidently identify seals at sea to species-level, and only seals that are at the surface are available to collect data on.

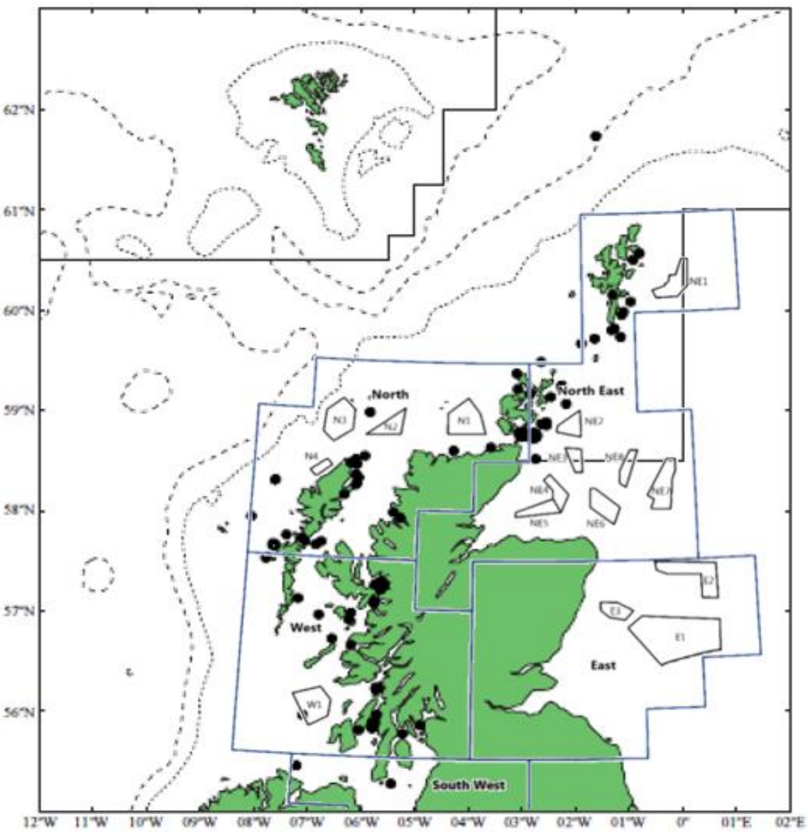


Figure 8: Harbour seal sightings (1979-1999) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

Stone (2015) collated sightings of marine mammals recorded by dedicated marine mammal observers working on seismic survey vessels between 1994-2010. Harbour seals were recorded in the Outer Moray Firth within the North East DPO region, specifically in sites NE4, NE6 and NE8 (Figure 9) (Stone 2015).

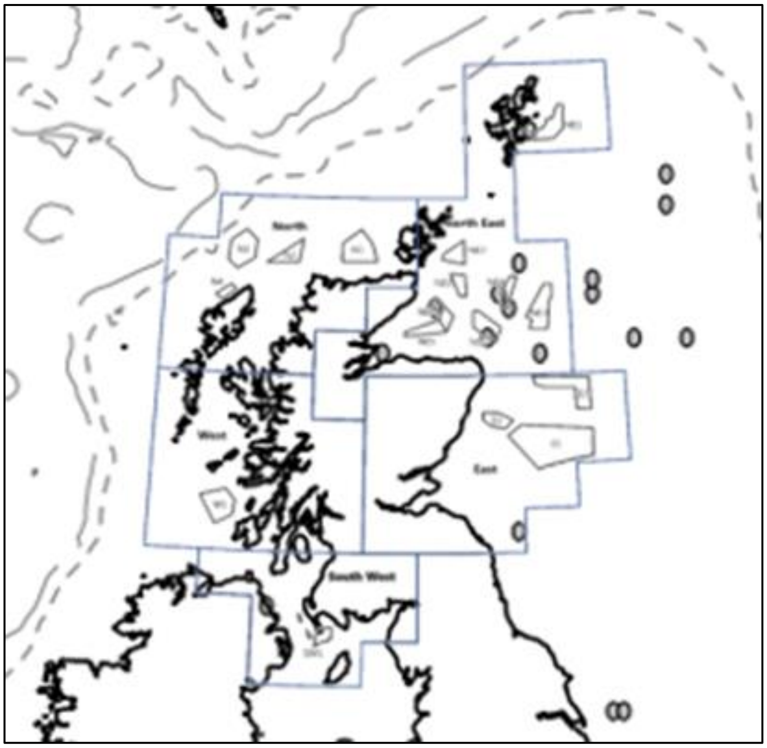


Figure 9: Harbour seals encountered during seismic surveys (grey ovals), 1994-2010. Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath (Stone 2015). Overlaid for reference are the approximate regional and DPO areas.

Marine mammal sightings recorded from ferries and other commercial shipping vessels are collected and held by organisations such as ORCA and MARINElife. ORCA did not record any harbour seal sightings within the DPOs areas between 2016 and 2019, with sightings most frequently remaining very close to the coastline (Figure 10). Between 2008 and 2019, MARINElife recorded sightings of harbour seals in the South West DPO region, including within the SW1 site boundary (Figure 11). Again, MARINElife harbour seal sightings records tended to be very coastal (Figure 11). The WDC sightings are again coastal, but harbour seals have been sighted at almost every WDC Shorewatch Site (Figure 12). The land-based or coastal nature of these surveys means that no sightings overlap the DPOs areas, however, these sightings combined with other haulout count data could be useful when determining cable landfall sites.

Harbour seals were recorded during the HiDef Ltd aerial surveys carried out in 2014, covering the east coast of Scotland and Orkney Isles. No sightings were recorded within the DPO sites (Figure 13).

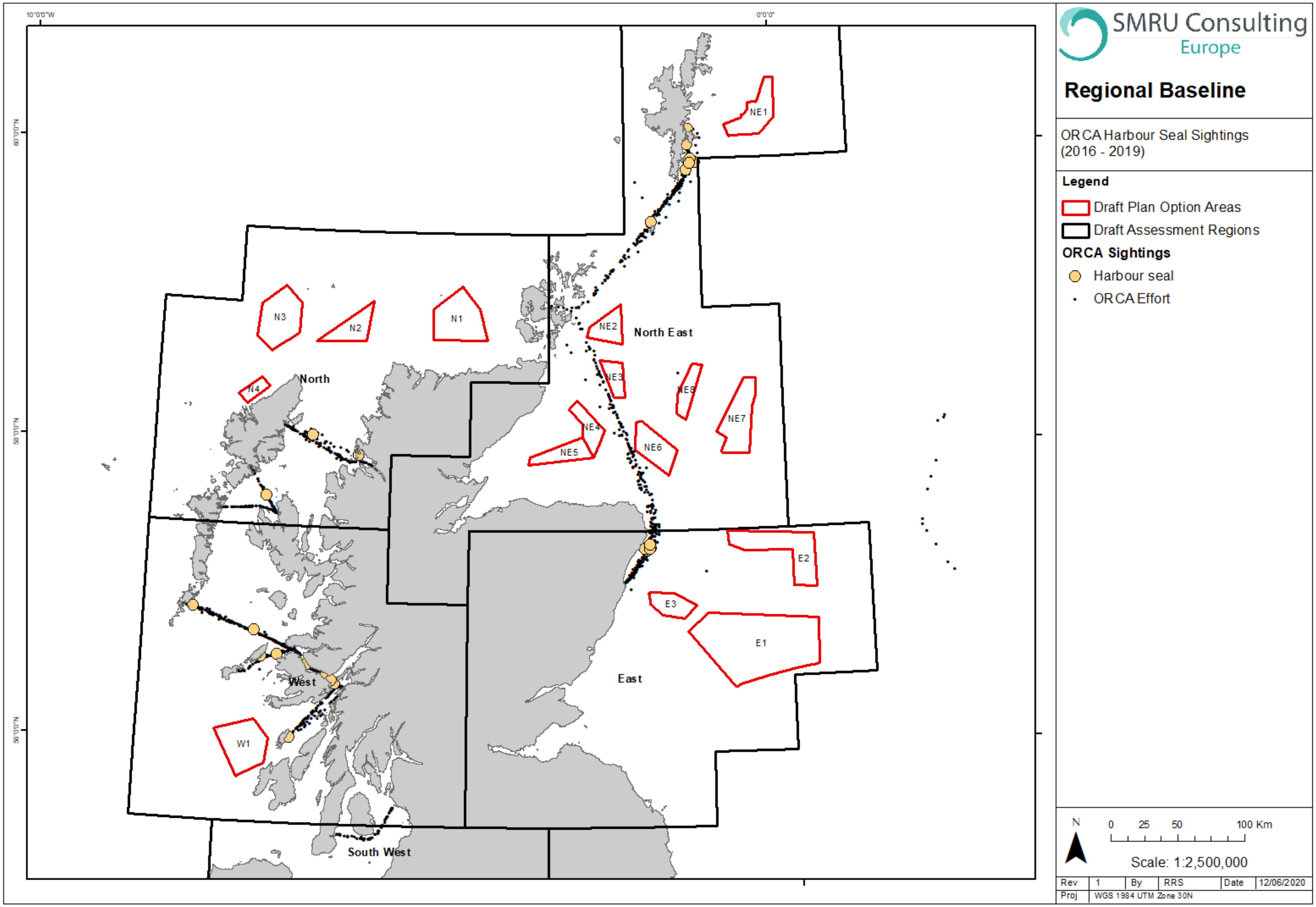


Figure 10: Harbour seal sightings (orange dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

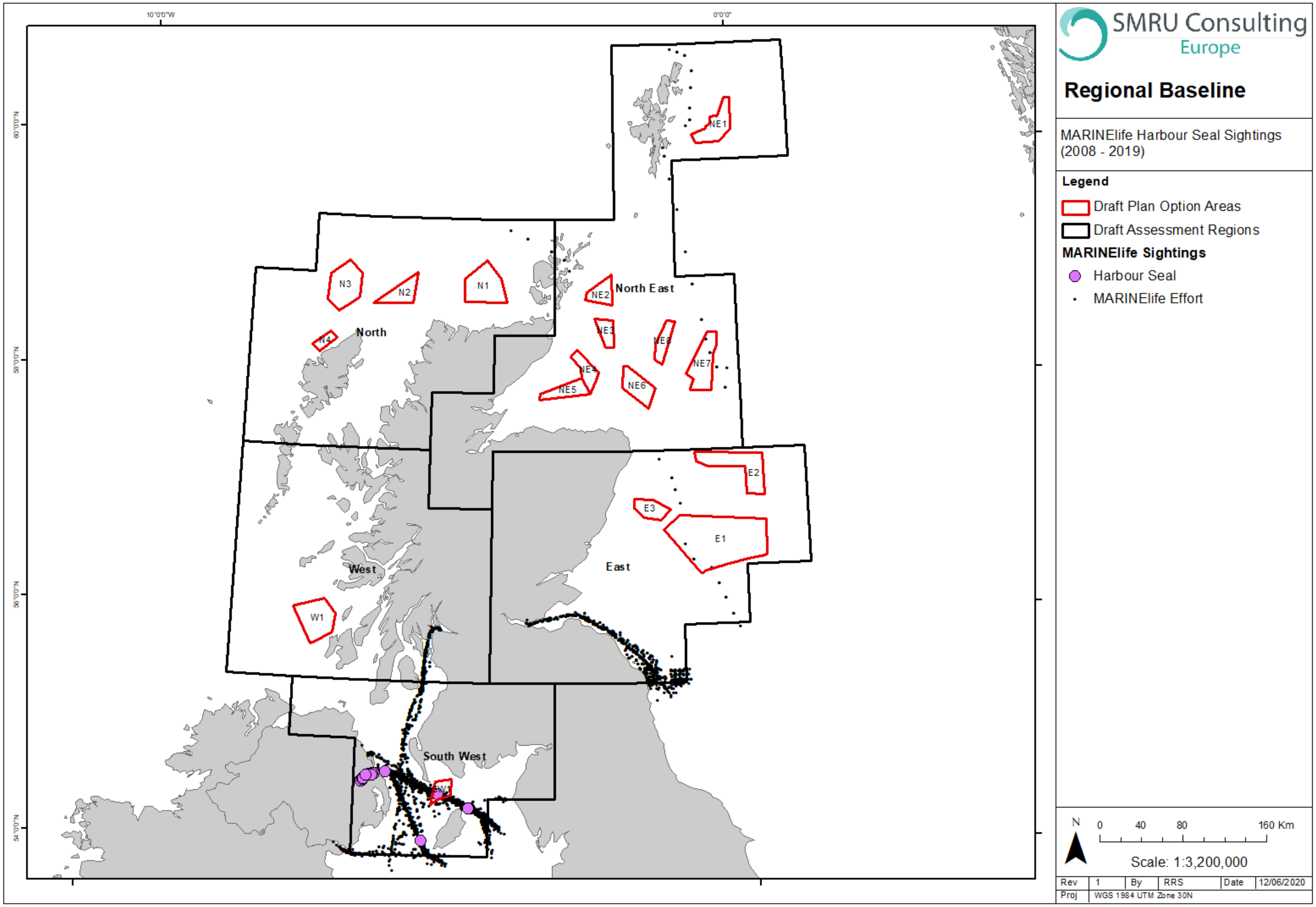


Figure 11: Harbour seal sightings (pink dots) recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

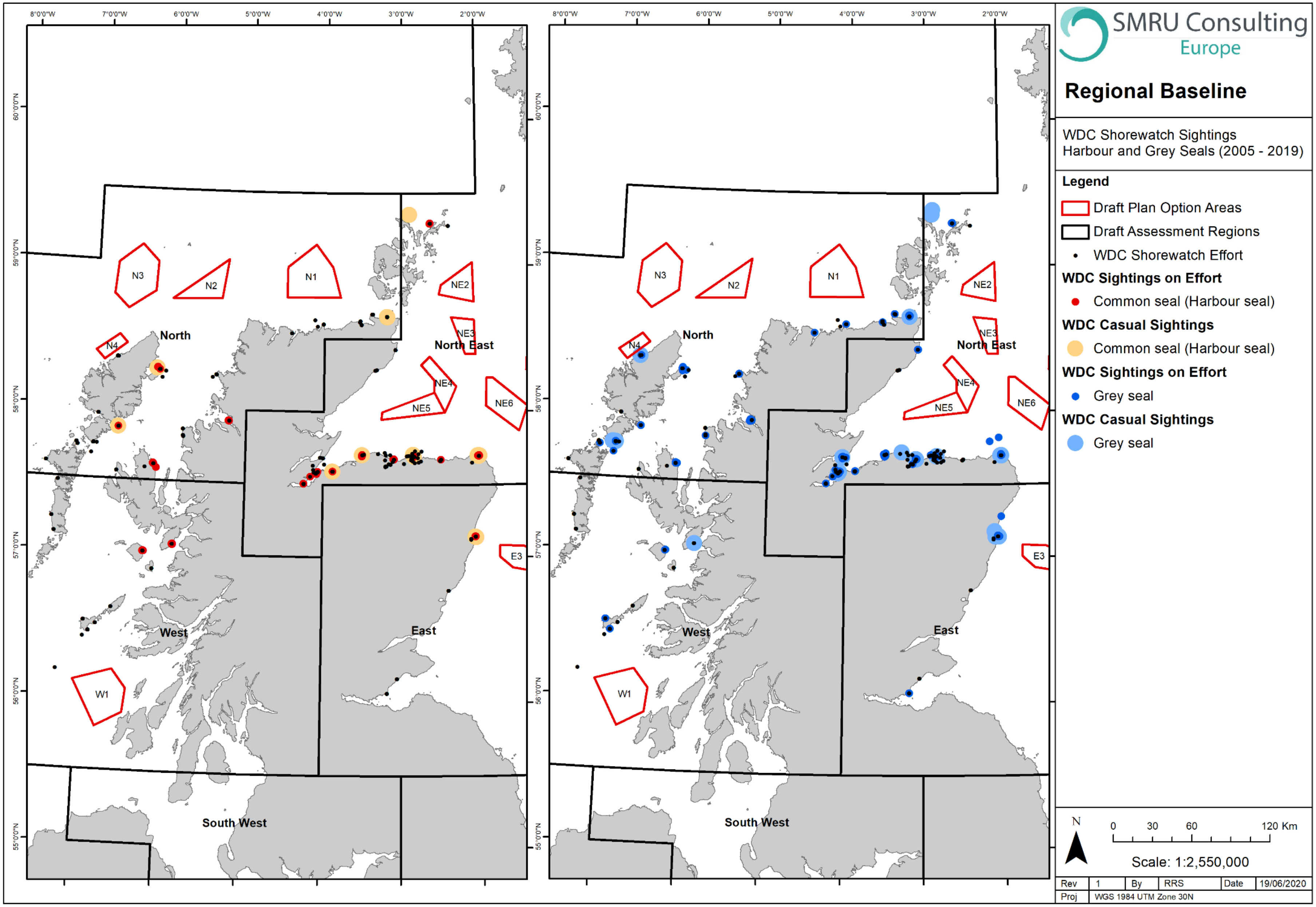


Figure 12: Sightings of harbour (left) and grey (right) seals recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

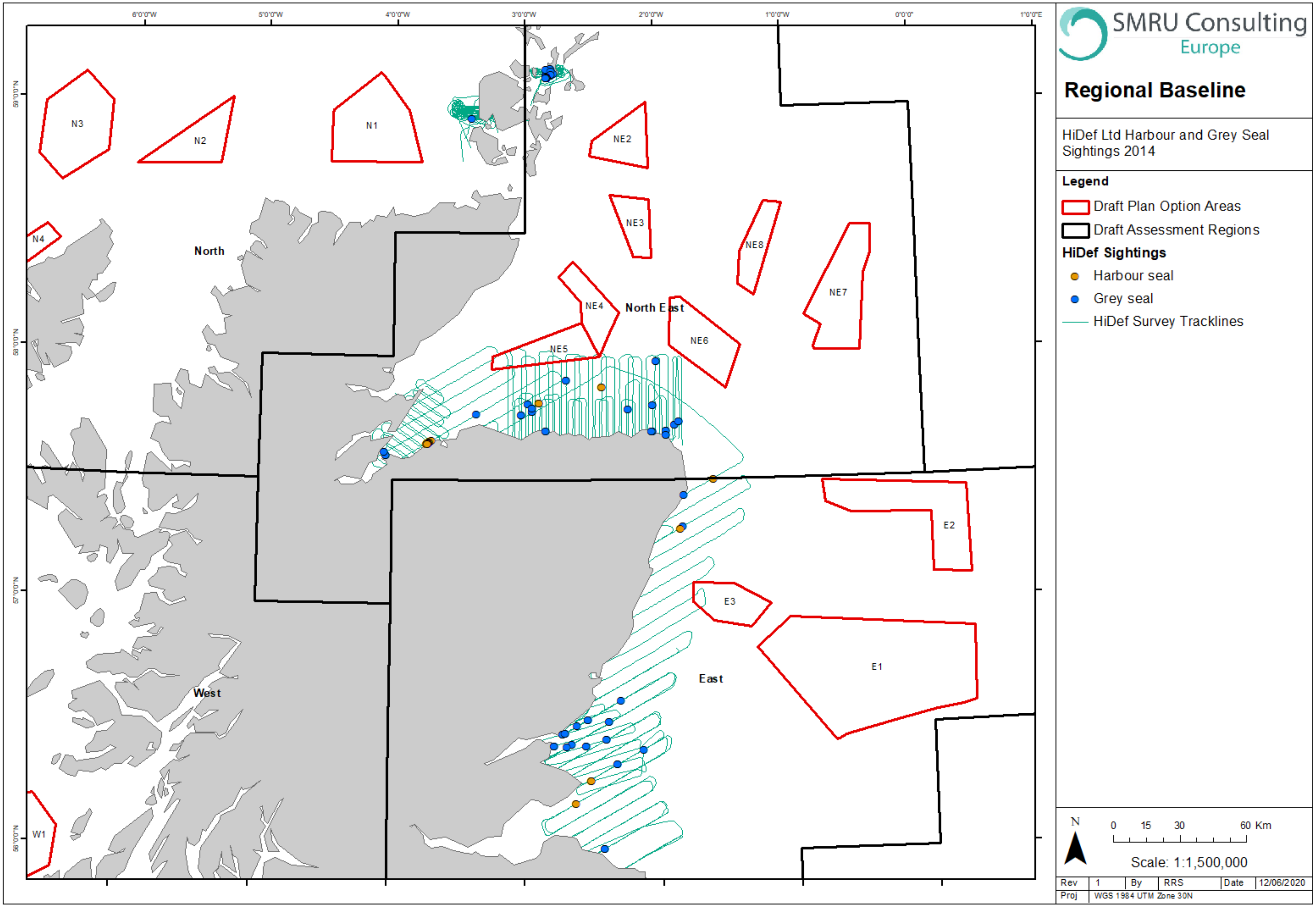


Figure 13: Harbour seal (orange dots) and grey seal (blue dots) sightings recorded during HiDef Ltd aerial surveys carried out in 2014.

In terms of more specific areas within Scottish waters, there is extensive data for harbour seals in the Moray Firth, and several iterations of density surfaces have been created in order to inform baseline characterisations for offshore developments in the Moray Firth (Moray East ES 2012, Bailey et al. 2014, Bailey 2017). The most recent iteration includes telemetry data collated up to 2017 (Figure 14), modelling habitat use using a case-control approach, where generated control points are combined with environmental data (Bailey 2017). This provides at-sea usage data for DPO areas NE4 and NE5, where harbour cell density per cell ranges from 0.0-4.0 (Figure 14).

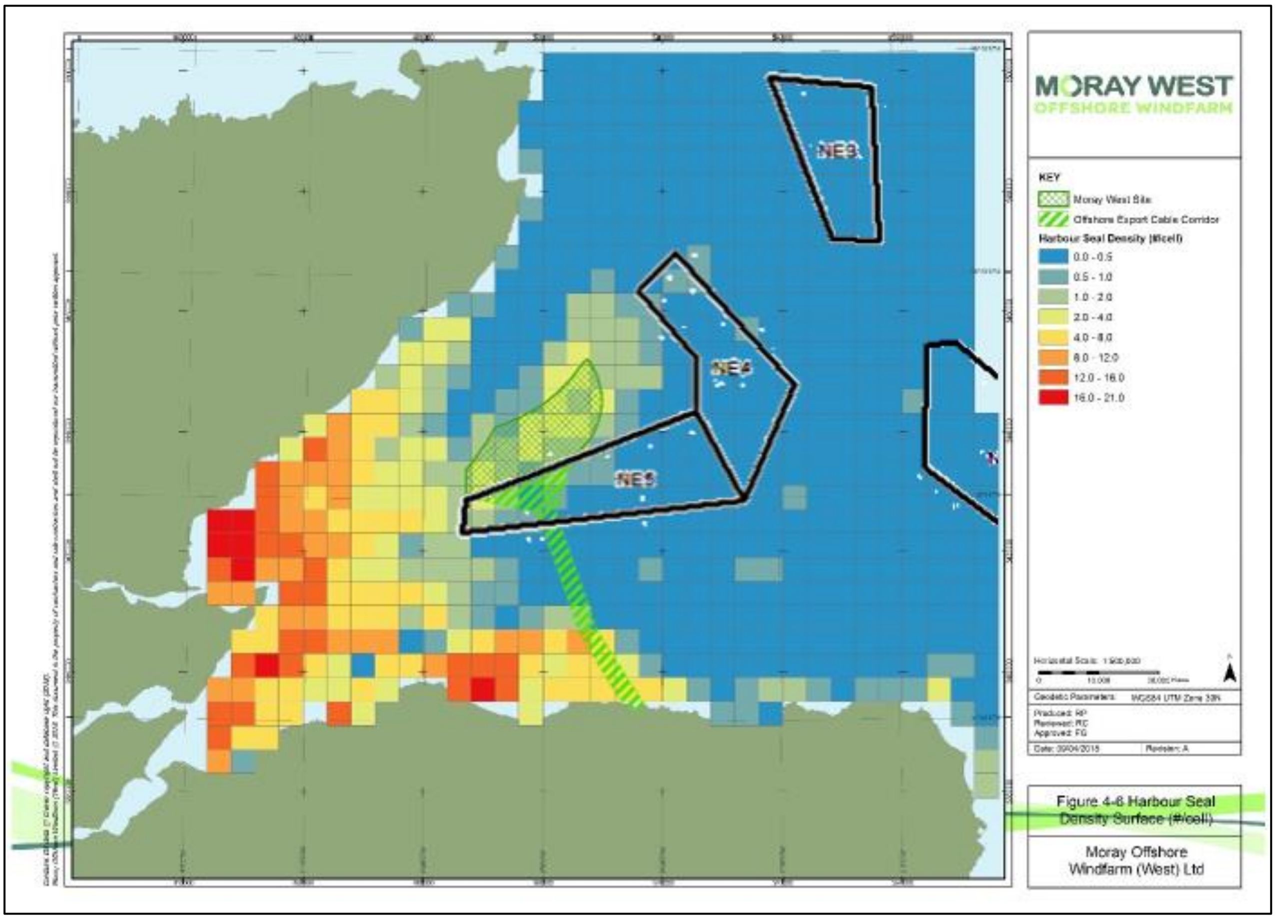


Figure 14: Harbour seal at sea usage estimates produced for the Moray West EIA (Bailey 2017).

Further aerial and vessel-based survey effort conducted in east Scotland for the Forth and Tay Offshore Wind Developers Group (FTOWDG) (Seagreen, Neart na Gaoithe and Inch Cape) have confirmed that harbour seals are present in the Forth and Tay area (Sparling et al. 2011, Grellier and Lacey 2012, Inch Cape 2012, Neart na Gaoithe 2012, Sparling 2012, Inch Cape Offshore Limited 2018, Neart na Gaoithe 2018). Species-level identifications have been much higher with vessel surveys (Figure 15) where there were only a few sightings of harbour seals; by contrast, species identification levels are much lower from the aerial surveys and as such most sightings are categorised as “unidentified” seal species (Figure 16). The closest DPO site to the Forth and Tay Offshore development region is site E1, which is ~15-20km to the north east.

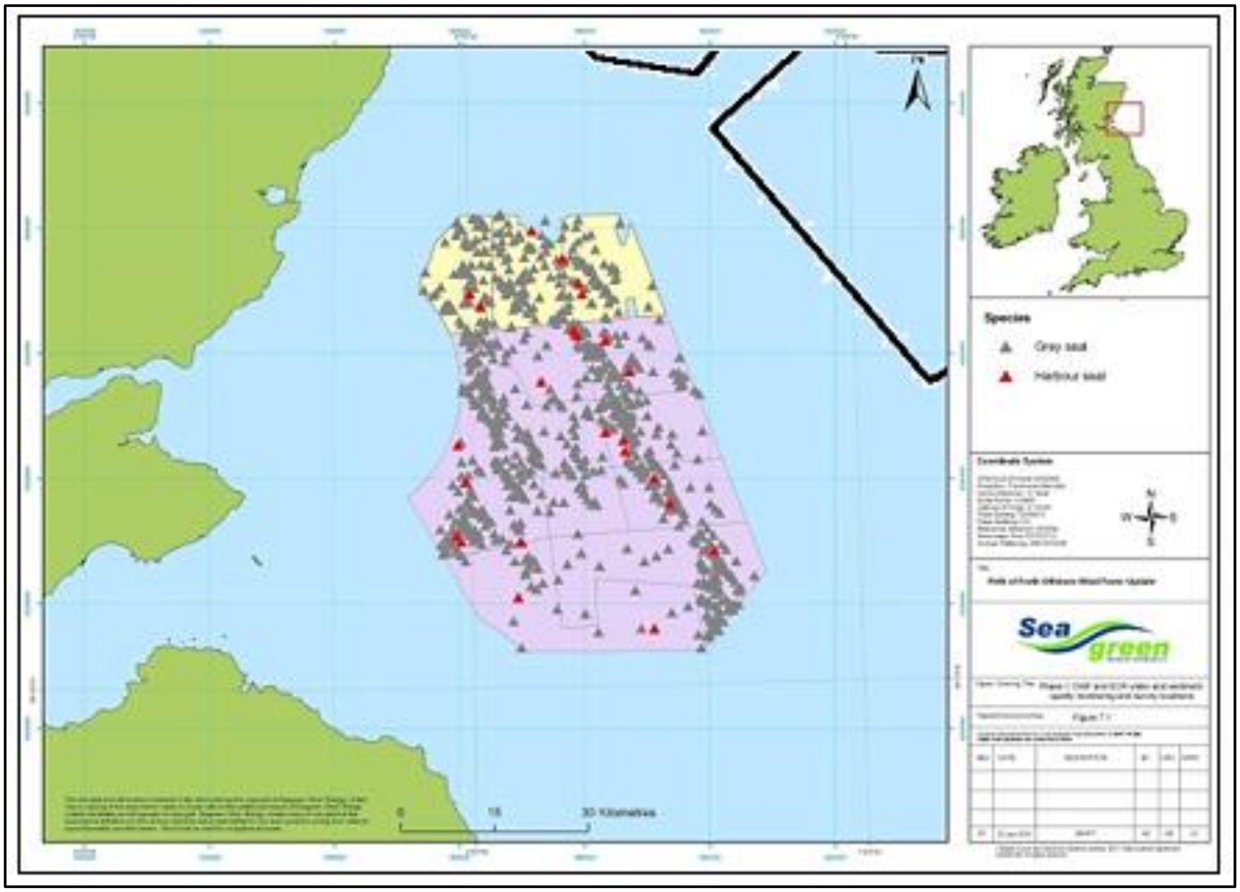


Figure 15: Harbour and grey seal sightings from the Firth of Forth Round 3 Zone vessel surveys May 2010 to November 2011 (Sparling 2012).

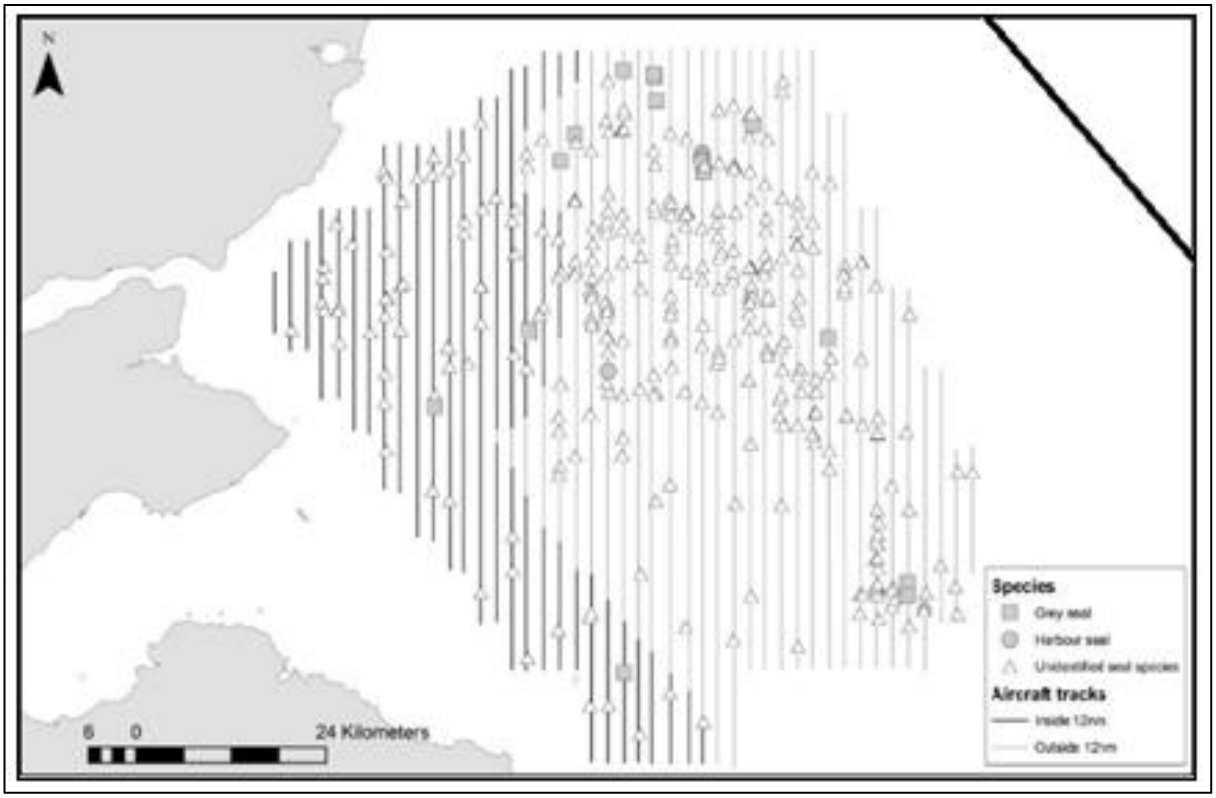


Figure 16: Harbour and grey seals sighted during The Crown Estate aerial surveys for the Forth and Tay Offshore Wind Developers Group (FTOWDG) region 2009-2010 (Grellier and Lacey 2012). The DPO site are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

Survey effort conducted at the European Marine Energy Centre (EMEC) have resulted in sightings of harbour seals at both the Fall of Warness tidal energy test site and the Billia Croo wave energy test site in the Orkney Islands (Robbins 2012b, a, EMEC 2014b, a). At the Fall of Warness site, between 2005-2011 a total of 11,415 seals were recorded, of which, 12% were harbour seals, 49% were grey seals and 39% were unidentified to species level (Robbins 2012b). Harbour seal sightings at the Fall of Warness site were highly seasonal; harbour seals were seen during more observations in the autumn months, but the number of individuals recorded per observation were higher in the summer months (Robbins 2012b). At the Billia Croo site, a total of 470 seals were recorded during the surveys between 2009-2011; of these, 9% were harbour seals, 66% were grey seals and 25% were unidentified to species level (Robbins 2012a). Due to the low harbour seal sightings rate they could not be modelled separately. In general, seals in the Billia Croo site were sighted more often in the summer months.

Sightings of harbour seals from aerial surveys conducted by HiDef in 2016 around the Hebrides were rare, with sightings only during one of the three surveys, though this sightings information was used to create density maps of the area close to DPO site W1 (Figure 17).

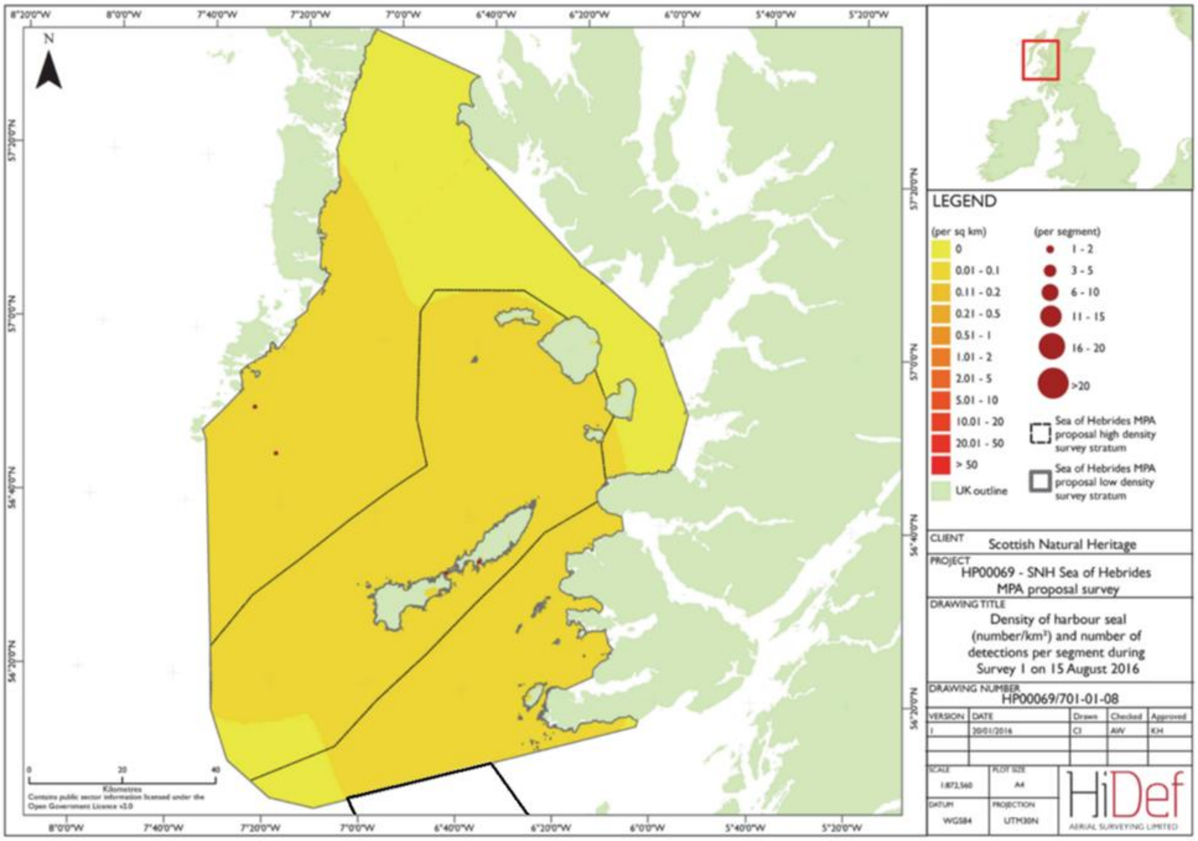


Figure 17: Density of harbour seals (number/km^2) and number of detections per segment during the HiDef aerial surveys for the Sea of Hebrides pMPA survey (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

3.3.2. Grey seal

Based on the information presented below, grey seals are resident year-round in Scottish waters. They are distributed further offshore than harbour seals, and so are expected to be present within the DPO areas. This species is important to consider for both coastal and offshore activities.

The most recent assessment of grey seals in UK waters concluded that the overall trend in Conservation Status was Favourable, with an overall trend in Conservation Status assessed as Improving (JNCC 2019e). Detailed information on grey seal August haulout counts, pup counts and population trends are reported annually in the SCOS reports. The most recent UK-wide August haulout count (2008-2017) gives a total grey seal count of 45,119, 61% of which were counted in Scotland. During the August haulout counts, grey seals are predominantly counted in the North Coast and Orkney SMU (35% of the Scottish count), the Western Isles SMU (21% of the Scottish count) and West Scotland SMU (19% of the Scottish count). It should be noted that while grey seals are counted during the August haulout surveys, these data do not necessarily provide a reliable index of population size. Grey seals aggregate in the autumn to breed at traditional colonies, therefore their distribution during the breeding season can be very different to their distribution at other times of the year.

Approximately 38% of the world's grey seal population breed in UK waters, and 88% of these are at colonies in Scotland (SCOS 2019). Based on the breeding surveys, pup production estimates are calculated and converted to estimates of the total population size (age 1+). The most recent estimate of UK grey seal population size is 150,000 (95% CI 131,000-171,600) (SCOS 2019). The main regional groups of breeding colonies in Scotland are: Inner Hebrides, Outer Hebrides, Orkney and Firth of Forth (Figure 18). The population of grey seals in the North Sea region has increased at a near constant rate since the 1980s and still remains high (SCOS 2019), whilst growth in the Inner and Outer Hebrides and Orkney has increased but with the rate beginning to slow in the mid-1990s as those populations reached carrying capacity (Thomas et al. 2019). Some breeding colonies, such as the Isle of May, have expanded from only having a few pups born each year in the 1970s to having >1000 pups per year since the early 1990s, with site expansion concurrent with increases in population size (Pomeroy et al. 2000).

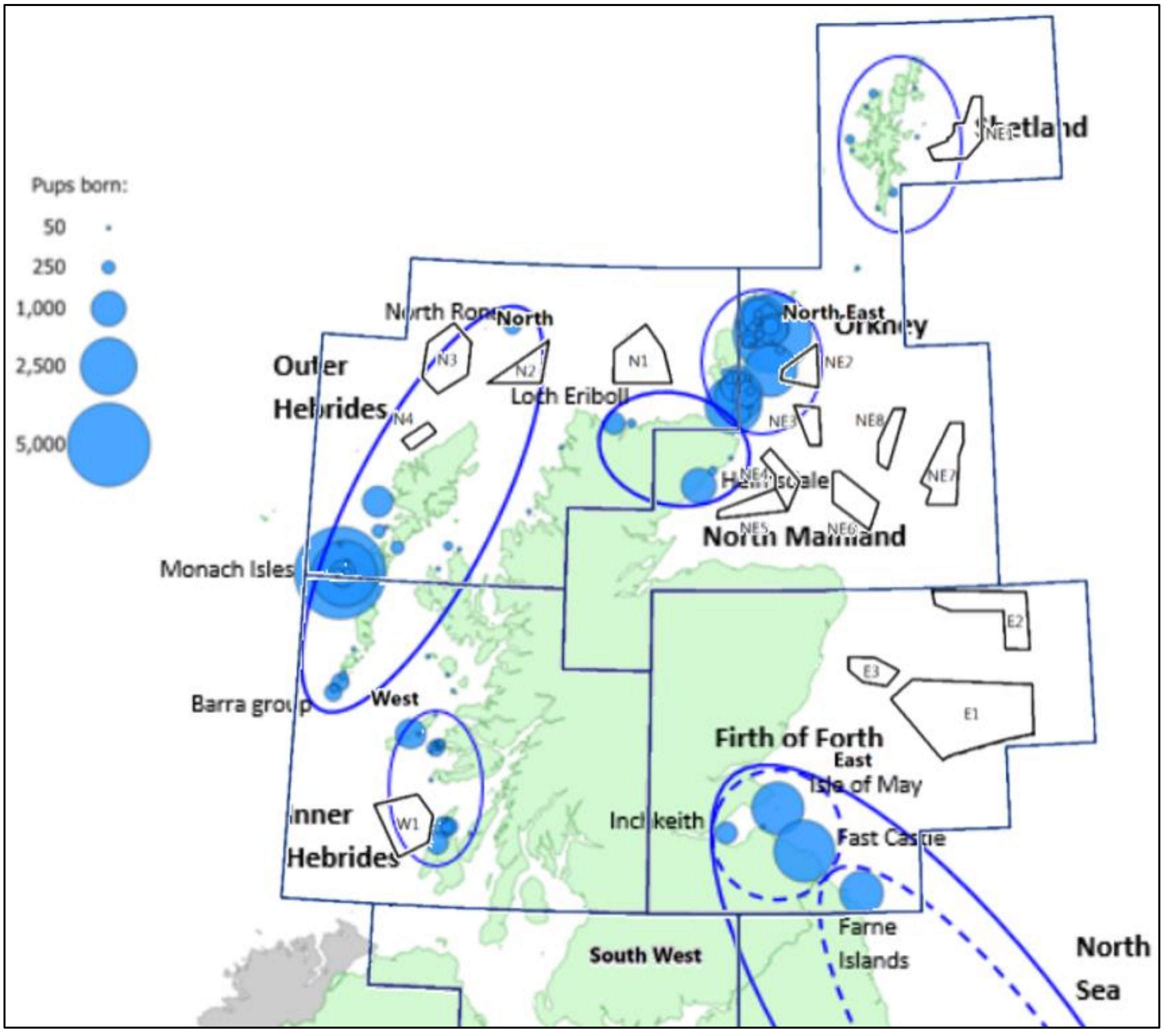


Figure 18: Distribution and size of the main grey seal breeding colonies in Scotland (SCOS 2019). Blue ovals indicate groups of colonies within each region. Overlaid for reference are the approximate regional and DPO areas.

Grey seals haulout on land to rest, moult and breed, and will disperse from these sites and forage at sea, where they will forage along the sea bed at depths of up to 100 m within 100 km of the haulout site with foraging trips lasting between one and 30 days (SCOS 2019). Their at-sea distributions are often characterised by gravel or sandy sediments, the ideal burrowing habitats of their sandeel prey (McConnell et al. 1999). As well as sandeels, gadids, especially cod, saithe and ling, also form a high proportion of the grey seal diet (Hammond and Wilson 2016). Grey seals will frequently travel over 100 km between haulout sites, with records of movements between the North Sea and the Outer Hebrides, or between Wales and the Inner Hebrides, for example (SCOS 2019). Between December and April grey seals will haulout to moult, and will haulout between August and December during the breeding season (SCOS 2019). Female grey seals in Scotland tend to pup between September and December, and will then suckle and care for the lanugo ‘white coat’ pup for 17-23 days before weaning (SCOS 2019).

Our current knowledge on grey seal at-sea distribution mainly comes from tagging data, with tagging work occurring intermittently since 1988. Of the 355 grey seals tagged in UK waters, 285 recorded telemetry tracks that are within the DPO Regions of Scottish waters (Figure 19). These telemetry data show a broad-scale distribution in Scottish waters, with grey seals utilising both coastal and offshore habitat and at least some overlap within each DPO area (Figure 19). The overall estimate at-sea usage of Scottish waters highlights key high-use areas at the scale of 5x5 km, such as the Orkney Isles and the west coast of the Outer Hebrides (Figure 20). There is a relatively high degree of overlap of seal at-sea usage within multiple DPO areas, especially including some or all of W1, N4, NE2, NE3, NE4, NE5, NE6, NE8, E2 and E3 (Figure 20) (Russell et al. 2017).

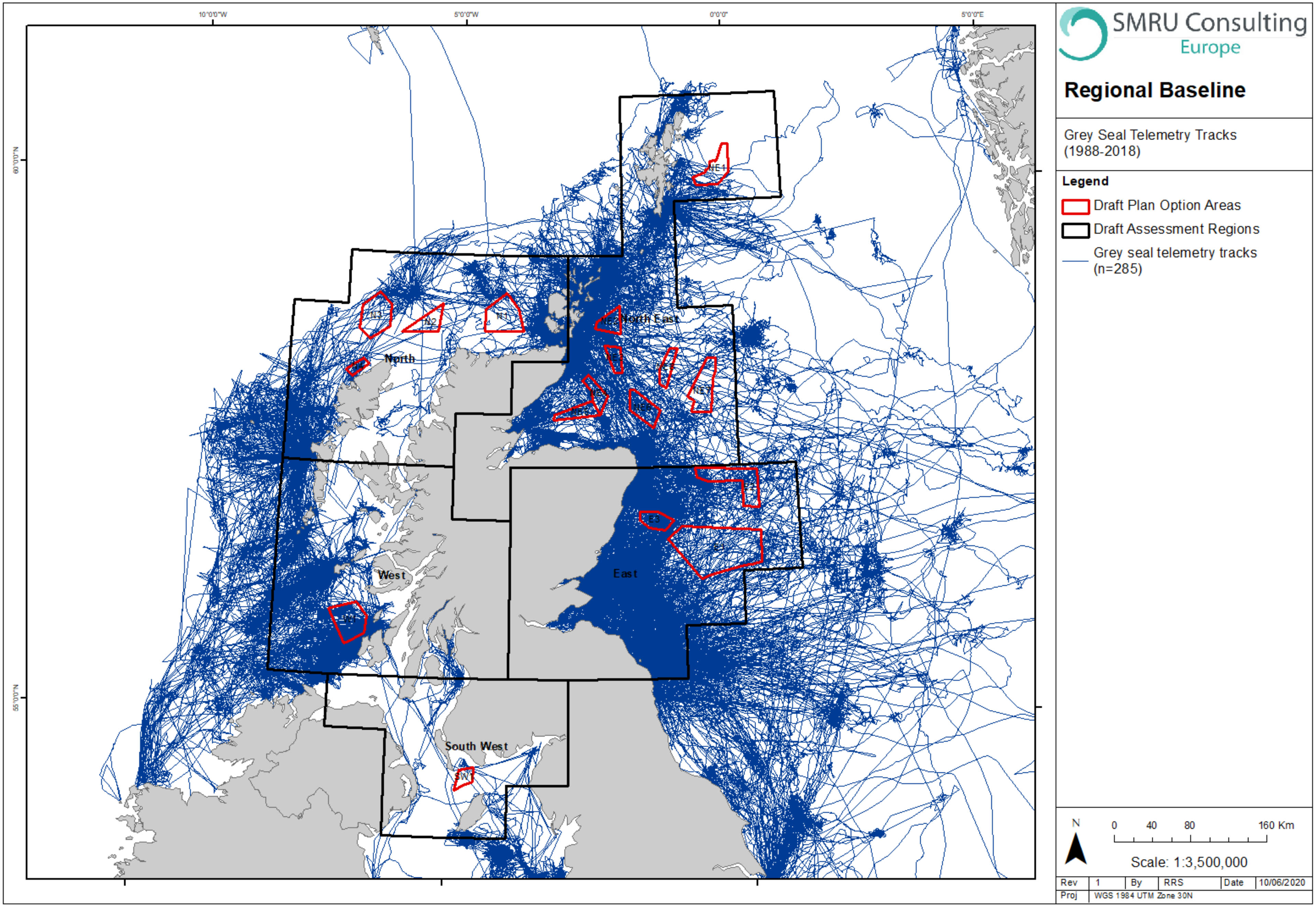


Figure 19: Telemetry tracks for grey seals tagged between 1988 and 2018 that had telemetry tracks within the DPO Regions (n=285).

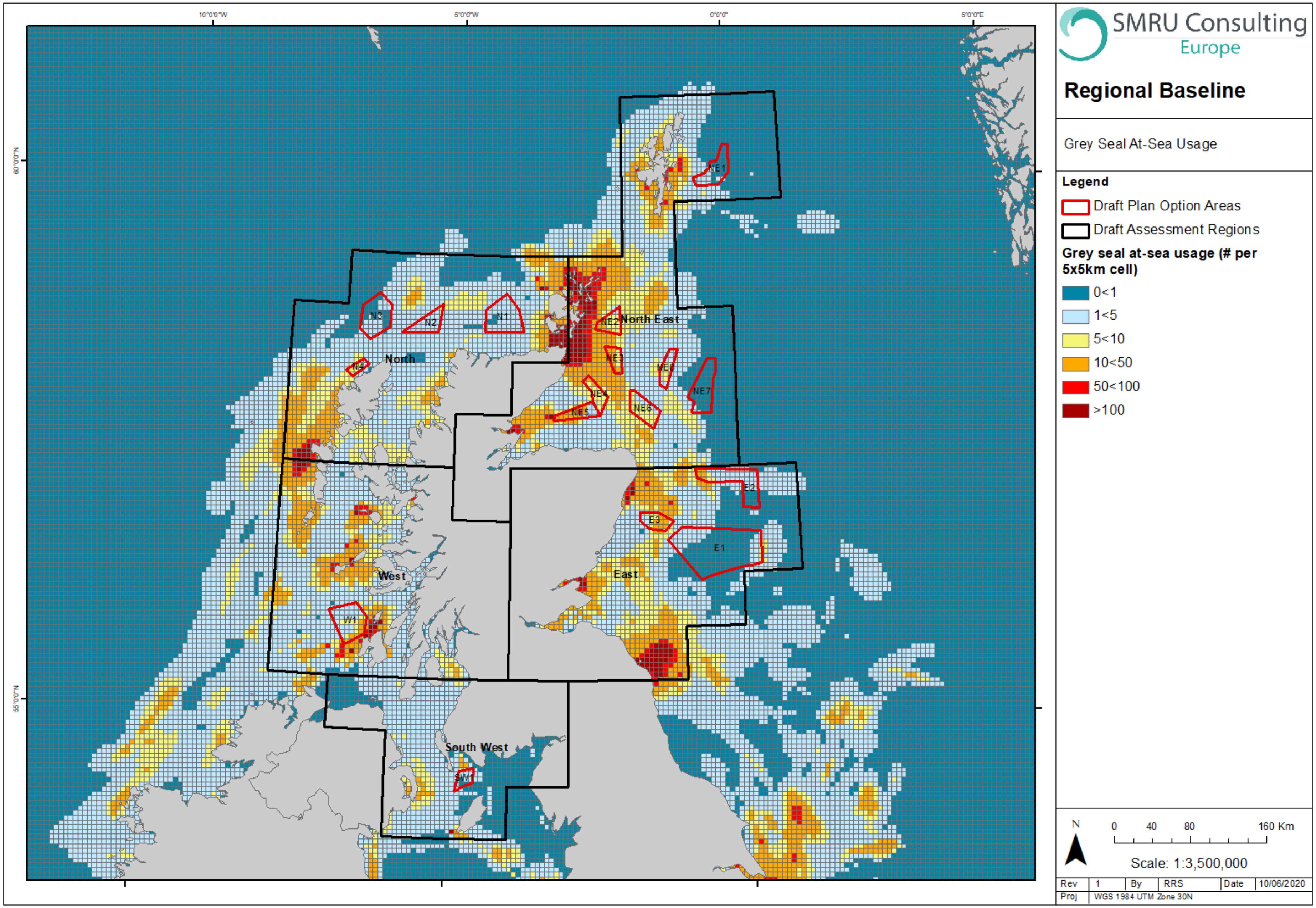


Figure 20: Grey seal estimated at-sea usage, which represents the mean number of grey seals estimated to be in the water in each cell at any given time (Russell et al. 2017).

In the aforementioned on-going project based at SMRU, part funded by BEIS, the telemetry data that contributed to the at-sea usage maps presented in Figure 19 and Figure 20 are now being combined with more recent telemetry data and environmental data to produce models that describe habitat preference of seals (Appendix 4: Seal Abundance and Distribution). These models are then being used to predict how grey seals use Scottish waters, based on their preferred habitat availability. Currently, the habitat preference modelling is the approach preferred by SMRU over the previous at-sea usage approach.

For grey seals, there were some differences in predictions between the at-sea usage maps and the habitat preference model approach (Table 6). Using the habitat preference modelling approach, some DPOs are to have higher densities of grey seals at any one time than previously predicted by the at-sea usage maps (e.g. NE1, NE2, NE3 and NE8), whereas others are predicted to be used less (e.g. E2 and E3). In some cases, the prediction in usage change is negligible, but for some sites the change in density prediction changes by an order of magnitude. For example, predictions of grey seal density in site NE3 by the at-sea usage approach suggest ‘medium’ density, whereas the habitat preference models predict ‘medium to high’ usage. This equates to a prediction <75 grey seals at any one time (medium) to a range of 75-750 grey seals at any one time (medium-high).

Table 6

Predicted by-cell seal density rating for grey seals (from habitat preference modelling; (Carter and al. In Prep), and from at-sea usage maps (Russell et al. 2017)) within DPO sites. For an idea of total abundance within DPO sites the size of area should also be considered; number of cells refers to the total number of complete and partial cells. Usage is presented as the number of grey seals expected to be using a cell at any one time: very low: <10 low: <15 med: <75 high: <750 grey seals. Bold indicates density ratings where the newer habitat preference model density ratings differ to previous density ratings available from the at-sea usage maps.

DPO	Number of cells (complete)	Grey seals	
		Habitat Preference Model: by-cell density rating	At-sea usage: by-cell density rating
E1	187 (127)	Very low - low	Very low - low
E2	78 (34)	Very low - **low**	Very low – **Medium**
E3	30 (9)	**Low** - Medium	**Very low** – Medium
N1	63 (31)	Very low - **Medium**	**Very low**
N2	35 (9)	Very low	Very low – **low**
N3	62 (30)	Very low-**low**	Very low
N4	17 (2)	Very low	Very low – **low**
NE1	46 (17)	Very low - **Medium**	Very low
NE2	31 (7)	**Low** - **high**	**Medium**
NE3	27 (6)	Medium - **high**	Medium
NE4	32 (6)	Very low - Medium	Very low – Medium
NE5	34 (9)	Very low - **Medium**	low – **high**

NE6	45 (15)	Very low - Medium	Very low – Medium
NE7	61 (25)	Very low - low	Very low – low
NE8	27 (4)	Very low - **Medium**	Very low – **low**
SW1	23 (3)	Very low - **low**	Very low – **Medium**
W1	63 (29)	Medium - high	Medium - high

Pollock et al. (2000) present boat-based sightings data of grey seals collected between 1979 and 1999, with sightings recorded during all months of the year and most frequently in shelf waters. Grey seals were more regularly encountered further offshore than harbour seals, but again rarely recorded in waters deeper than 200 m (Figure 21). Sightings of grey seals presented by Pollock et al. (2000) were most concentrated in the North, North East and West DPO regions, with some sightings within DPO site boundaries (e.g. N2, N4, NE3).

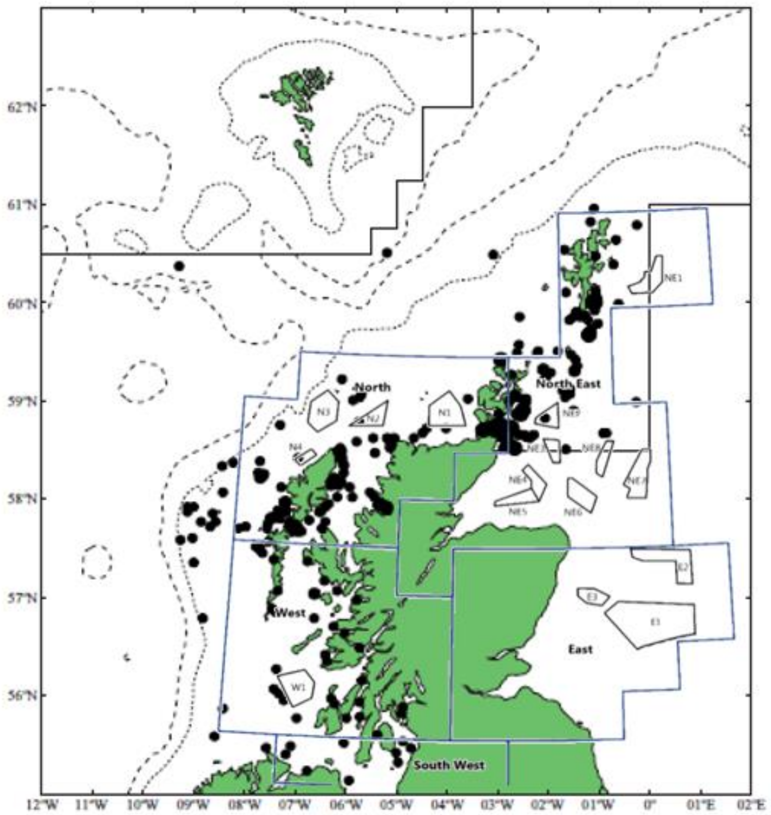


Figure 21: Grey seal sightings (1979-1999) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

Marine mammal sightings, including grey seals, were also recorded by dedicated marine mammal observers working on seismic survey vessels between 1994-2010. Grey seals were recorded throughout the Outer Moray Firth within the North East DPO region, specifically in sites NE3, NE4, NE5, NE6, NE7 and NE8 (Figure 22) (Stone 2015). Grey seals were also seen within the East DPO region, but not directly within any sites.

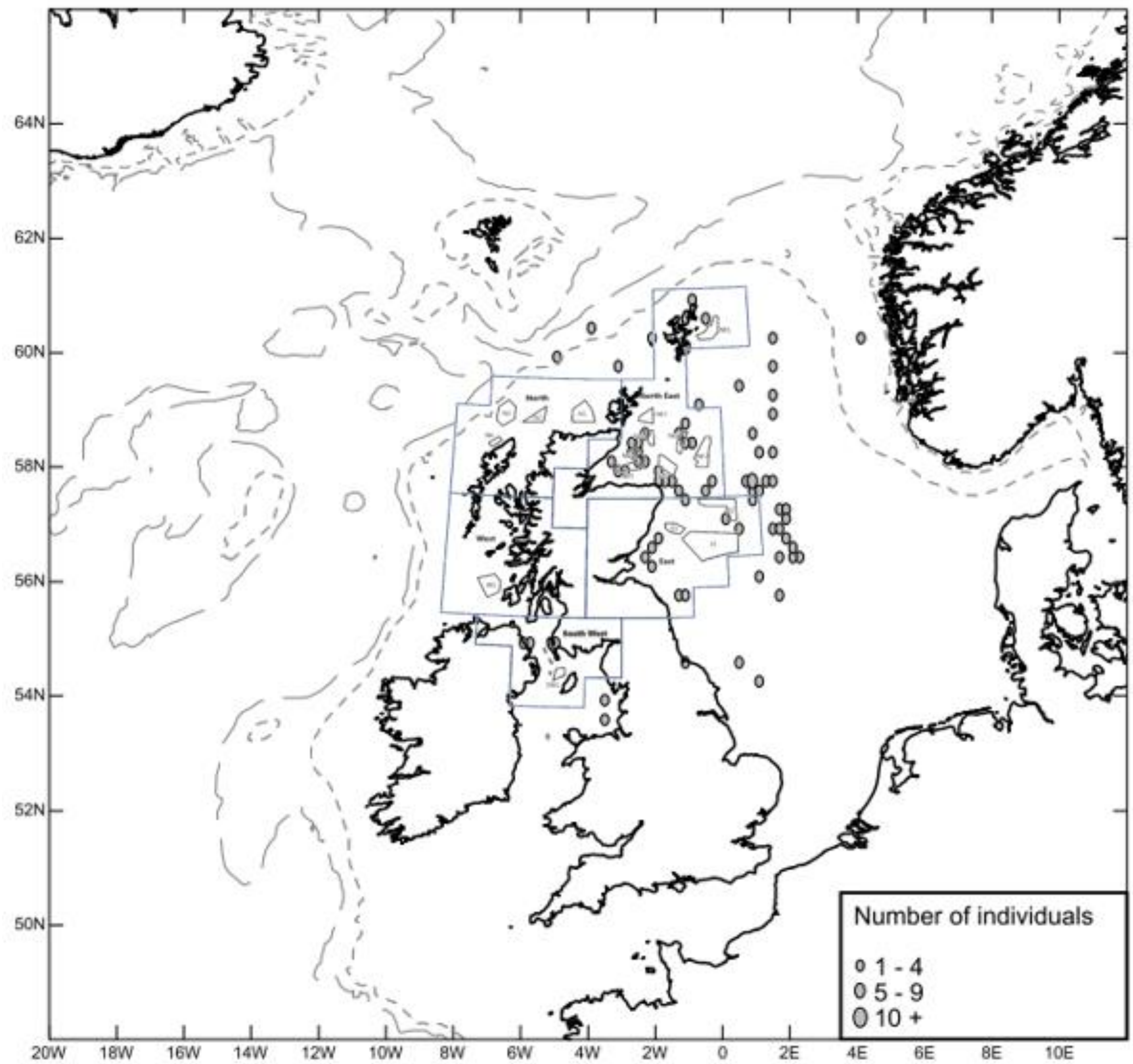


Figure 22: Grey seals encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Overlaid for reference are the approximate regional and DPO areas.

ORCA and MARINElife both undertake dedicated vessel-based marine mammal watches following various routes within Scottish waters. Between 2016 and 2019 ORCA recorded numerous grey seal sightings along the Aberdeen-Kirkwall route, in both the East and North East DPO regions (Figure 23). ORCA sightings did not overlap with any DPO sites, but were close to the NE3 site boundary. Between 2008 and 2019, MARINElife also reported a high number of grey seal sightings, particularly in the South West DPO region, with many sightings within the SW1 site boundary.

During land-based Shorewatches WDC observed grey seals in various locations around the Scottish coastline, especially the Moray Firth (Figure 25). The coastal nature of this effort means no sightings overlap the DPOs areas, however, these sightings combined with other haulout count data could be useful when determining cable landfall sites.

Aerial surveys of the east coast of Scotland and the Orkney Isles carried out by HiDef in 2014 recorded grey seals for a large portion of the survey area (Figure 26). The tracklines did not frequently overlap the DPO sites, and as such no grey seals were recorded within the site boundaries.

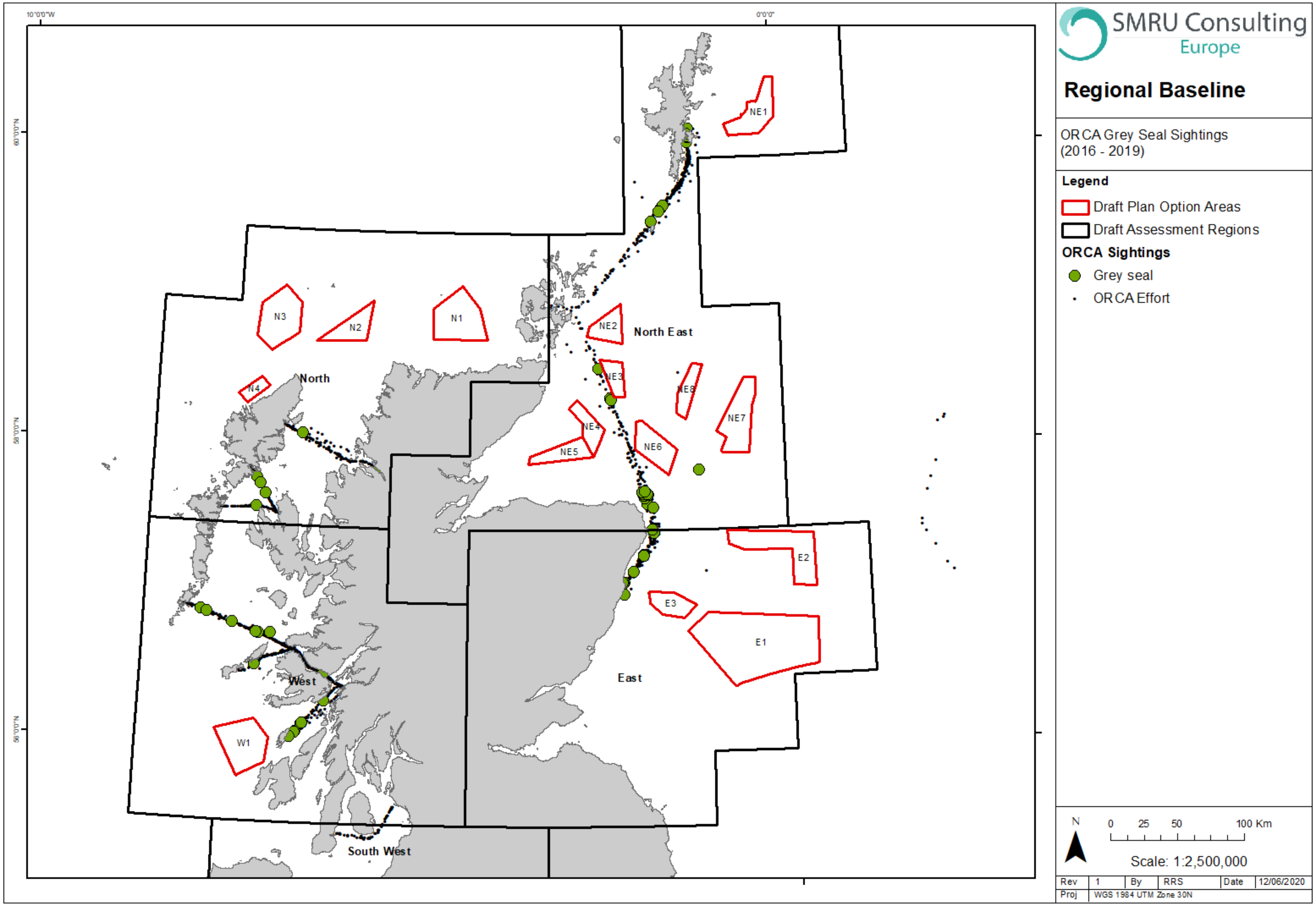


Figure 23: Grey seal sightings (green dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

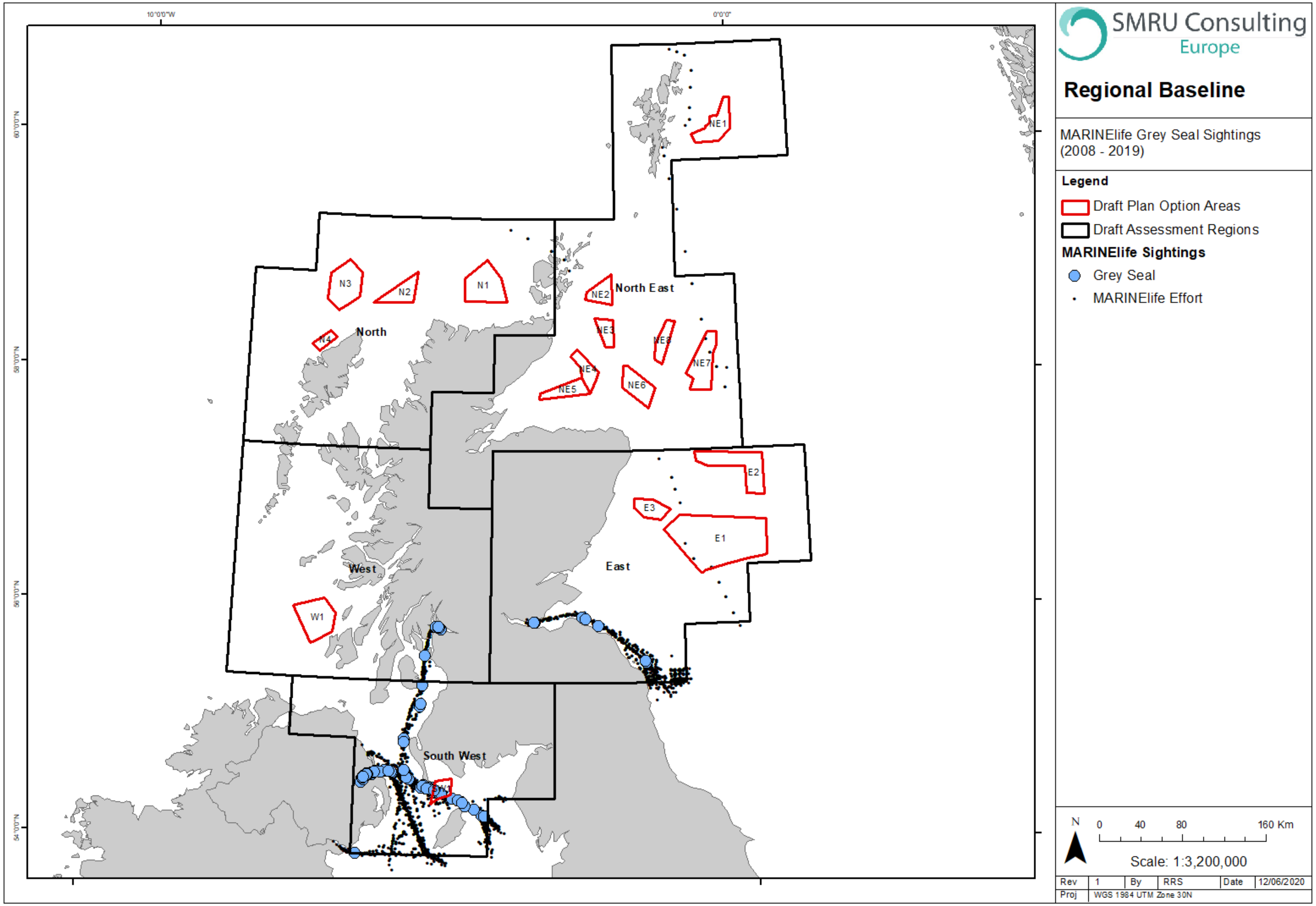


Figure 24: Grey seal sightings (blue dots) recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

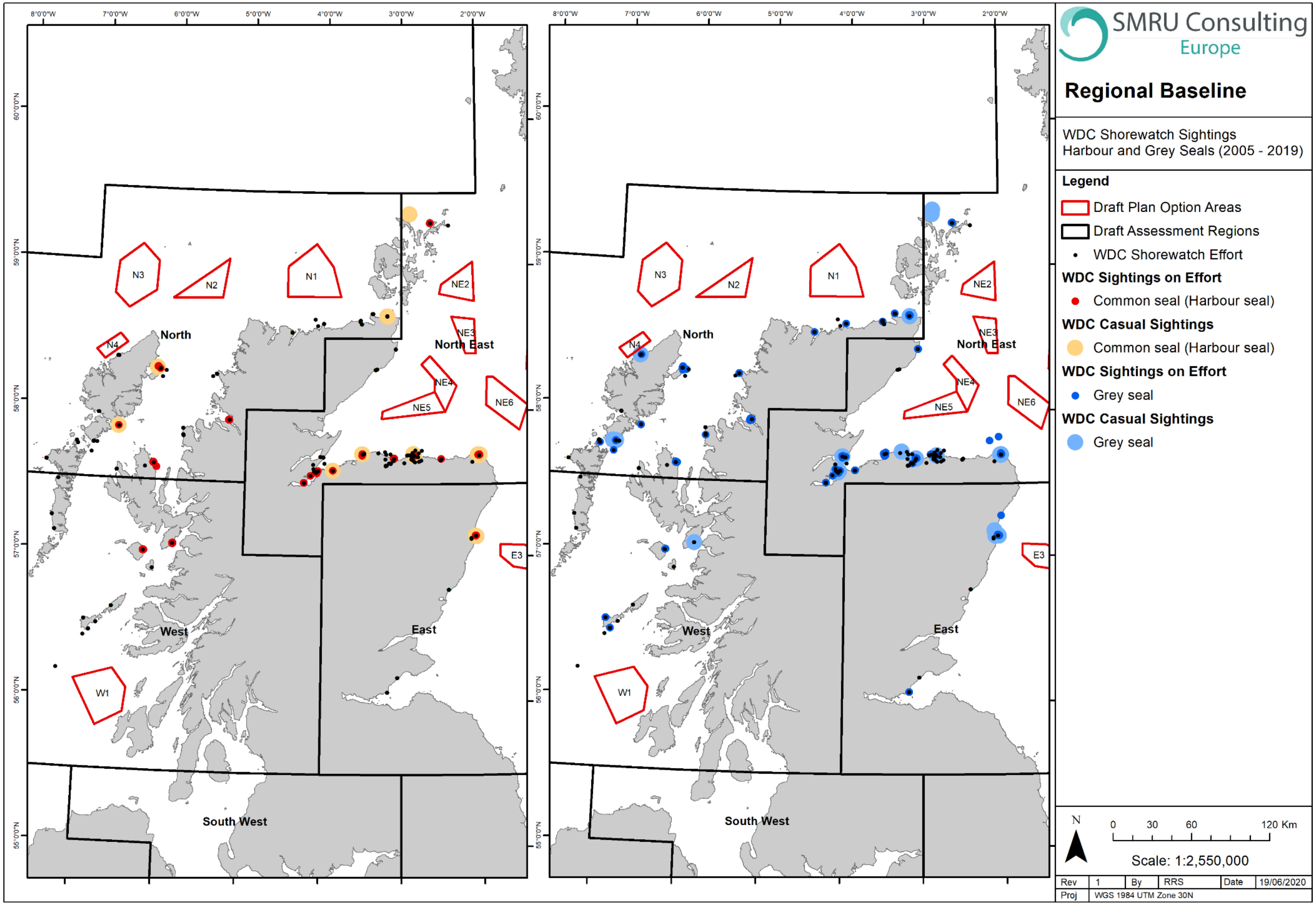


Figure 25: Sightings of harbour (left) and grey (right) seals recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

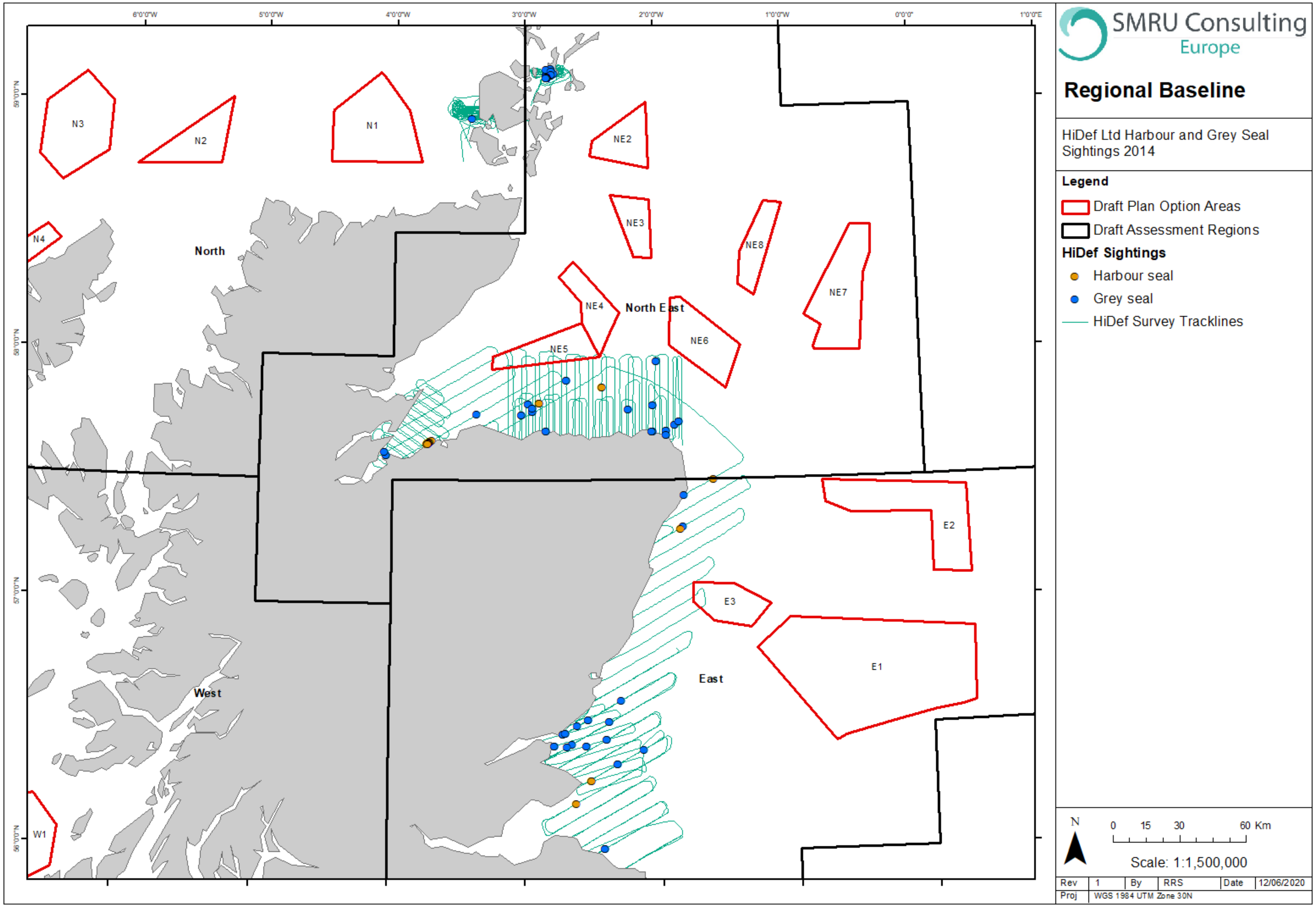


Figure 26: Harbour seal (orange dots) and grey seal (blue dots) sightings recorded during HiDef Ltd aerial surveys carried out in 2014.

Extensive survey effort conducted in east Scotland for the Forth and Tay offshore windfarms (Seagreen, Neart na Gaoithe and Inch Cape) have confirmed that grey seals are present in the Forth and Tay area (Sparling et al. 2011, Grellier and Lacey 2012, Inch Cape 2012, Neart na Gaoithe 2012, Sparling 2012, Inch Cape Offshore Limited 2018, Neart na Gaoithe 2018). The ability to identify seals to species level tends to be higher during vessel surveys (Figure 27), with grey seals the most frequently sighted seal species; by contrast, identifications to species level are lower for aerial surveys and as such most sightings are categorised as “unidentified” seal species (Figure 28).

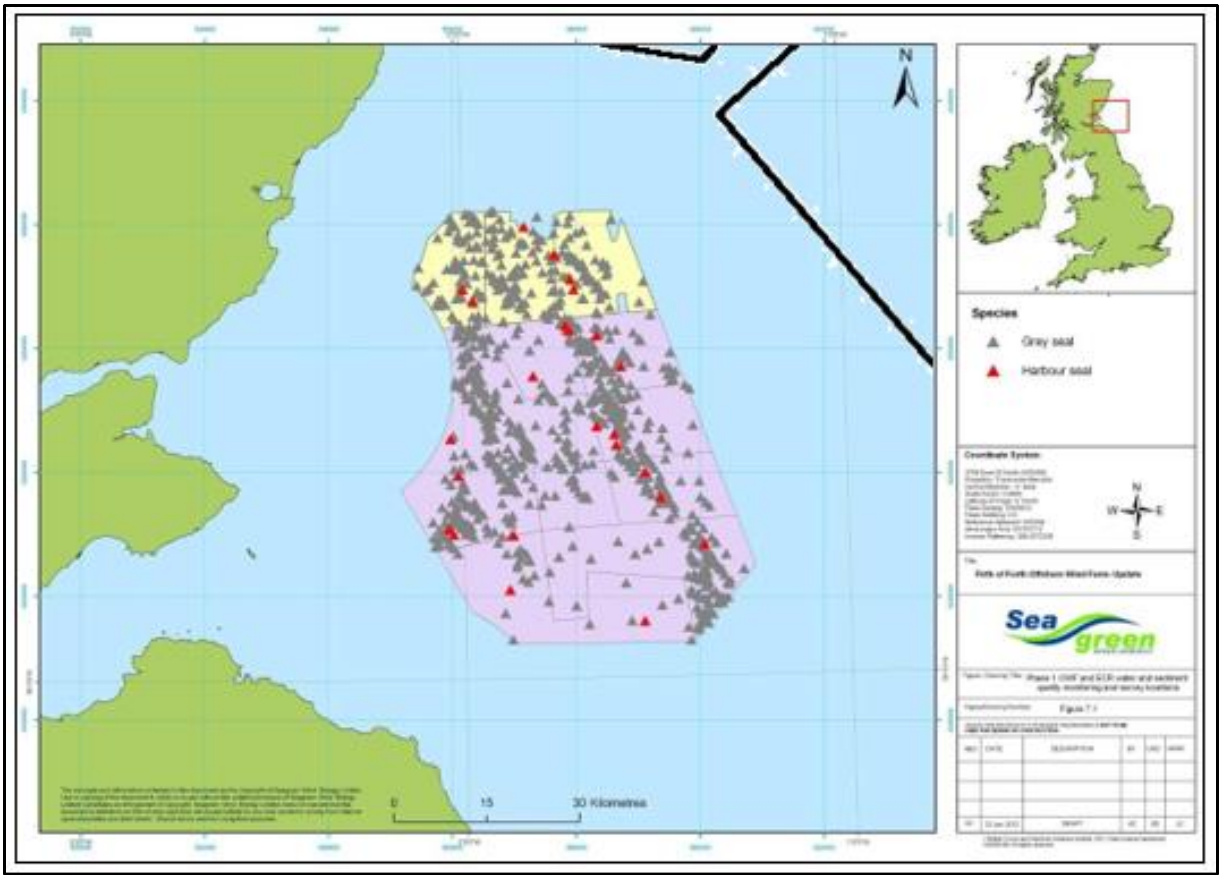


Figure 27: Harbour and grey seal sightings from the Firth of Forth Round 3 Zone vessel surveys May 2010 to November 2011 (Sparling 2012). DPO sites are Overlaid for reference, with sites E1 and E3 to the north east of the survey site.

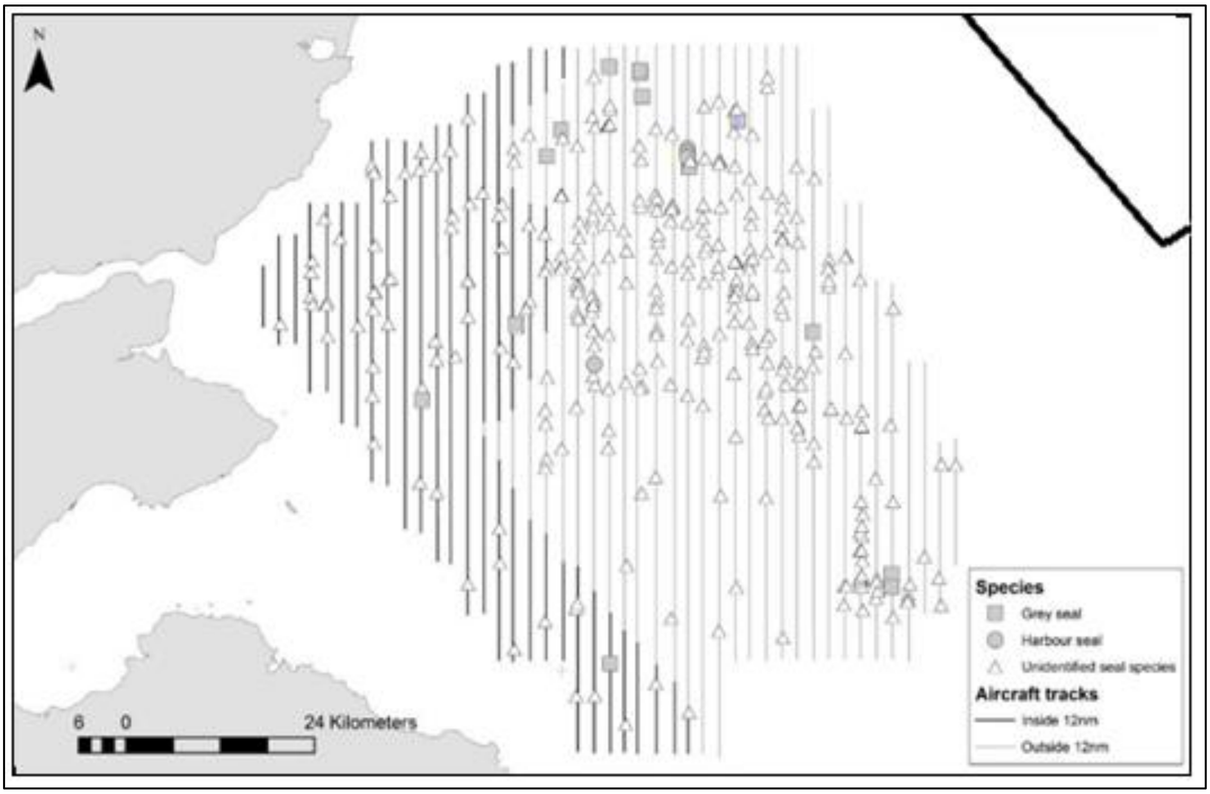


Figure 28: Harbour and grey seals sighted during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPO sites are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

Survey effort conducted for the EMEC projects have resulted in sightings of grey seals at both the Fall of Warness site and the Billia Croo site in the Orkney islands (Robbins 2012b, a, EMEC 2014b, a). At the Fall of Warness site, between 2005-2011 a total of 11,415 seals were recorded of which, 12% were harbour seals, 49% were grey seals and 39% were unidentified to species (Robbins 2012b). Grey seal sightings at the Fall of Warness site were highly seasonal; the grey seal encounter rate was highest during the autumn months which coincides with the grey seal pupping season. (Robbins 2012b). At the Billia Croo site, a total of 470 seals were recorded during the surveys between 2009-2011; of these, 9% were harbour seals, 66% were grey seals and 25% were unidentified to species (Robbins 2012a). In general, seals in the Billia Croo site were sighted more often in the summer months.

Sightings of grey seals from aerial surveys conducted by HiDef in 2016 around the Hebrides were used to create density maps of the area close to DPO site W1 (Figure 29).

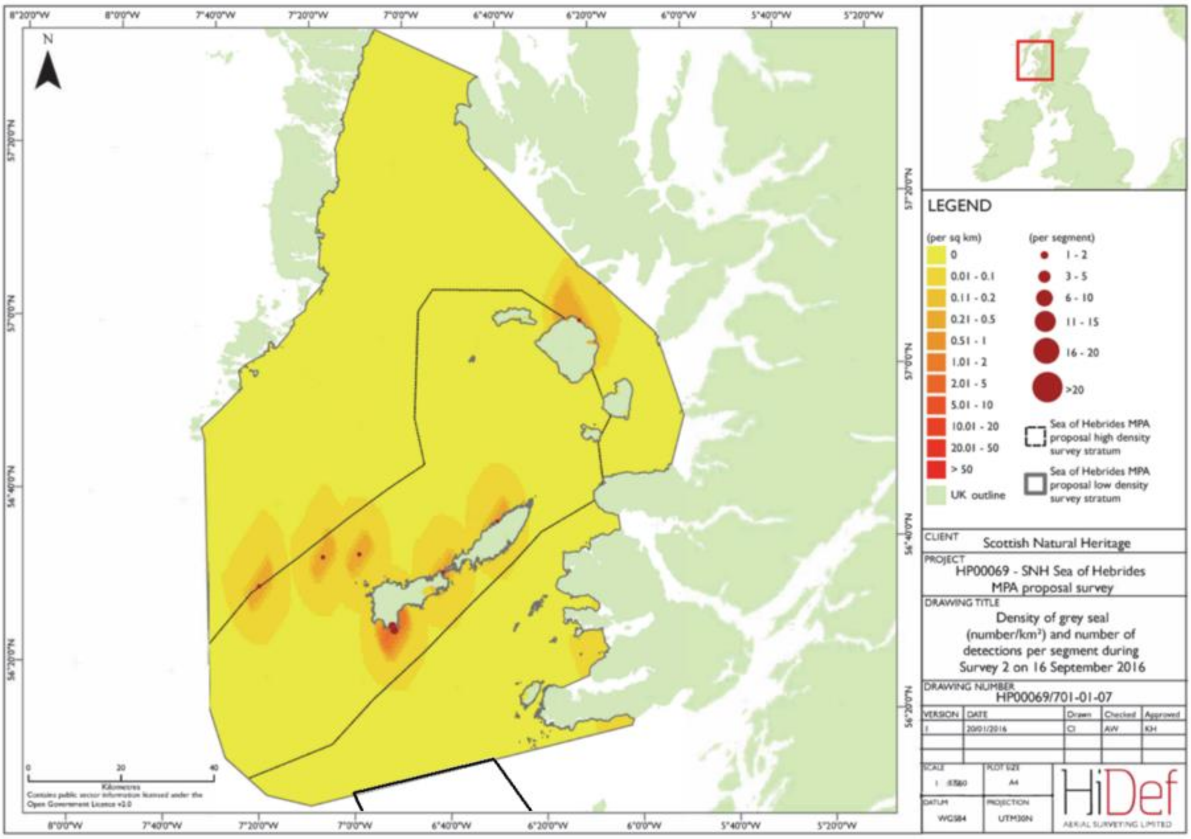


Figure 29: Density of grey seals (number/km^2) and number of detections per segment during the HiDef aerial surveys for the Sea of Hebrides pMPA survey (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

3.3.3. Harbour porpoise

Based on the information presented below, harbour porpoise are resident and abundant year-round in Scottish waters, with a distribution that overlaps with all DPO regions and sites.

The most recent assessment of harbour porpoise in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the UK population (JNCC 2019d).

The most recently collected broad scale data on harbour porpoise abundance and distribution are available from the SCANS III survey (Hammond et al. 2017). All three SCANS surveys identified harbour porpoise as the most frequently sighted cetacean in Scottish waters, with harbour porpoise sighted within all survey blocks in Scottish waters. The series of SCANS surveys between 1994 and 2016 have shown a change in harbour porpoise distribution, with a southwards shifts in density from the northwest North Sea (around Scotland) in 1994 to the southwest North Sea in 2005 (Figure 30), remaining in the southwest North Sea in 2016 (Figure 31), although it must be noted the SCANS surveys reflect summer distribution only (Hammond et al. 2017). In Scottish waters, the most recent density estimates provided from SCANS III survey data suggest densities range from 0.058 porpoise/km^2 in Block J (western Outer Hebrides) to 0.599 porpoise/km^2 in Block R (east coast) (Figure 31) (Hammond et al. 2017). Harbour porpoise were sighted in all DPOs regions during the SCANS III survey, and more specifically were sighted in DPO sites W1, N3, NE1, NE2, NE7, E1 and E2 (Figure 32).

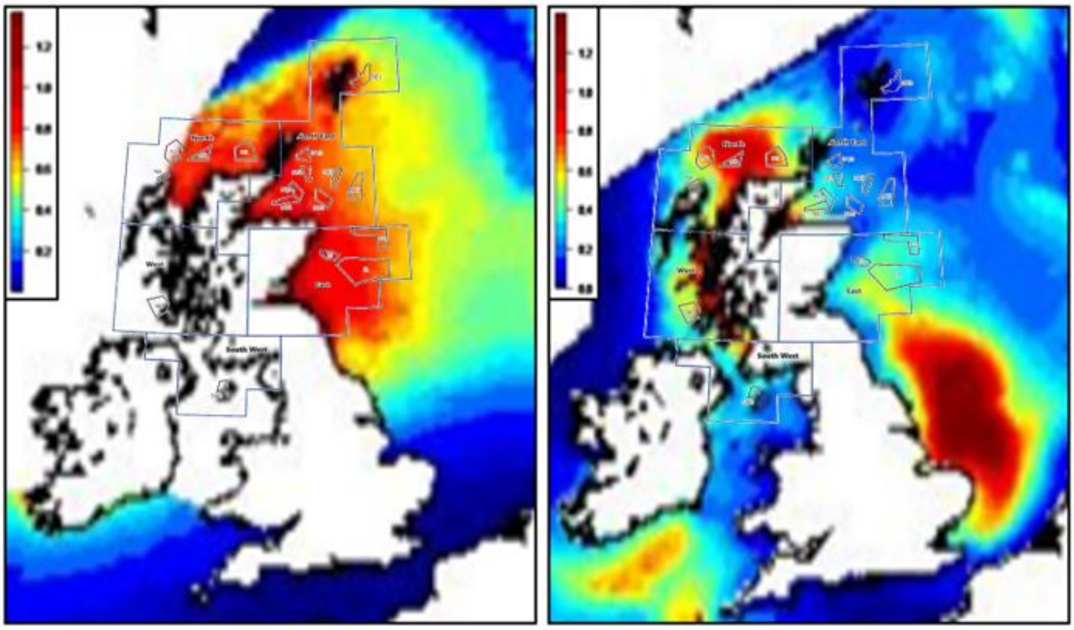


Figure 30: Harbour porpoise estimated density surface (porpoise/km^2) in (left) 1994 and (middle) 2005 (Hammond et al. 2006).

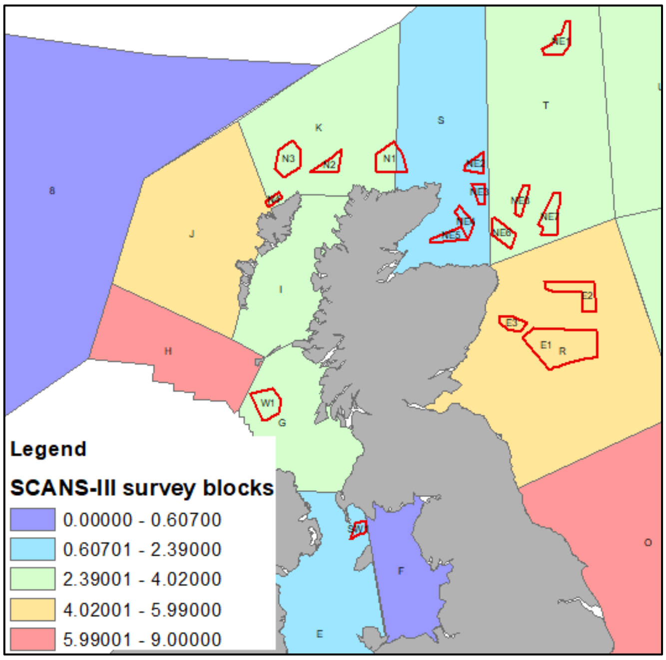


Figure 31: SCANS III block-wide uniform density estimates for harbour porpoise in Scottish waters, with DPOs plotted in red (adapted from Hammond et al. 2017).

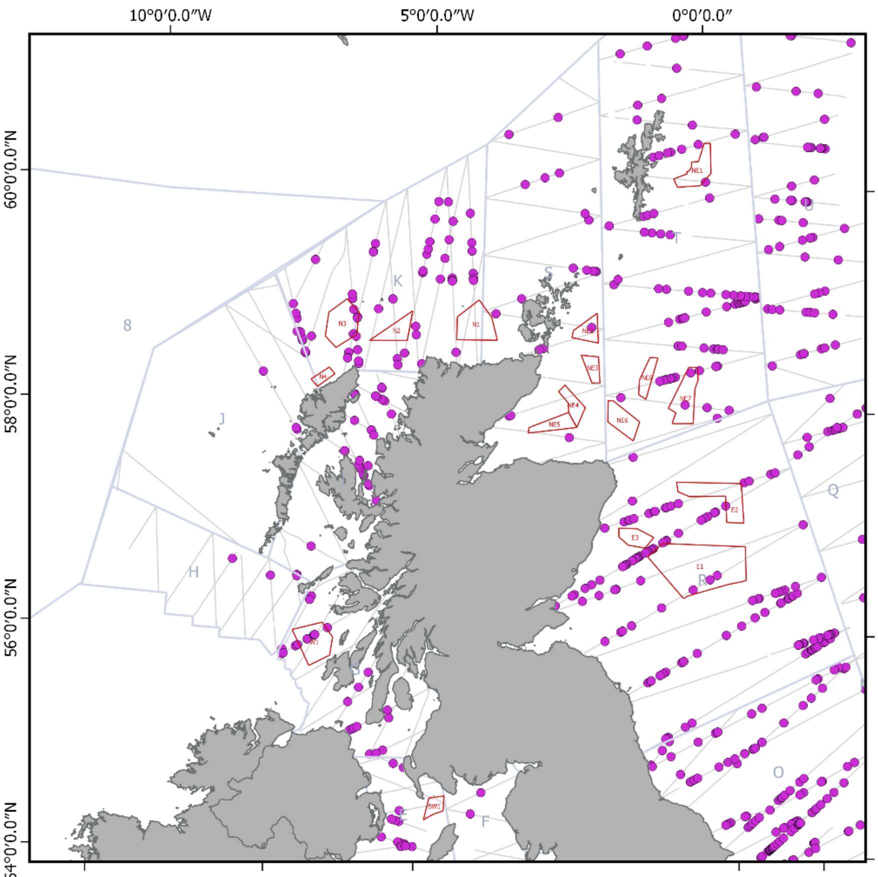


Figure 32: Sightings of harbour porpoise seen during the SCANS III survey in blocks containing DPO areas (red). Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

For the purpose of this report, Hammond & Lacey (Appendix 3: SCANS surveys) have provided predicted density surfaces for harbour porpoise within Scottish waters using SCANS III survey data. The highest harbour porpoise density prediction per km^2 are within the North Sea, in the East DPO region, especially site E1 with a prediction of >0.5 animals per km^2 across the whole site (Figure 33).

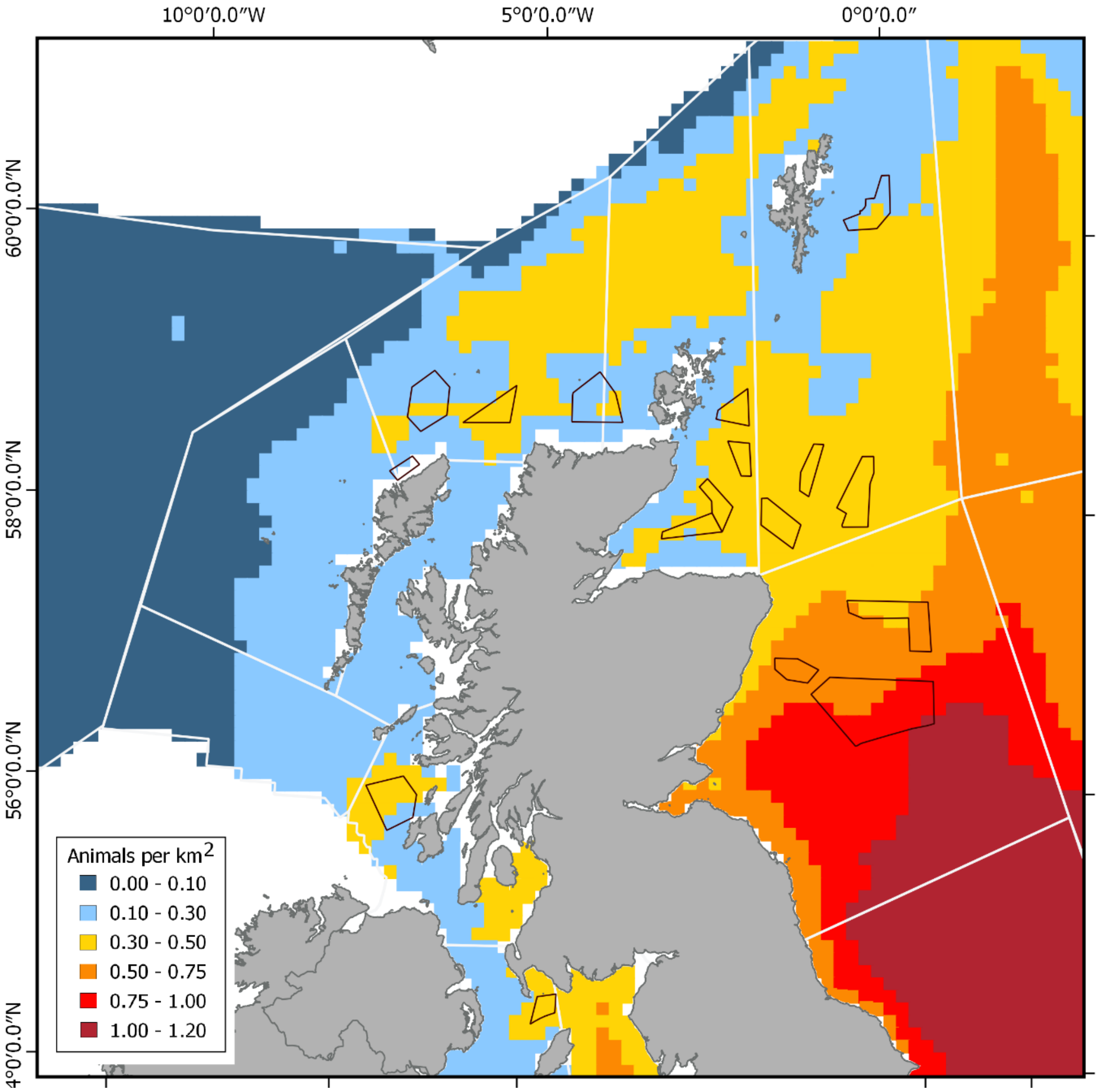


Figure 33: Predicted density surface for harbour porpoise in 2016 using SCANS III survey data. The colour scale is in units of animals per km^2. DPO Areas are outlined in black for reference. SCANS III survey block areas are marked in white. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The most recent analysis of data seeking to provide estimates of harbour porpoise distribution within the North-East Atlantic, including Scottish waters, is presented in Waggitt et al. (2020) and was collated as part of the Marine Ecosystems Research

Programme project (MERP)[10]. Waggitt et al. (2020) produced species distribution maps using a number of data sources, using sightings data between 1980 and 2018. Waggitt et al. (2020) predict harbour porpoise to be present in Scottish waters year-round, but with generally higher estimated densities in the summer months and within the more inshore waters (Figure 34). The authors interpret variation in monthly predicted surfaces as indicative of seasonal movements of harbour porpoise, with animals predicted to move into the innermost North Sea during winter months. The analysis presented by Waggitt et al. (2020) did not take into account the change in distribution within the North Sea observed between the 1994 and 2005 SCANS surveys, where porpoise summer distributions shifted from the northern to the southern North Sea (Hammond et al. 2006). Because these modelled monthly surfaces do not take into account changes between years, with outputs representing data gathered over a very long time period, it is uncertain how much these surfaces can be used in any predictive capacity to indicate contemporary relative abundance.

Note: the Waggitt et al. (2020) distribution maps are available for all months, however, only January and July are presented here for illustrative purposes.

[10] https://www.pml.ac.uk/Research/Projects/Marine_Ecosystems_Research_Programme_(MERP)

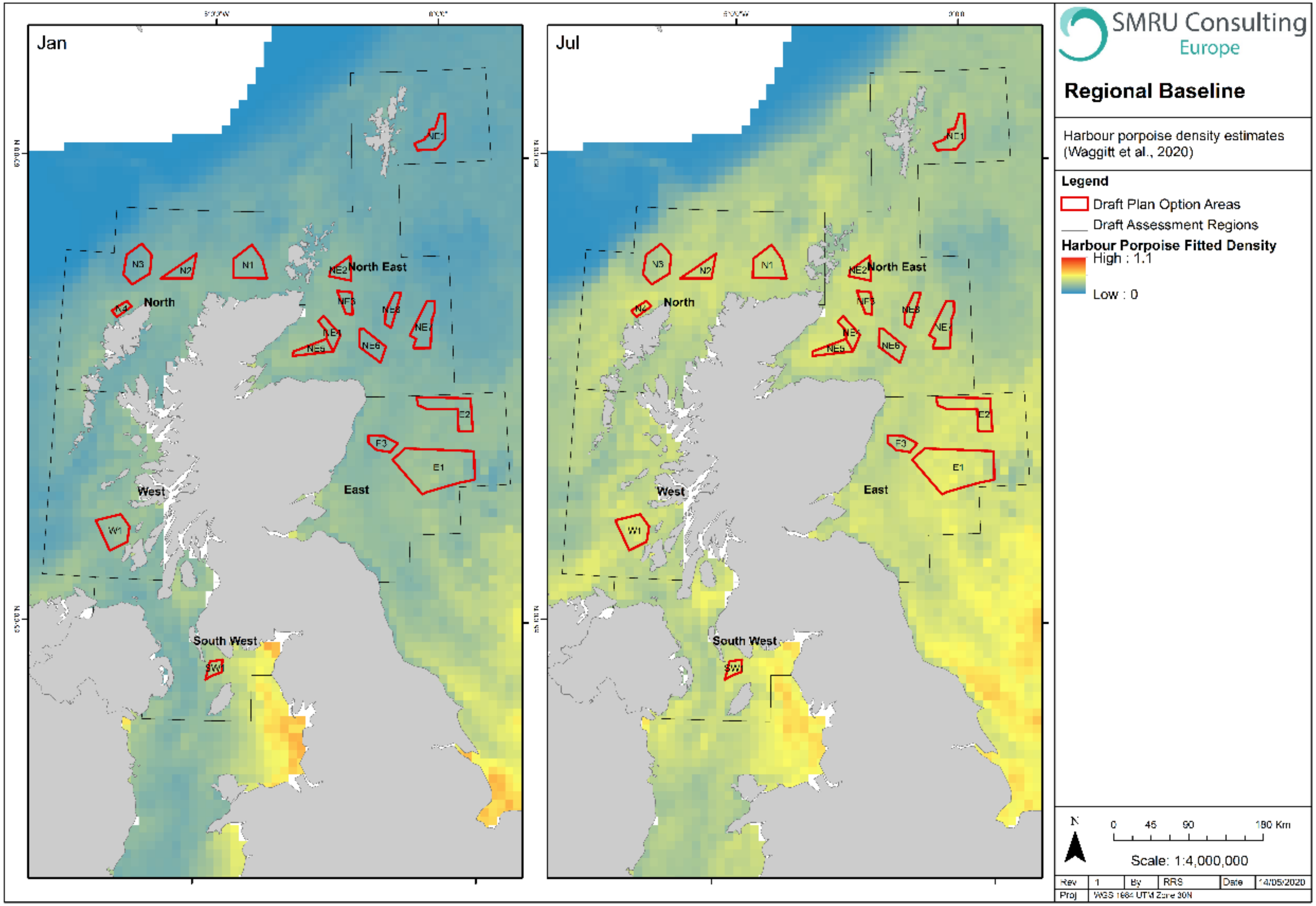


Figure 34: Spatial variation in predicted harbour porpoise densities (animals per km^2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

In a similar analysis of a database of pooled data, the Joint Cetacean Protocol dataset was used to produce two reports. Paxton et al. (2016) developed distribution maps for seven UK cetacean species including harbour porpoise, and Heinänen and Skov (2015) used 18 years of survey data held within the JCP database to recommend two harbour porpoise Marine Protected Areas within Scottish waters, after their analysis noted two sites with high and persistent density: Smith Bank in the outer Moray Firth (summer only) and the coastal areas off north-west Scotland, including the Minches and eastern parts of the Sea of Hebrides (Figure 35). The high use of the Inner Hebrides by harbour porpoise demonstrated by the analysis led to the designation of the Inner Hebrides and Minches SAC[11] in 2018, with harbour porpoise listed as an Annex II species (species that are a primary reason for site selection). The western boundary of DPO site W1 overlaps lies along the SAC boundary (Figure 36), a consideration when assessing the potential impacts commercial development of this site may have on marine mammals.

The high-density areas modelled for the Moray Firth include the DPO areas NE4 and NE5, whilst the high-density areas along the west coast of Scotland include the DPO site W1 (Figure 35). The offshore area north of Shetland and the edge of the Norwegian Trench were also identified as persistent high-density areas, but due to less than three years of survey effort, confidence in these predictions was low.

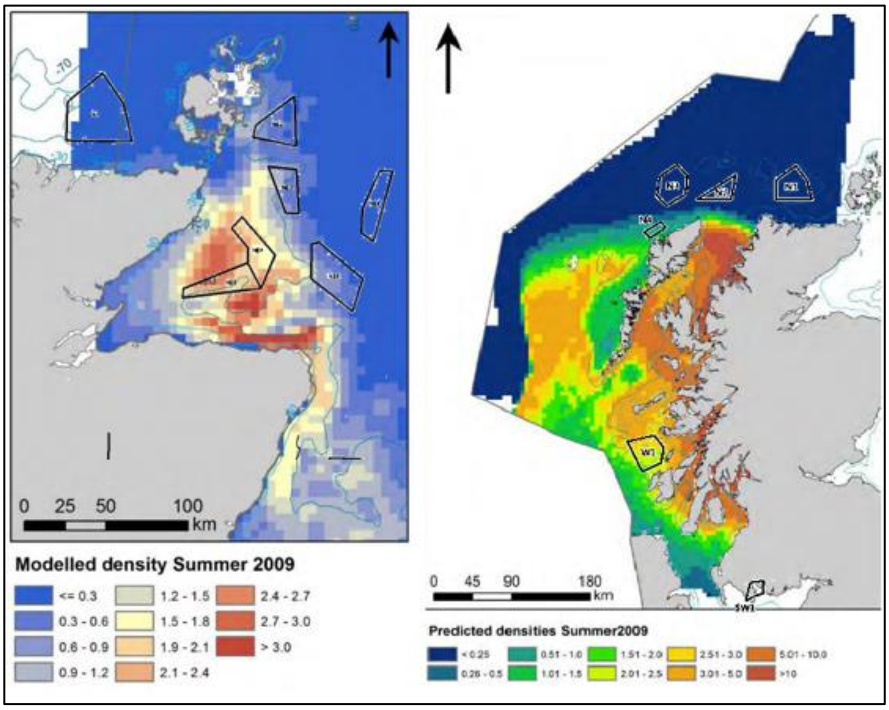


Figure 35: Areas of high harbour porpoise density (number/km^2) identified in Heinänen and Skov (2015). Overlaid for reference are the approximate regional and DPO areas.

[11] https://sac.jncc.gov.uk/site/UK0030393

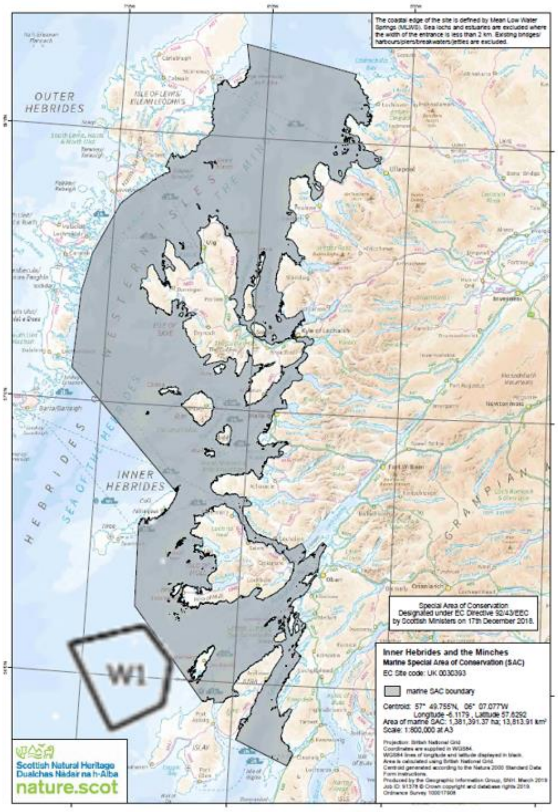


Figure 36: Inner Hebrides and the Minches Marine Special Area of Conservation (SAC)[12]. Overlaid for reference are the approximate regional and DPO areas.

Harbour porpoise were observed on all three of the HiDef aerial surveys conducted by Webb et al. (2018) covering the Sea of Hebrides pMPA survey area in 2016 (Figure 37), although only one was observed during the second survey. In the first survey on 15 August low numbers were widely dispersed, whilst on the third survey on 30 September there were a higher number of observations, especially in the nothern part of the survey area (Figure 37).

[12] https://sitelink.nature.scot/site/10508

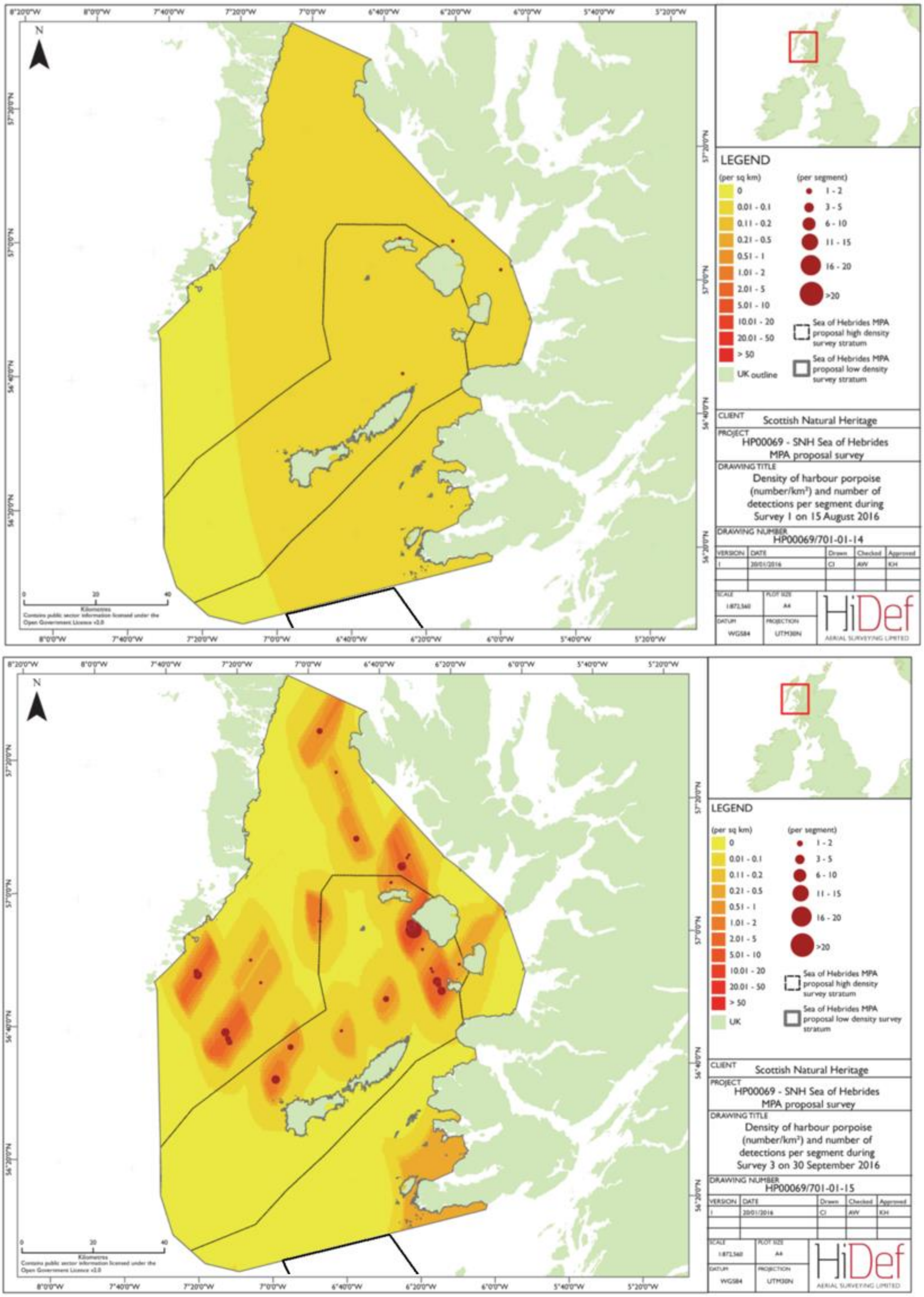


Figure 37: Density of harbour porpoise (number/km^2) and number of detections per segment during the first (top) and third (bottom) HiDef aerial surveys for the Sea of Hebrides pMPA survey (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

Data from the Hebridean Whale and Dolphin Trust (HWDT) were used as some of the primary evidence to inform the boundary of the Inner Hebrides and the Minches Special Area of Conservation (Figure 36). Their data shows harbour porpoise to be resident around the west of Scotland year-round, widespread in the Hebrides and with the highest occurrence around the Small Isles. For the purpose of this report, HWDT provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020) (Figure 38). This data overlaps the North, West and South West DPO regions, though sightings and effort data for specific DPOs sites are more sparse. Harbour porpoise were sighted in some areas of site W1 relatively frequently (>0.06 sightings per unit effort (km)), although some parts of site W1 had no effort recorded.

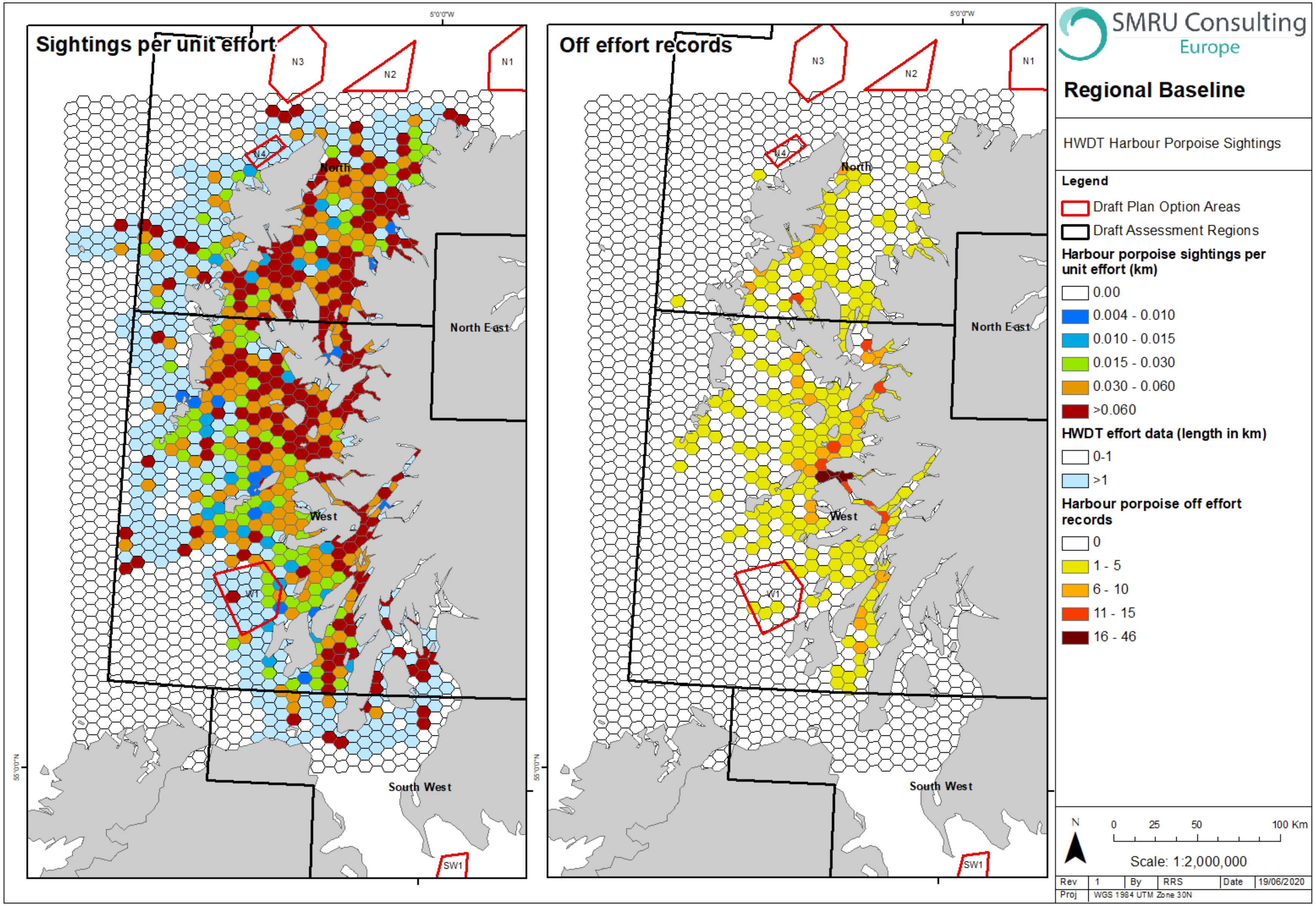


Figure 38: Sightings per unit effort, and off effort sightings of harbour porpoise recorded by HWDT during vessel based surveys 2003-2019 (Hebridean Whale and Dolphin Trust 2020).

The Scottish Marine Atlas describes harbour porpoise as being abundant in all Scottish waters with a preference for open coast, shallow bays, estuaries and sea lochs (Baxter et al. 2011). Mapped encounter rates show higher encounter rates in the Inner Hebrides and further offshore of the east coast of Scotland (Figure 39). The high encounter rates predicted by the Scottish Marine Atlas maps overlap somewhat with all DPOs areas in the North East and East regions.

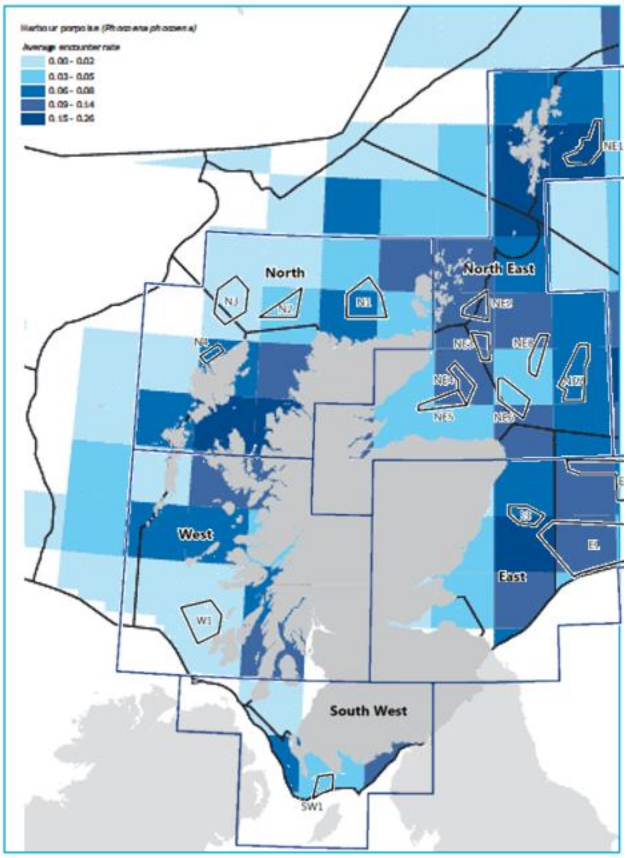


Figure 39: Harbour porpoise average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Older large-scale surveys are presented by Reid et al. (2003), Weir et al. (2001) and Pollock et al. (2000), although the data are now two decades old and so likely do not represent contemporary distribution of harbour porpoise in Scottish waters. However, we have presented the results here for reference.

Reid et al. (2003) describe the distribution of harbour porpoise in north-west Europe as being mainly confined to the shelf waters, with some sightings in deeper waters. Harbour porpoise are distributed within all Scottish waters, with locally relative high density areas off the west coast of Scotland in the Hebrides (Figure 40), particularly in the summer months (June to September), though this may be an artifact of increased detectability in summer months.

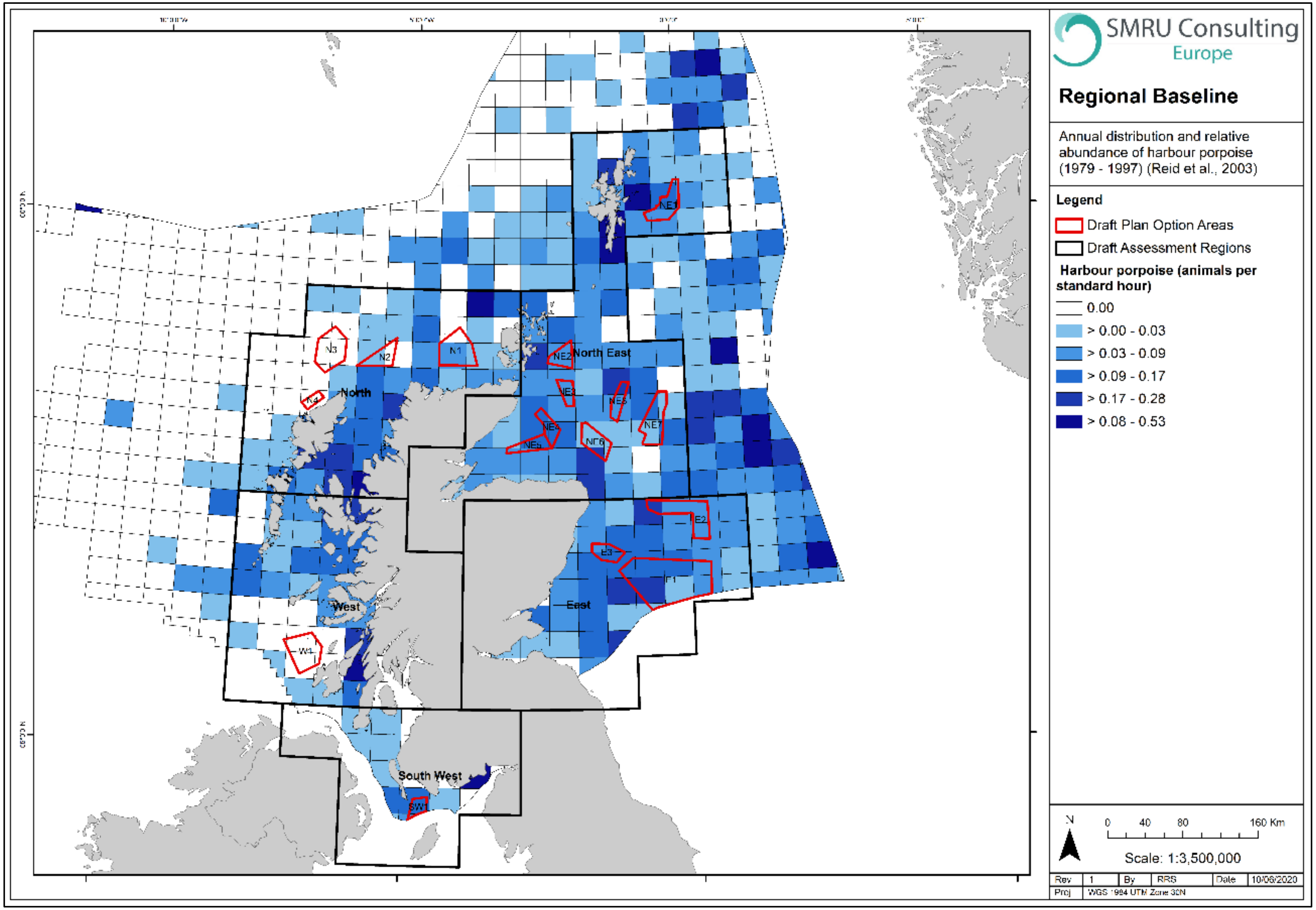


Figure 40: Aggregated annual distribution and relative abundance of Harbour porpoise (1979-1997) on quarter ICES rectangles based on data presented in Reid et al. (2003).

Harbour porpoise were the most frequently sighted cetacean during the Cetaceans of the Atlantic Frontier surveys presented by Weir et al. (2001), and were widely distributed in shelf waters, particularly around the Outer Hebrides and Shetland (Figure 41). Numbers increased between June and September, peaking during July and August, and were distributed throughout shelf waters during the summer months, though harbour porpoise were also occasionally sighted in deep waters off the shelf edge. This would suggest a likely increase in harbour porpoise distribution over some DPOs areas in the months between April to October, including NE1 and NE2 (Figure 41) (Pollock et al. 2000).

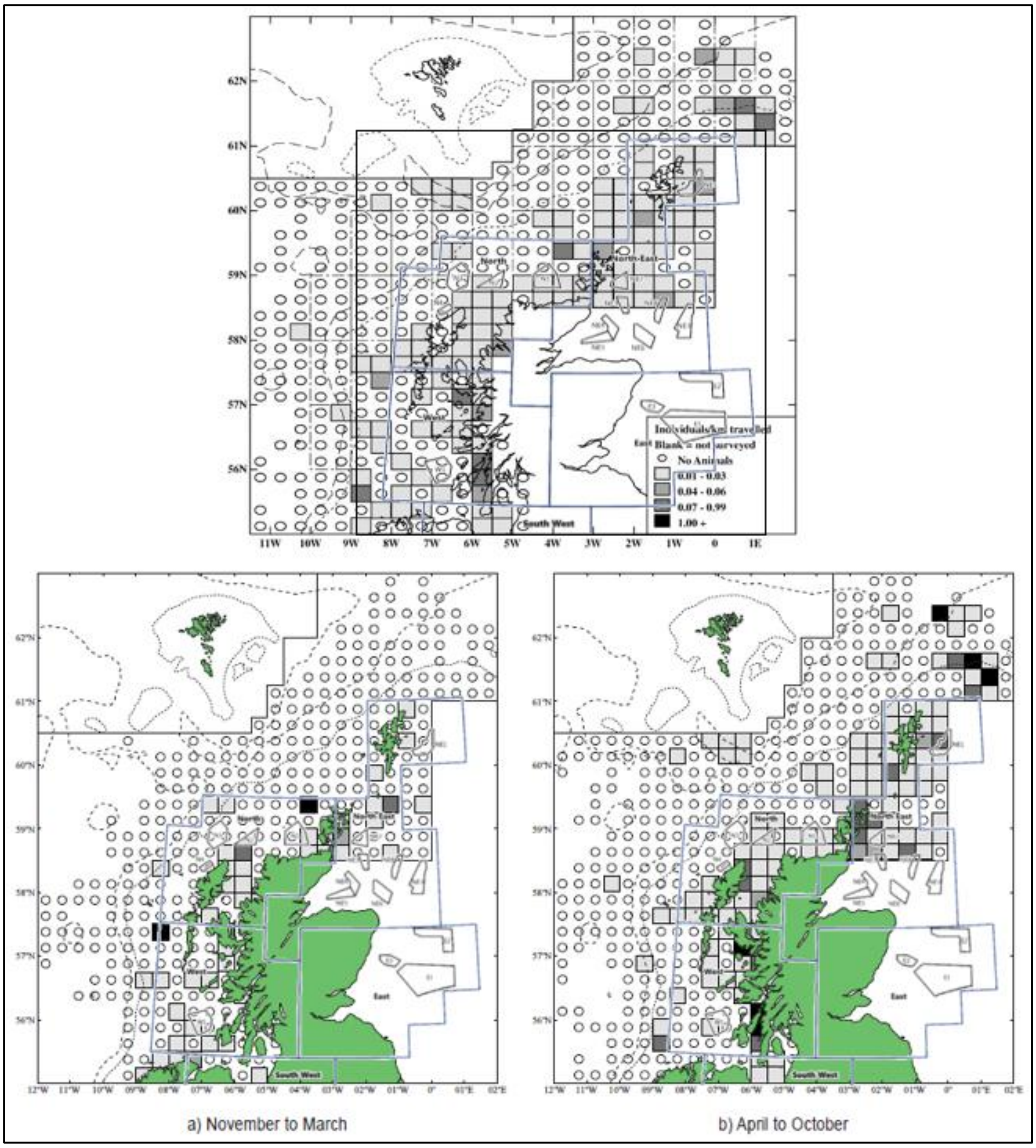


Figure 41: Abundance of harbour porpoises (1979-998) Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001). Below: Distribution of harbour porpoise sightings between (left) November and March, and (right) April and October (1979-1999). (Pollock et al. 2000). Note, same legend applicable to all figures. Overlaid for reference are the approximate regional and DPO areas.

Various passive acoustic monitoring (PAM) arrays around Scotland provide data on the ‘detection positive hours’ of harbour porpoise clicks, giving some indication of the frequency of harbour porpoise presence in that area. To be detected this requires the harbour porpoise to be echolocating, and for the click beam to be detected by the acoustic array.

Harbour porpoise were detected at all ECOMMAS PAM sites in all survey years between 2013 and 2019 (Figure 42). Detection rates were generally lower at the most coastal sites, and where there is overlap with known bottlenose dolphin ranges. The ECOMMAS sites do not overlap the DPO sites, but provide an indication of species presence within the DPO region.

The array of COMPASS and MarPAMM hydrophones across the west of Scotland are similar in spatial coverage to the survey coverage of HWDT (Figure 43). Data from the devices have been analysed preliminarily and have detected harbour porpoise in all months (Aug 2017-Nov 2019), with the highest rate of detection in the winter period, and a stronger seasonal pattern at deeper water sites, perhaps indicative of porpoises moving to deeper water in the winter months (Edwards et al. 2019). More in-depth analyses of project findings will be published in associated reports in future years. The Colonsay MarPAMM site falls within the DPO site W1, which according to preliminary analyses has recorded on average 12.7 porpoise detections per hour (see table inset of Figure 43).

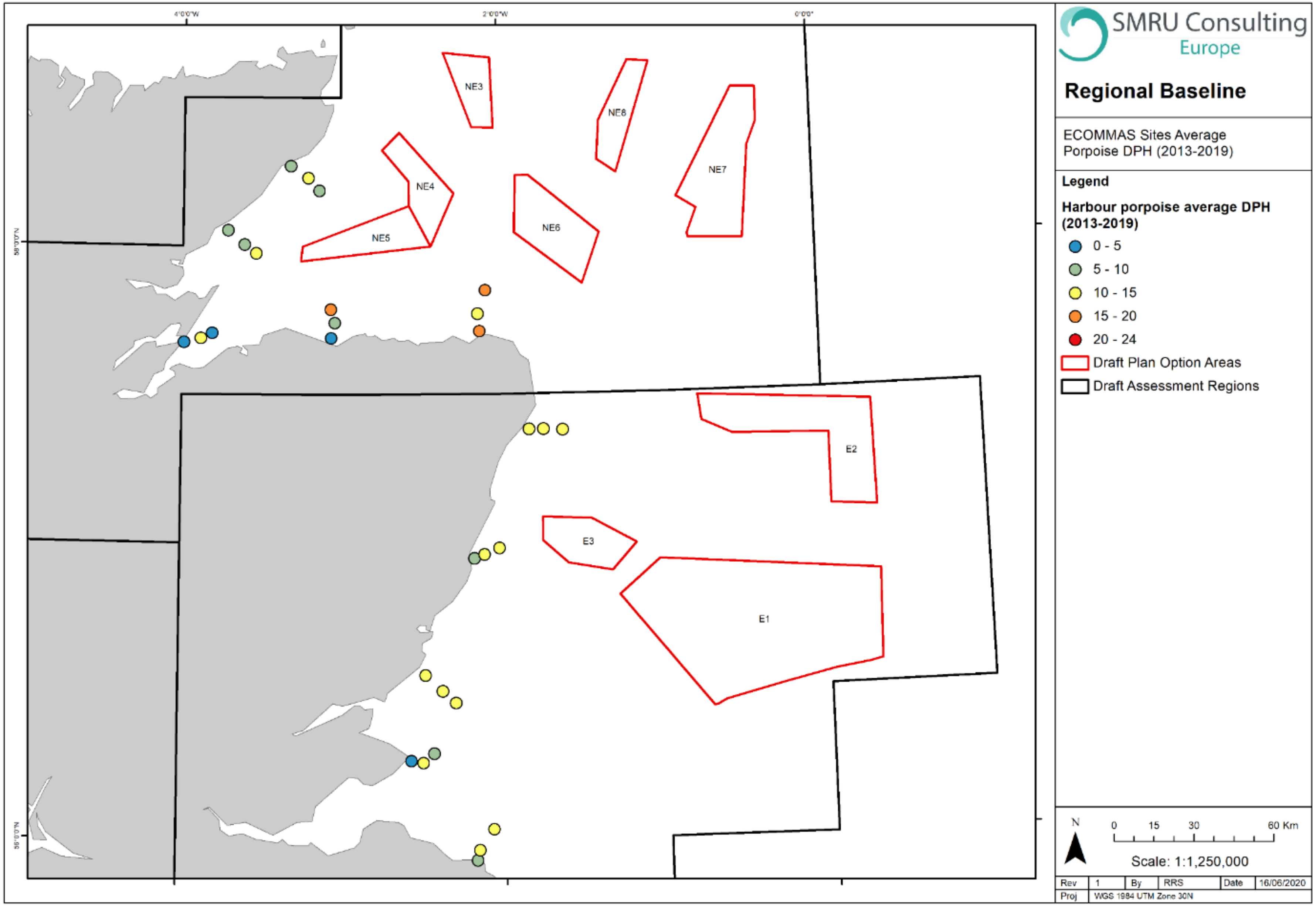
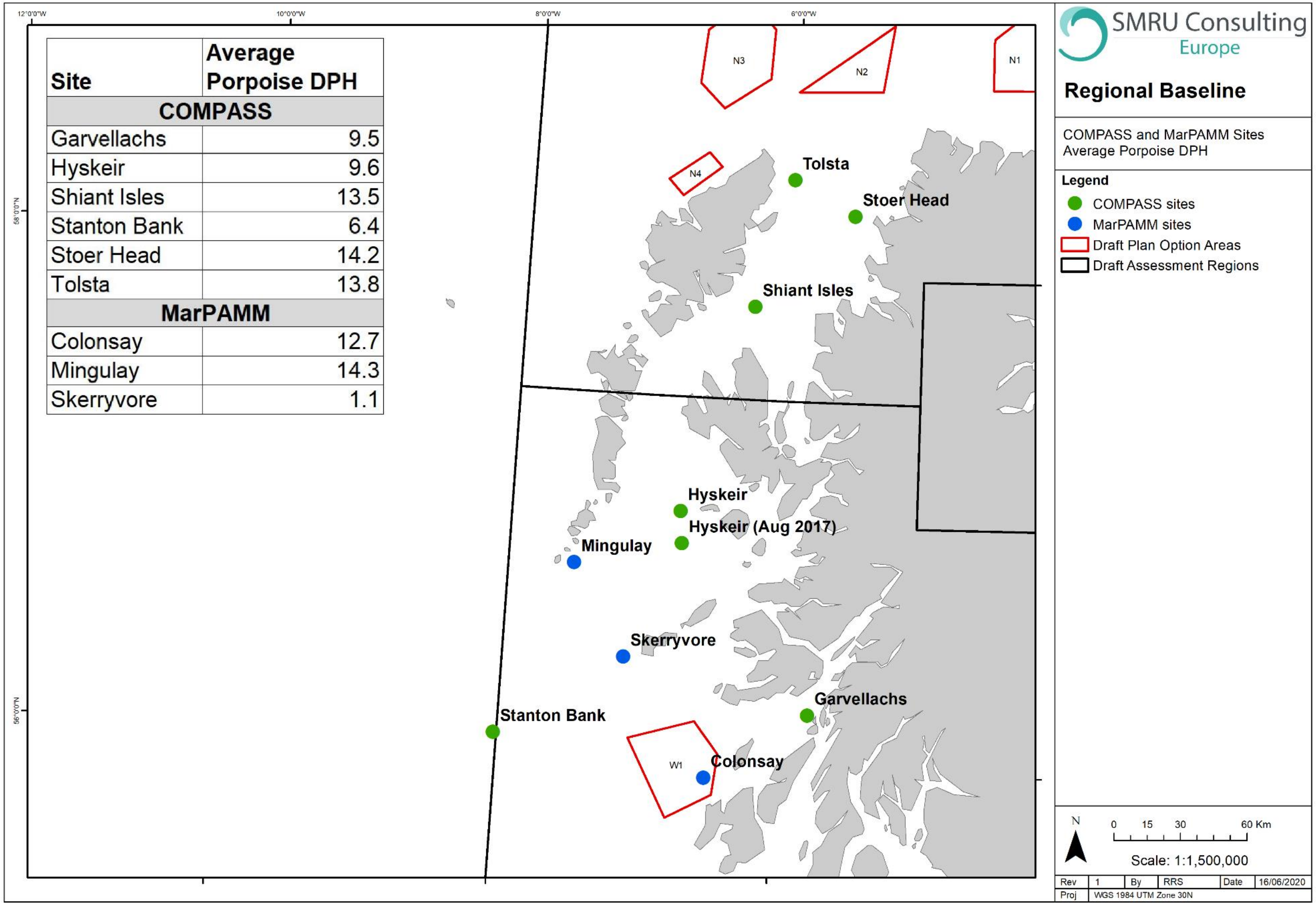


Figure 42: ECOMMAS acoustic monitoring sites along the east coast of Scotland.



Site	Average Porpoise DPH
COMPASS	
Garvellachs	9.5
Hyskeir	9.6
Shiant Isles	13.5
Stanton Bank	6.4
Stoer Head	14.2
Tolsta	13.8
MarPAMM	
Colonsay	12.7
Mingulay	14.3
Skerryvore	1.1

Figure 43: COMPASS and MarPAMM acoustic monitoring sites along the west coast of Scotland, including table (inset) demonstrating average porpoise detections per hour for each site.

Booth et al. (2013) analysed both vessel and acoustic data collected by HWDT, and found that within the Hebrides, harbour porpoise were more commonly detected in regions close to shore, in water between 50-150 m deep, and between 1-20 km from land, showing a strong inshore distribution (Figure 44). The predicted density maps are proximal to the north and western region DPOs sites, though there is little coverage within the actual sites.

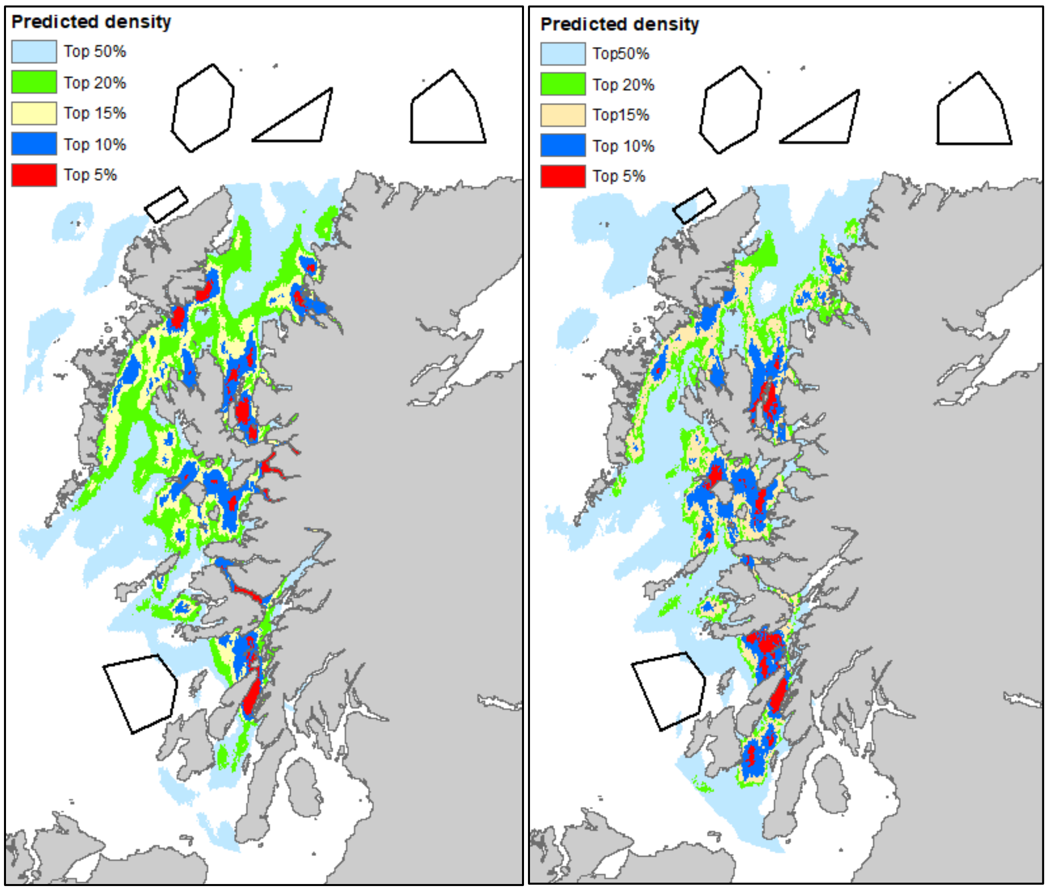


Figure 44: Areas of predicted high density of harbour porpoise, based on visual data (left) and acoustic data (right) (Booth et al. 2013). Overlaid for reference are the regional and DPO areas.

Analysis of sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010 found harbour porpoise seemed to prefer shelf waters, and were widespread throughout the North Sea, into the Moray Firth and observed in lower numbers towards the shelf edge and around Shetland and west of Scotland. Similar to the shift observed between SCANS surveys (Hammond et al. 2017), a shift in harbour porpoise distribution over time was observed, with more harbour porpoise recorded in the southern North Sea, and fewer in the northern North Sea between 2006 and 2010 compared to previous years (Table 7) (Stone 2015). For the Outer Moray Firth, sightings rates of harbour porpoise per 1,000 hours survey effort increased from 0.00 between 1996-2000, to 7.57 between 2001-2005 and then decreased to 6.71 between 2006-2010 (Table 7) (Stone 2015). In terms of the DPOs regions, harbour porpoise were recorded in all regions but in highest numbers in the North East region (Figure 45). Sightings overlapped DPO sites NE2, NE3, NE4, NE5, NE6, NE7, NE8, E1 and E2.

Table 7

Sightings rates of harbour porpoise per 1,000 hours survey effort by marine mammal observers (Table reproduced using data from Stone (2015))

Area	1996-2000	2001-2005	2006-2010
Northern North Sea	5.77	5.09	2.55
Outer Moray Firth	0.00	7.57	6.71
Central North Sea	1.69	6.01	4.54
Southern North Sea	0.00	1.83	28.56

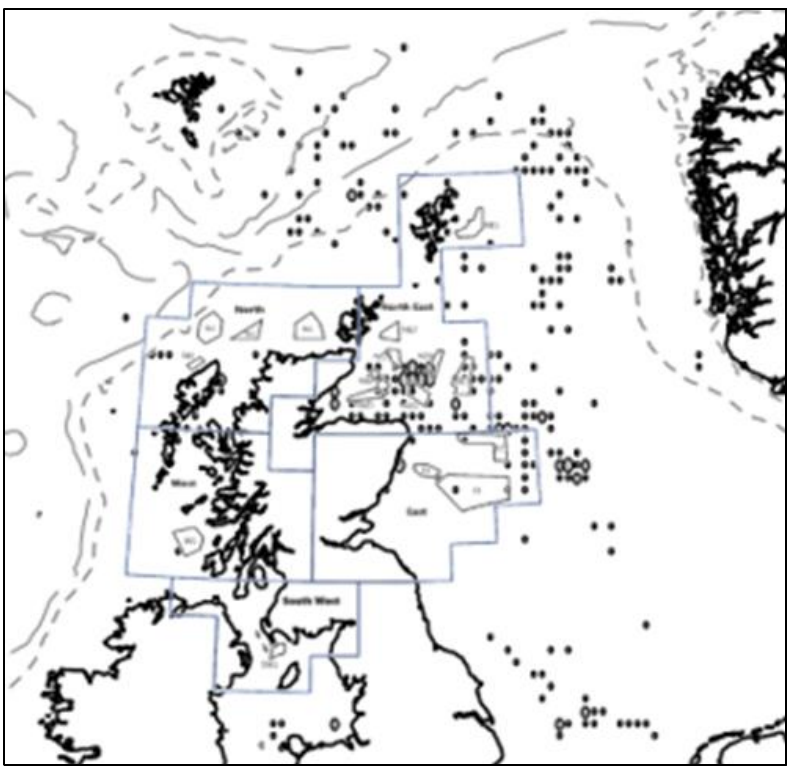


Figure 45: Harbour porpoise encountered during seismic surveys (black and grey ovals), 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000m isobath. Overlaid are the approximate locations of the DPO areas and regions.

Dedicated vessel-based marine mammal watches by MARINElife and ORCA also reported numerous harbour porpoise sightings along their regular survey routes (Figure 46, Figure 47). Between 2016 and 2019 ORCA recorded numerous harbour porpoise sightings along all their designated survey routes, which fall within all the DPO regions, although none of the sightings overlapped with any of the DPO site boundaries (Figure 46). Between 2008 and 2019, MARINElife also reported a high number of harbour porpoise sightings, particularly in the South West DPO region, with many sightings within the SW1 site boundary.

During land-based Shorewatches, WDC observed harbour porpoise in various locations around the Scottish coastline (Figure 48). The coastal nature of this effort means no sightings overlap the DPOs areas, however, these sightings could be useful when determining cable landfall sites.

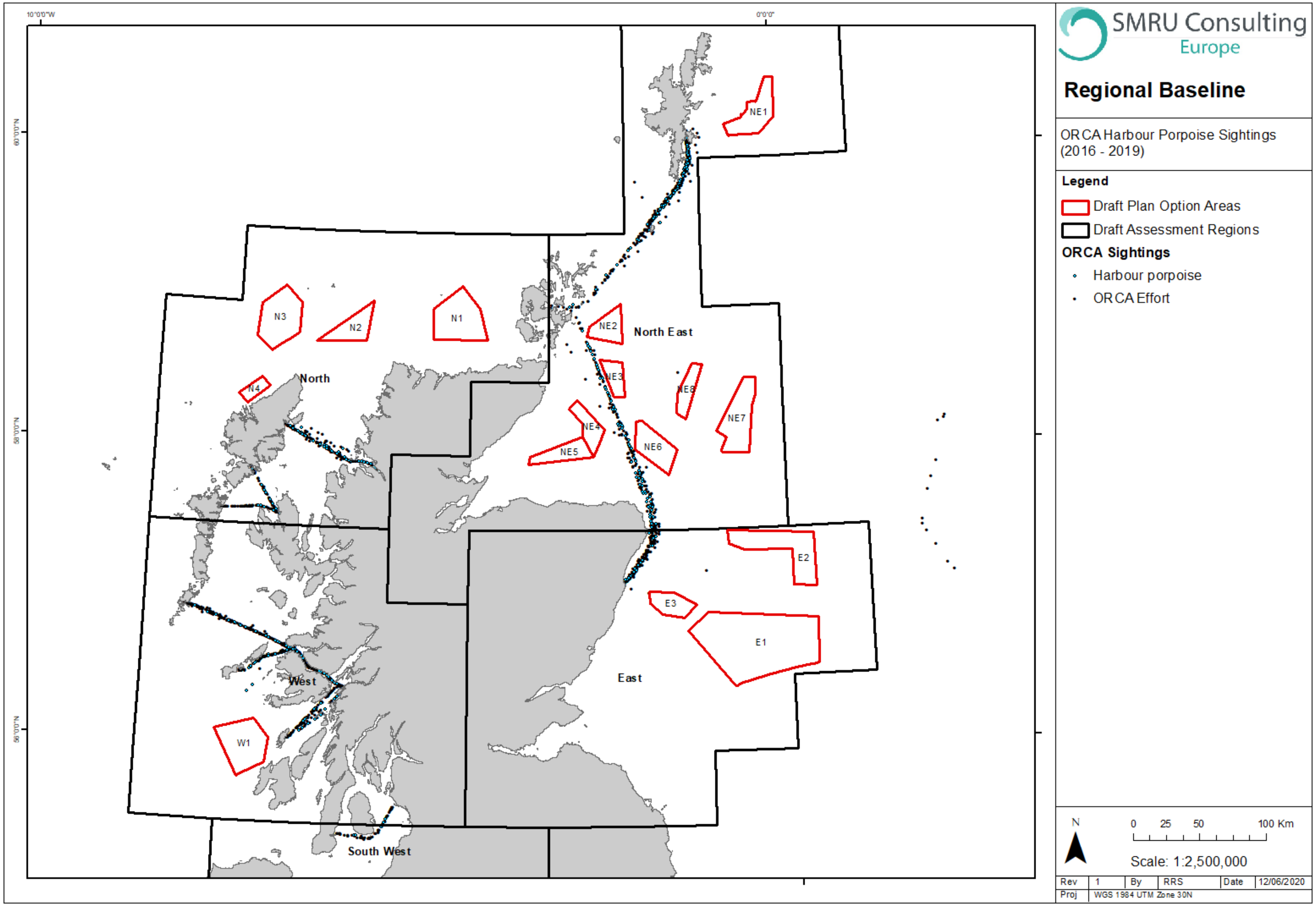


Figure 46: Harbour porpoise sightings (blue dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

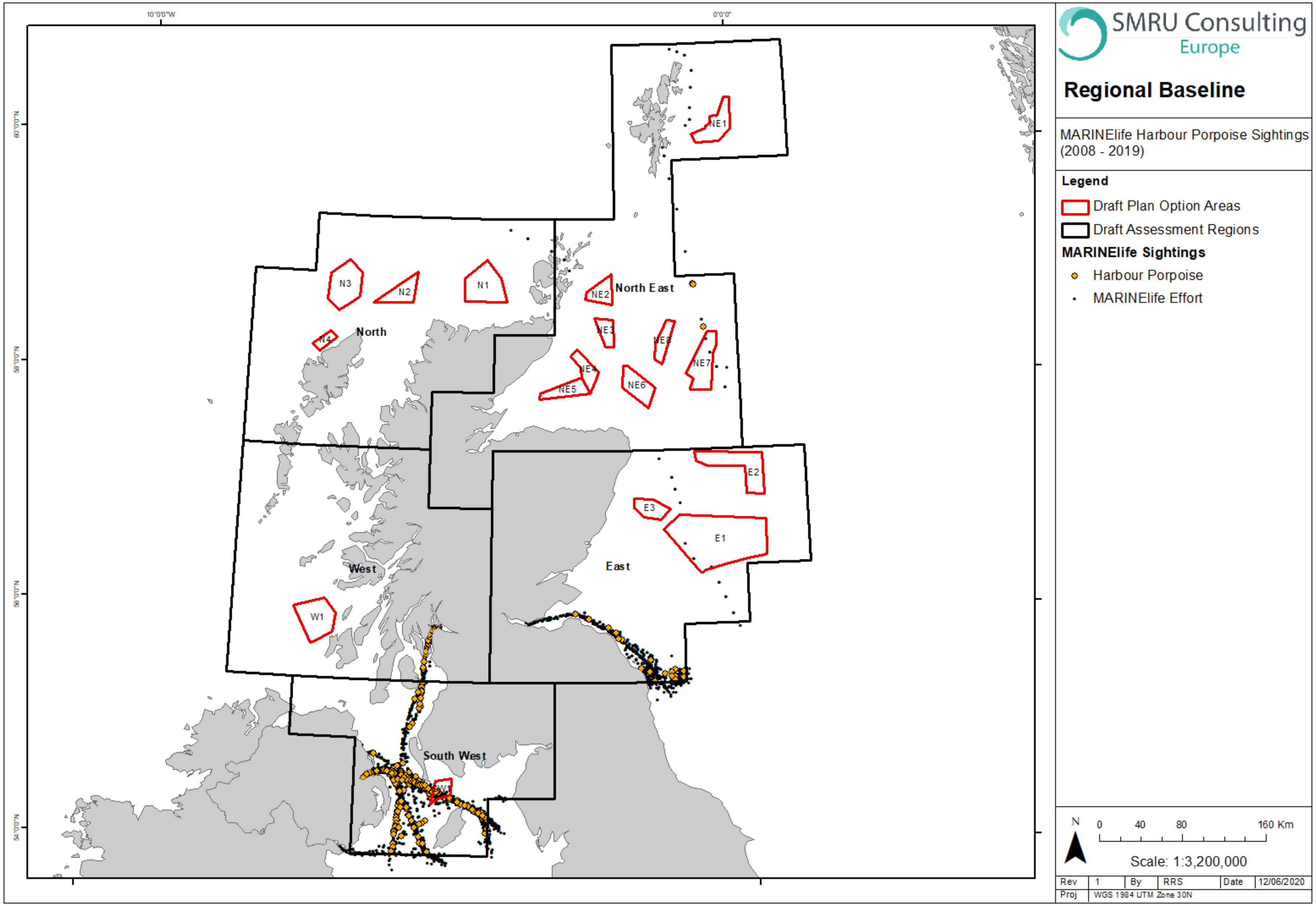


Figure 47: Harbour porpoise sightings (orange dots) recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

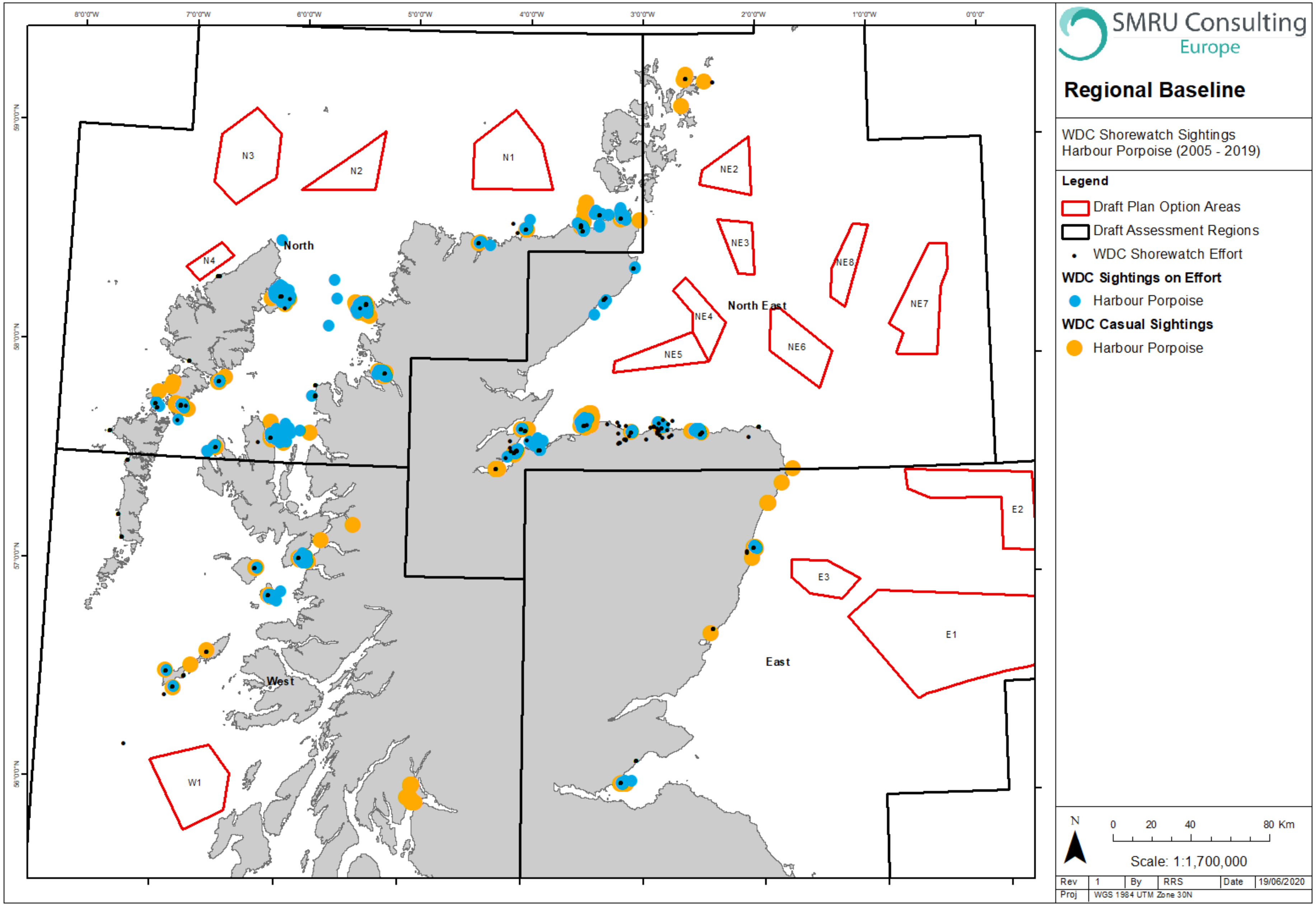


Figure 48: Sightings of harbour porpoise recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

Extensive survey effort conducted in east Scotland for the Forth and Tay offshore windfarms (Seagreen, Neart na Gaoithe and Inch Cape) confirmed that harbour porpoise are present in the Forth and Tay area (Sparling et al. 2011, Grellier and Lacey 2012, Inch Cape 2012, Neart na Gaoithe 2012, Sparling 2012, Inch Cape Offshore Limited 2018, Neart na Gaoithe 2018). Harbour porpoise were the most frequently sighted cetacean species in the Forth and Tay area, and were sighted throughout the survey areas (e.g. Figure 49 and Figure 50). Harbour porpoise were sighted year-round (Grellier and Lacey 2012, Sparling 2012), though the Neart na Gaoithe site specific surveys recorded fewer sightings in the summer months between May and July (Neart na Gaoithe 2018).

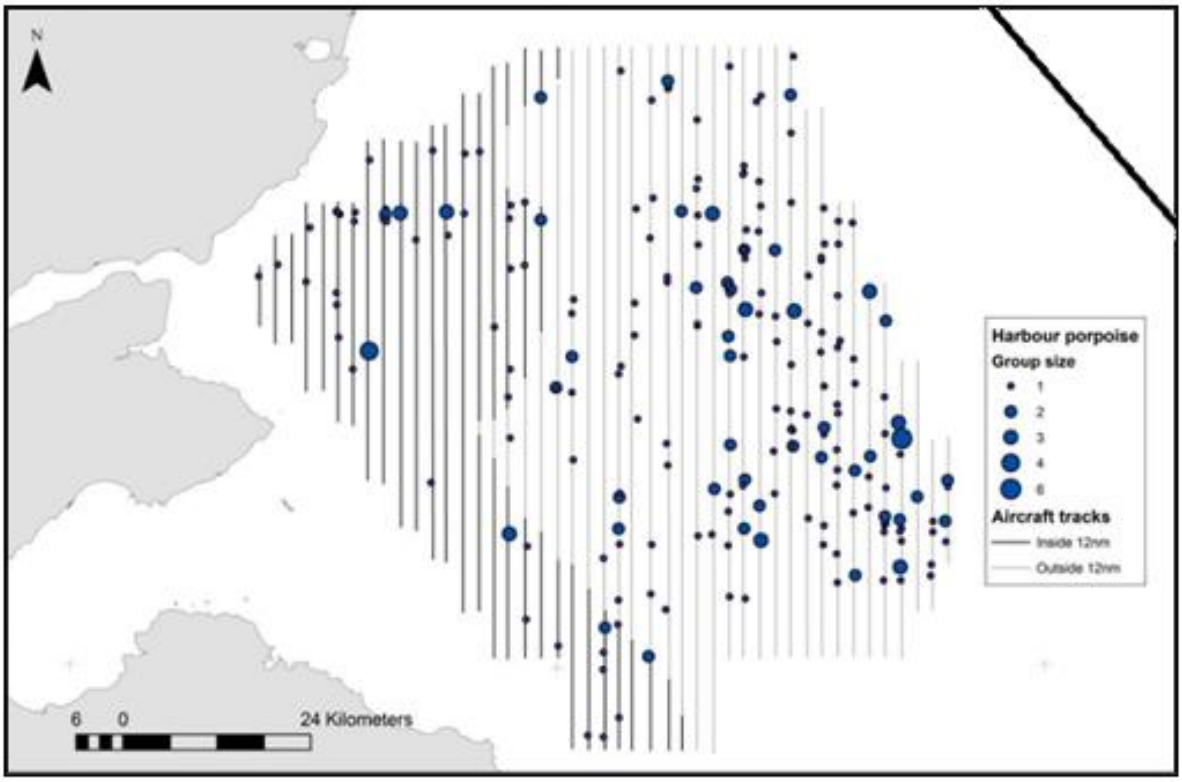


Figure 49: Harbour porpoise sighted during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPO sites are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

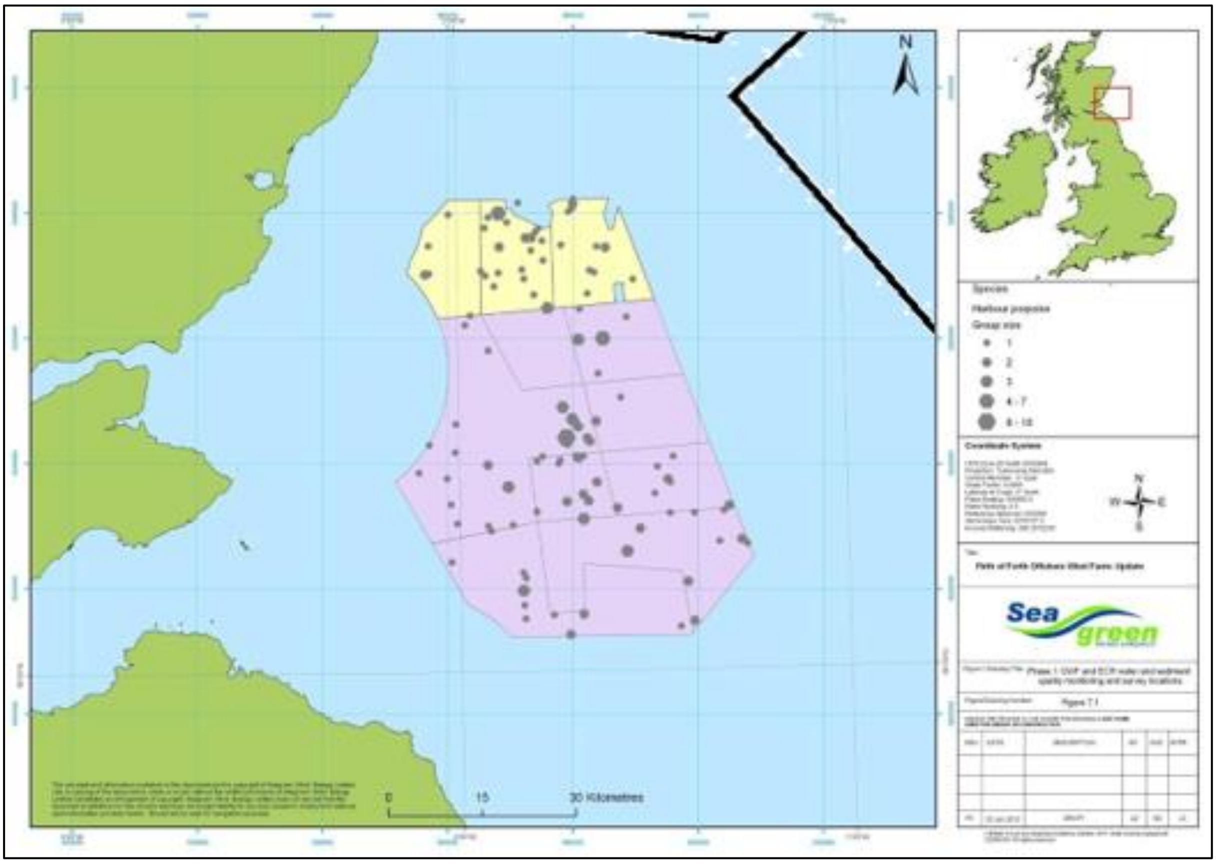


Figure 50: Harbour porpoise sightings from the Firth of Forth Round 3 Zone vessel surveys May 2010 to November 2011 (Sparling 2012). DPO sites are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

Extensive surveys of the Moray Firth (for seismic work and offshore windfarm projects), has resulted in a large visual and PAM dataset for harbour porpoise in the area. For the Moray East offshore windfarm Environmental Impact Assessment, five of these datasets were combined to model the harbour porpoise distribution across the Moray Firth:

1. Aberdeen University boat surveys in the Beatrice Demonstrator site (2004 and 2005).
2. Aberdeen University boat surveys in the Outer Moray Firth (2009).
3. Aberdeen University aerial surveys in the Outer Moray Firth (2010).
4. NPC boat surveys of the Moray East site (Apr 2010 – Mar 2012).
5. International Council for the Exploration of the Sea (ICES) boat surveys of the BOWL site (Apr-Oct 2010).

The harbour porpoise sightings data were modelled using a GAMM to predict the spatial variation in the relative abundance of porpoise across the Moray Firth. The predicted relative abundance was then scaled to obtain absolute abundance estimates and a density surface using the density estimates obtained from the 2010 aerial line transect survey (for full model details see Moray East ES 2012). This resulted in a spatial density surface for harbour porpoise in the Moray Firth (Figure 51), which provides a density estimate for DPO Areas NE3, NE4 and NE5. For example, for site NE5, the density estimate predictor was 3.3-14.19 porpoise per 4x4 km cell.

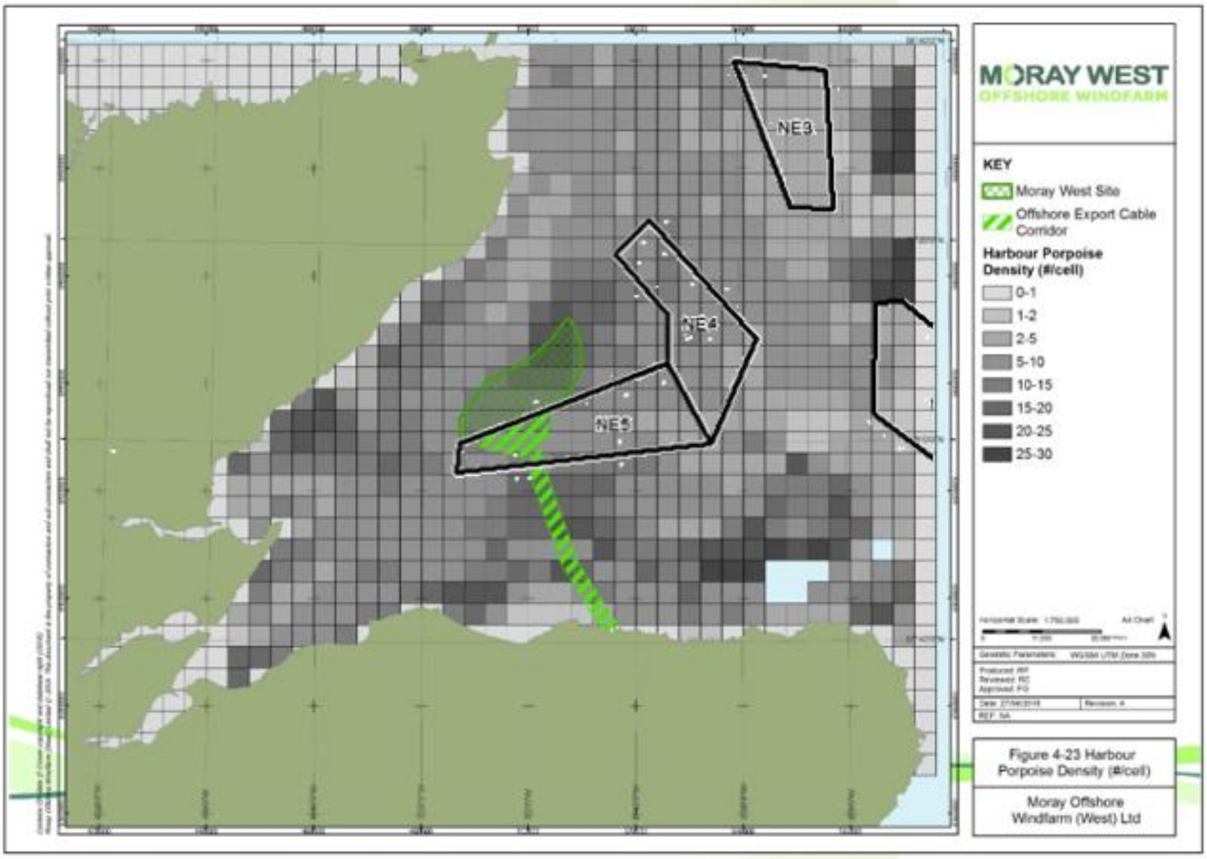


Figure 51: Predicted number of harbour porpoise in the Moray Firth (4x4 km grid cells) (Moray East ES 2012)

More fine scale sightings-only data are also available within the Moray Firth. Whilst conducting bottlenose dolphin photo-ID surveys, the Aberdeen University Lighthouse Field Station recorded a total of 218 harbour porpoise opportunistic encounters between 2002 and 2016, during a total of 241 trips, although none of the sightings (or survey tracks) overlap the DPOs sites within the Moray Firth (Figure 52).

HiDef completed aerial surveys in 2014 along the coastal east coast of Scotland, including the Moray Firth, covering a large proportion of coastal waters of the East and North East DPO regions (Figure 53). Harbour porpoise were sighted relatively frequently, with some sightings overlapping the boundary of DPO sites NE5 and E3.

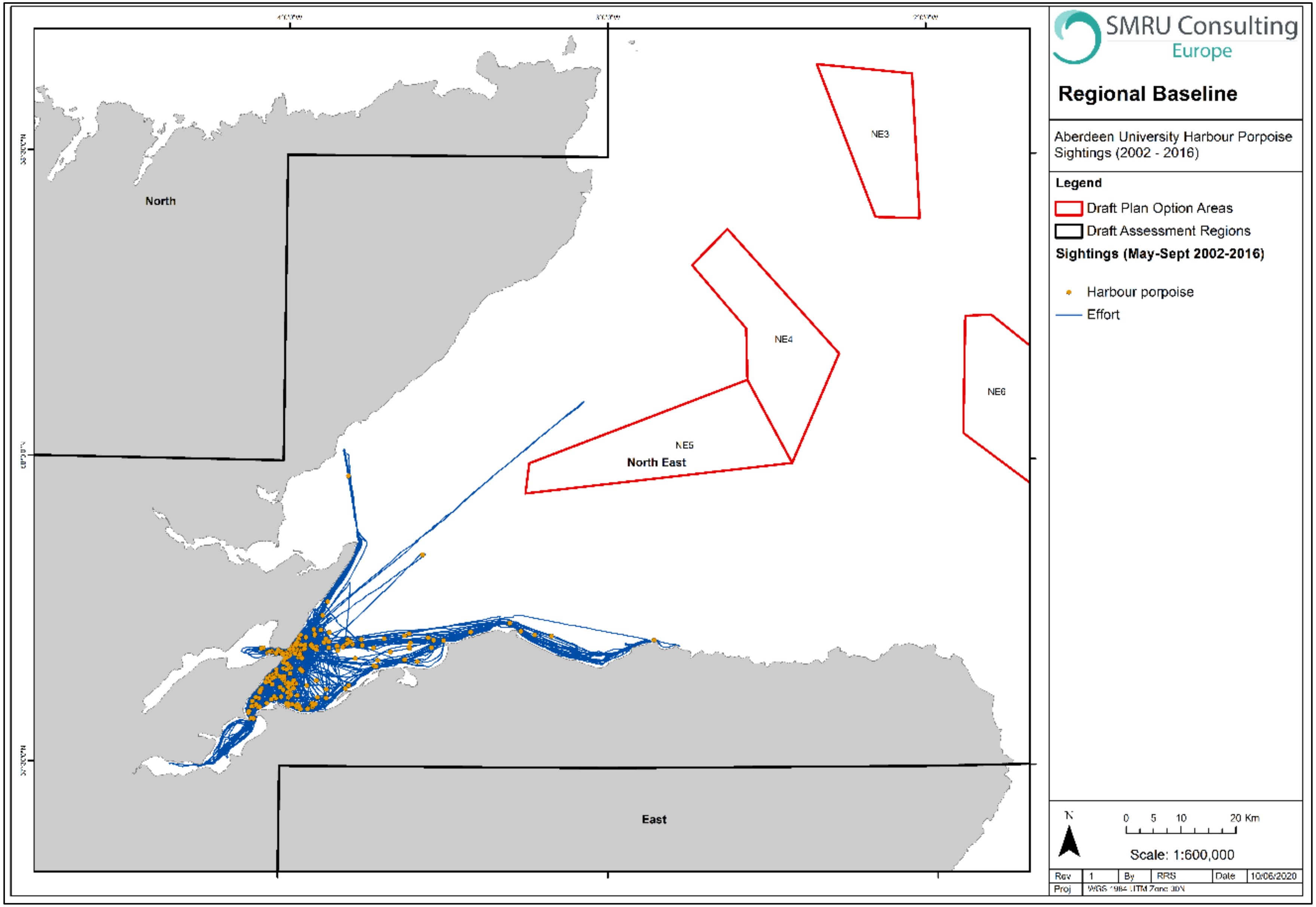


Figure 52: Sightings of harbour porpoise recorded during bottlenose dolphin photo-ID surveys by the Aberdeen University Lighthouse Field Station. Data provided by Barbara Cheney.

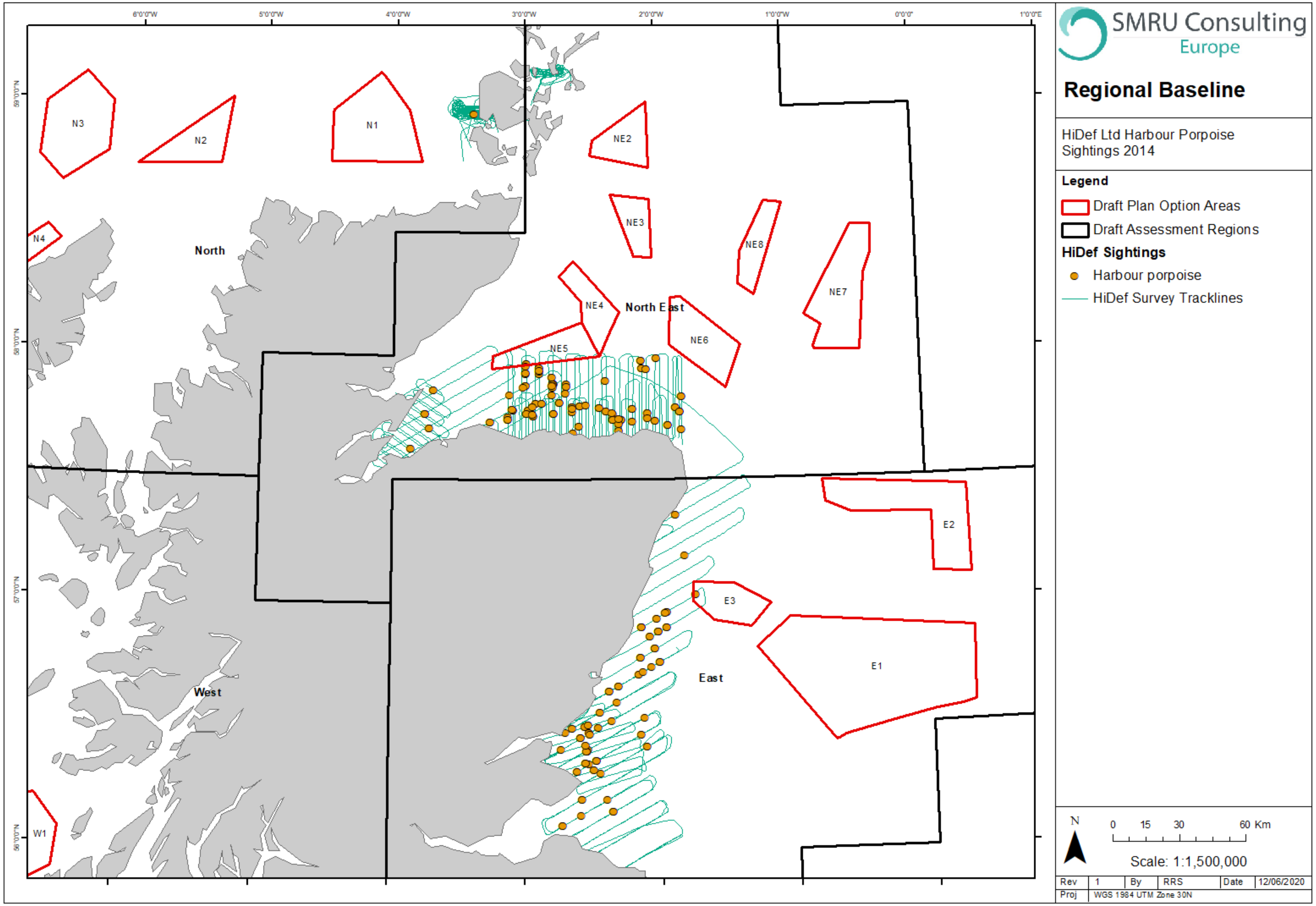


Figure 53: Harbour porpoise sightings recorded during HiDef Ltd aerial surveys carried out in 2014.

Finer scale information on sightings of harbour porpoise in the Pentland Firth and Orkney waters are presented in Evans et al. (2011), and are especially relevant to DPOs sites N1 and NE2. The sightings presented are from a collation of at least 12 sources, including Sea Watch Foundation, ESAS, SCANS I and SCANS II, and the John O'Groats ferry. Most of the records presented are opportunistic without associated effort, and therefore may contain biases, but can be utilised to highlight presence in these areas. Within this study area, Evans et al. (2011) report relatively high densities of porpoises around Orkney and the north Caithness coastline (Figure 54). In the Northern Isles, large groups of harbour porpoise (>30) have been observed moving inshore during autumn and winter months, with some mating behaviour observed (K. Hall, personal communication).

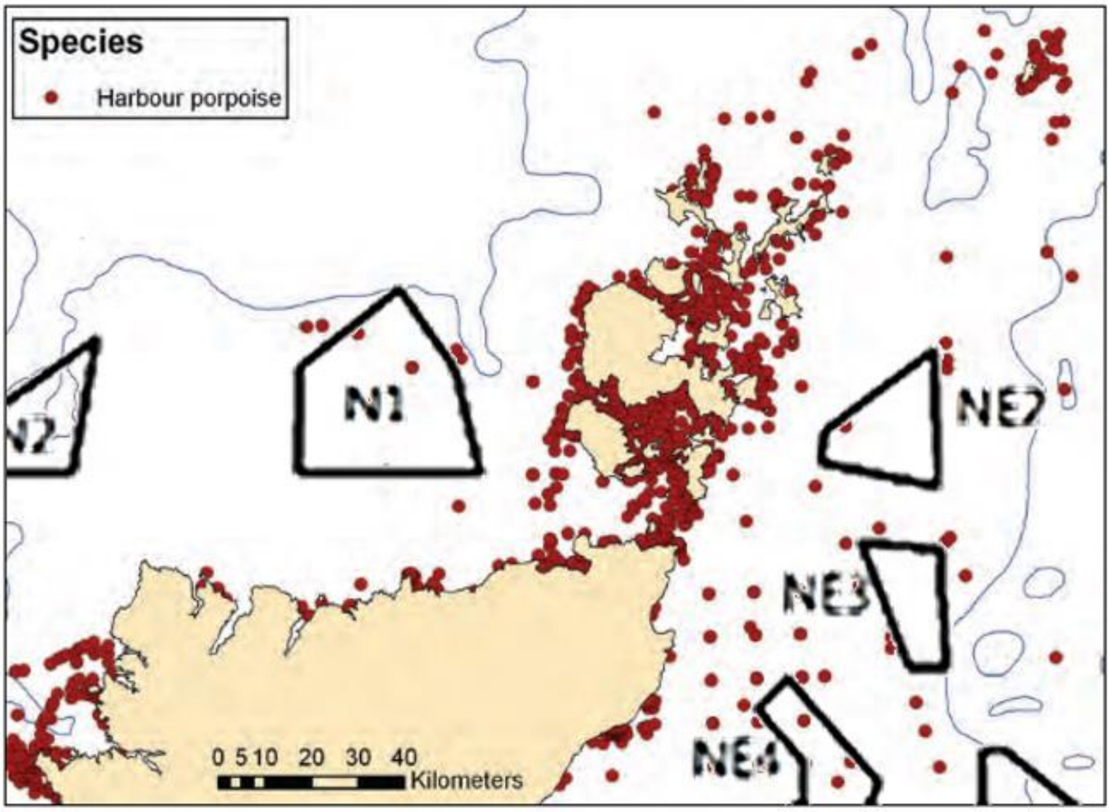


Figure 54: Distribution of sightings of harbour porpoise, around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Survey effort conducted for the EMEC projects have resulted in sightings of harbour porpoise at both the Fall of Warness site and the Billia Croo site in the Orkney islands (Robbins 2012b, a, EMEC 2014b, a). At the Fall of Warness site, harbour porpoise sightings rates differed significantly with time of day, with an increased sightings rate in the late afternoon/evening (Robbins 2012b). At the Billia Croo site, harbour porpoise sightings were highly seasonal, with a peak in sightings rates between May and August (Robbins 2012a).

3.3.4. Bottlenose dolphin

Based on the information presented below, bottlenose dolphins (coastal ecotype) are resident year-round in Scottish waters, but their distribution is primarily limited to coastal waters with little expected overlap with DPO sites. Bottlenose dolphins are resident in the Moray Firth and the Firth and Tay estuaries areas, with a very small resident population in the Barra area. This species is more likely to be important when considering coastal activities related to development such as landfall and vessel activities given their coastal distribution. There is considerably less information available on the offshore ecotype.

The most recent assessment of bottlenose dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that although the population size appears to be stable, there were too few datapoints to confidently conclude on the current and future population trends (JNCC 2019b). It is important to consider that there are two different ecotypes of bottlenose dolphins in Scottish waters: the coastal ecotype and the offshore ecotype. The north coast of Scotland is the most northerly known extent of the coastal bottlenose dolphin ecotype in the Atlantic coasts of Western Europe, and while bottlenose dolphins have been encountered further north and off the shelf edge, they are likely to be the offshore ecotype (Cheney et al. 2013).

The SCANS surveys identified bottlenose dolphins in Scottish waters, however the surveys included both coastal and offshore waters and as such will have included both coastal and offshore ecotypes. Bottlenose dolphins were identified in SCANS III Block G (Northern Ireland and southern Inner Hebrides), Block S (the Moray Firth and Orkney) and Block R (east Scotland) and Block 8 (Atlantic west of Scotland – expected to be the offshore ecotype) (Figure 55). Block-wide uniform density estimates for SCANS III blocks in Scottish waters ranged from 0.000 to 0.121 bottlenose dolphins/km^2 (Figure 55). Bottlenose dolphins were sighted during the SCANS III survey in DPOs site E2 (Figure 56), with a medium density estimate for the East DPO region, and a high density estimate for the West DPO region, including site W1 (Figure 55).

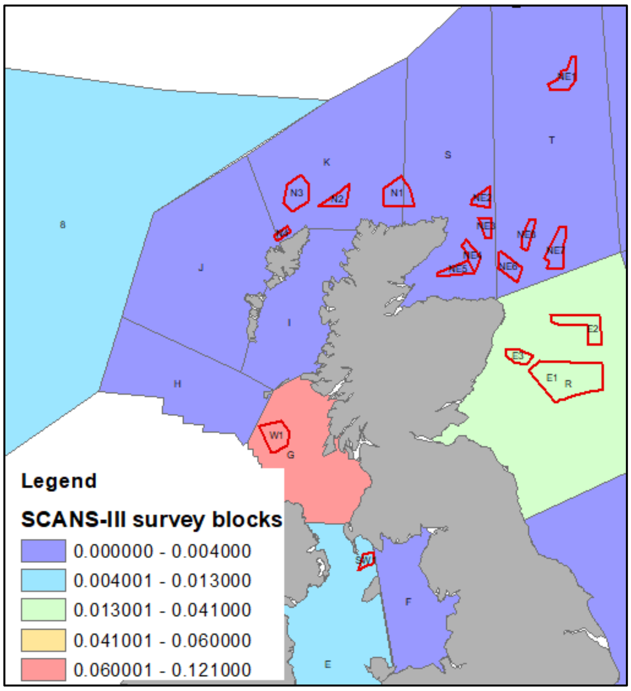


Figure 55: SCANS III block-wide uniform density estimates for bottlenose dolphins in Scottish waters (Hammond et al. 2017). Overlaid for reference are the DPO areas.

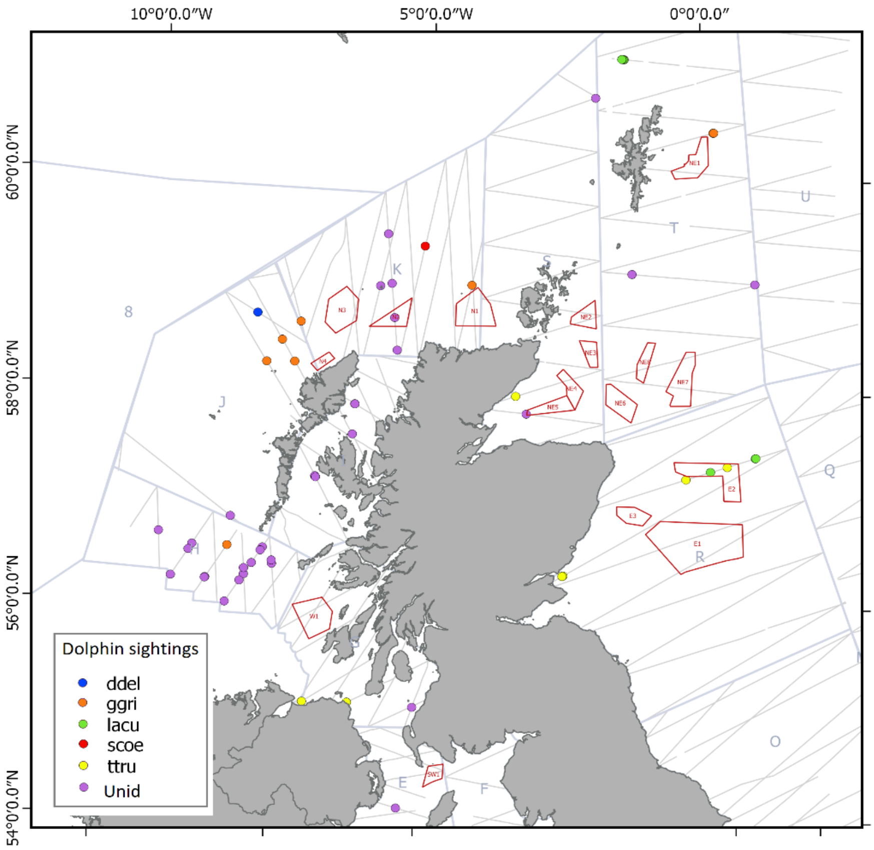


Figure 56: Sightings of dolphin species seen during the SCANS-III survey blocks containing DPO Areas (red). Ddel = Common dolphin (*Delphinus delphis*), ggri= Risso's dolphin (*Grampus griseus*), lacu= white-sided dolphin (Lagenorhynchus acutus), scoe = striped dolphin (*Stenella coeruleoalba*), ttru= bottlenose dolphin (*Tursiops truncatus*). Unid= dolphins not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

Analysis of sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010 showed bottlenose dolphin sightings were evenly split between shelf waters and deeper waters over the shelf edge and beyond (Stone 2015). In terms of the DPOs regions, bottlenose dolphins were recorded in all regions, with sightings overlapping DPO site NE7 (Figure 57).

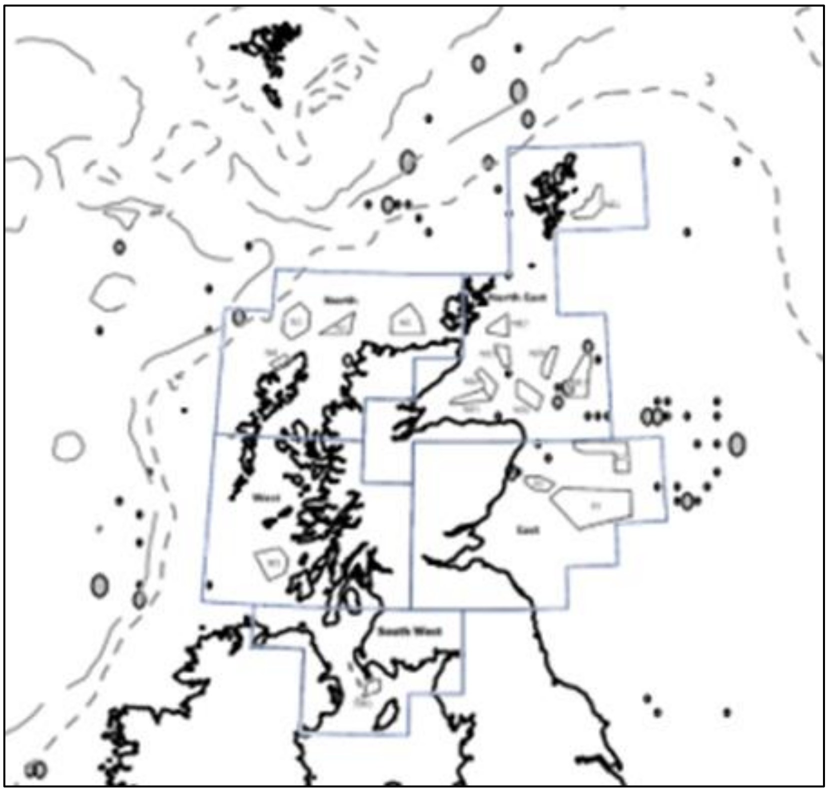


Figure 57: Bottlenose dolphins encountered during seismic surveys (black and grey ovals), 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Overlaid are the approximate locations of the DPO areas and regions for reference.

The Atlas of Cetacean Distribution, presented by Reid et al. (2003) on behalf of JNCC, includes cetacean sightings data between 1979 and 1997 from three main sources: European Seabirds at Sea database (ESAS), Sea Watch Foundation and SCANS. In Scottish waters, sightings were concentrated mostly within the Moray Firth, though there were also sightings distributed further offshore off the north west coast of Scotland, between Scotland and the Faroe Islands along the Wyville Thompson Ridge and Ymir Ridge, which likely represent the coastal ecotype (Figure 58).

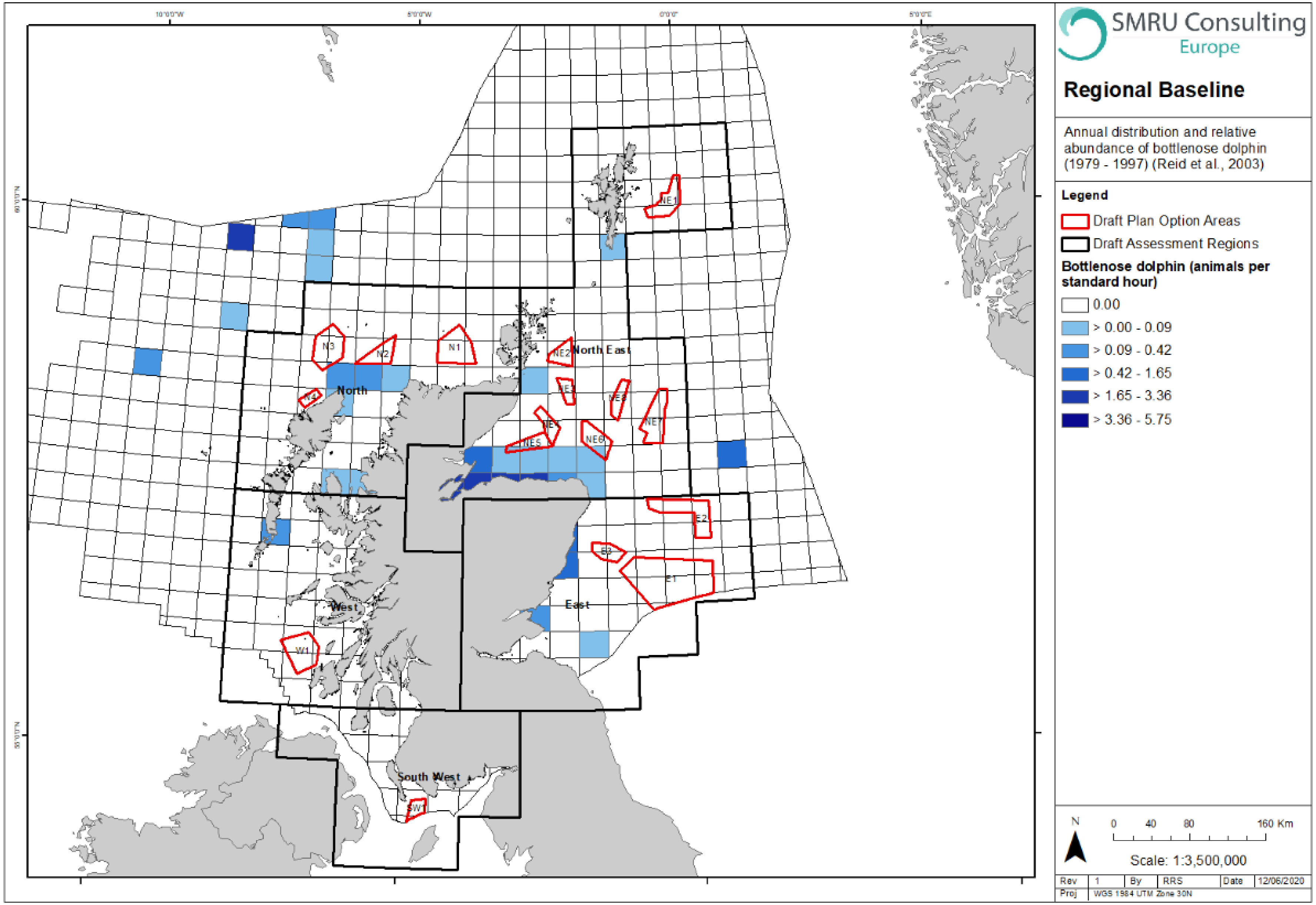


Figure 58: Aggregated annual distribution and relative abundance of bottlenose dolphins (1979-1997) based on data presented in Reid et al. (2003).

The Cetaceans of the Atlantic Frontier report covers SAST and ESAS data collected from chartered vessels, ferries and other vessels of opportunity, mainly covering deeper waters (i.e. >2,300 m) off north and west Scotland between 1979 and July 1998 (Pollock et al. 2000, Weir et al. 2001). Bottlenose dolphins were generally uncommon, with coastal sightings in depths <150 m more frequent. Bottlenose dolphins were also recorded along the Atlantic Frontier shelf edge, close to the 1,000 m isobath between September and November, along the Wyville Thomson and Ymir Ridges, again with this likely being the offshore ecotype (Figure 59) (Pollock et al. 2000). These data were also used in a later overview, ‘The Atlas of Cetacean Distribution’ presented by Reid et al. (2003) on behalf of JNCC, hence why Figure 58 and Figure 59 are similar.

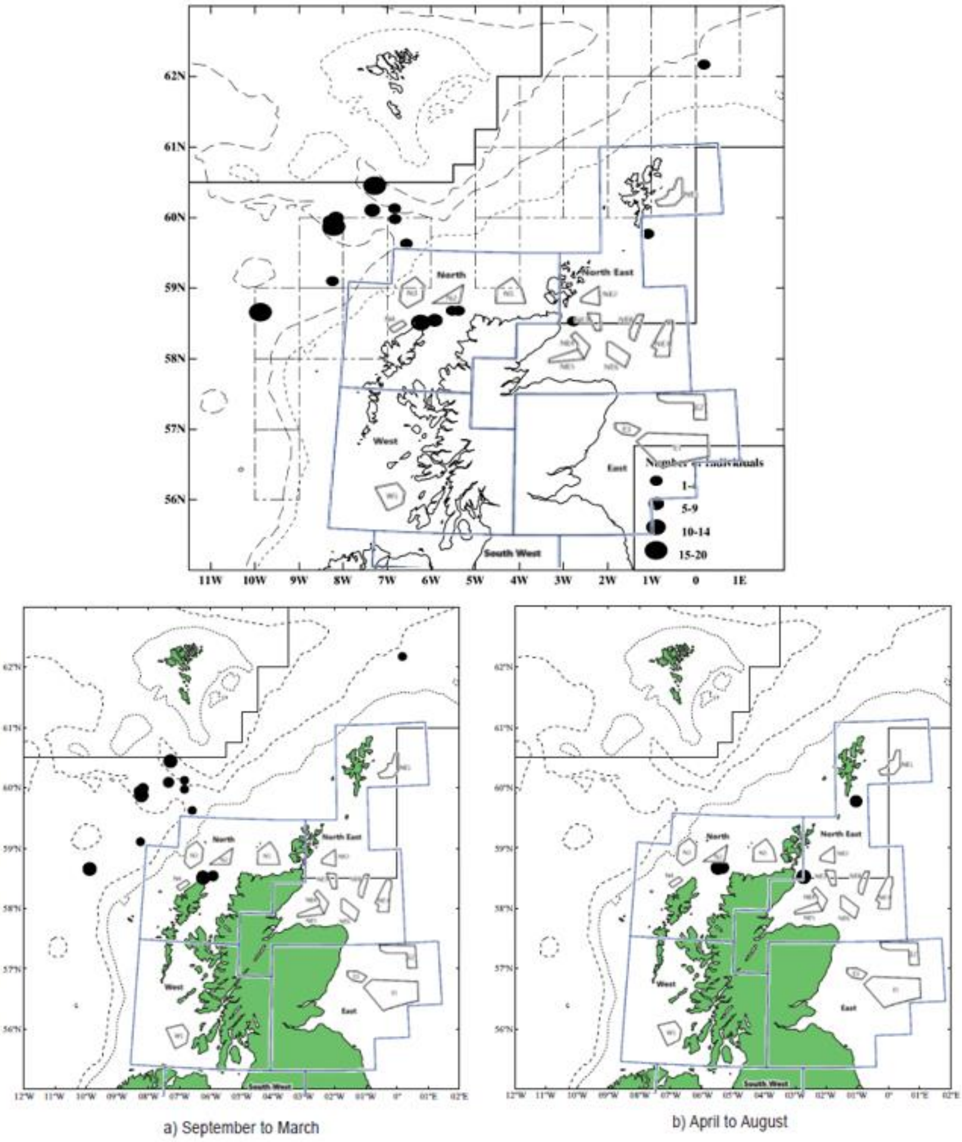


Figure 59: Above: Distribution of bottlenose dolphin sightings (1979-1998) presented in the Cetaceans of the Atlantic Frontier. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001). Below: Distribution of bottlenose dolphin sightings between (left) September and March, and (right) April and August (1979-1999). (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

The Scottish Marine Atlas describes bottlenose dolphin habitat as open coast, sea lochs, firths and offshore. The Atlas then describes the distribution of bottlenose dolphins as a resident population of around 111 known individuals from the Moray Firth and adjacent coastal waters, with sightings records also around the Inner and Outer Hebrides (Baxter et al. 2011). Mapped encounter rates show higher encounter rates in the Moray Firth and further offshore of north west Scotland, with slight overlaps of high encounter rates with the most southerly Moray Firth DPOs sites (Figure 60).

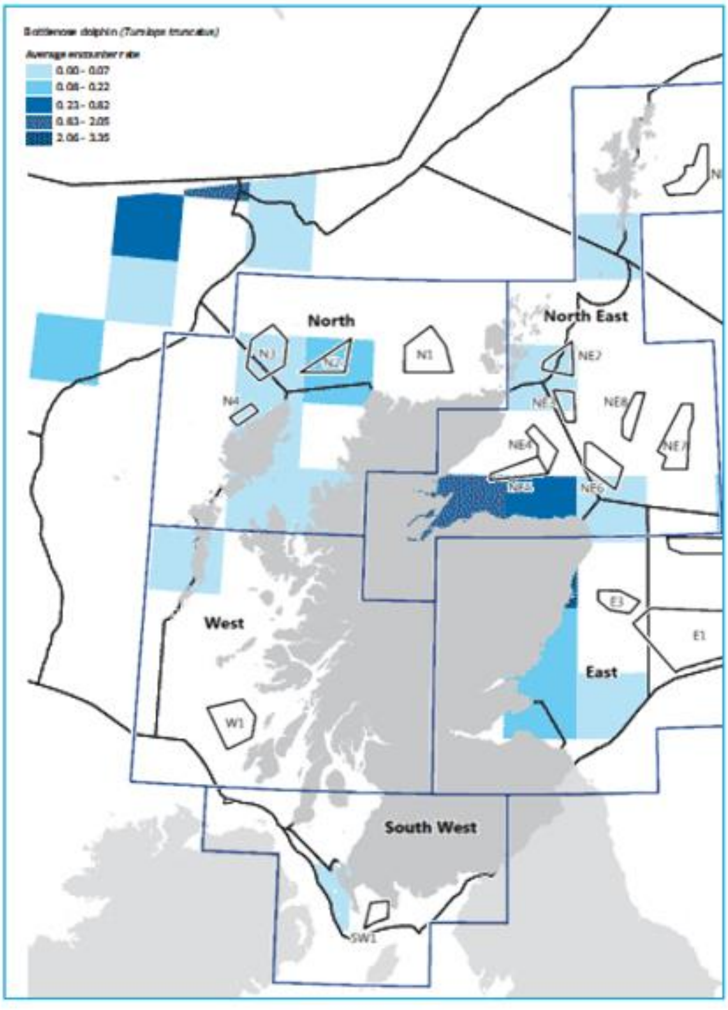


Figure 60: Bottlenose dolphin average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Our current state of knowledge on the abundance and distribution of bottlenose dolphins is currently much more advanced for the coastal ecotype than the offshore ecotype, with dedicated studies focusing on the coastal population(s).

3.3.4.1. Coastal bottlenose dolphin ecotype

The majority of bottlenose dolphins sightings are concentrated on the east and west coasts, though records are rare prior to the 1990s (Cheney et al. 2013). The Moray Firth has the only dedicated Special Area of Conservation (SAC) for bottlenose dolphins in Scottish waters, encompassing the waters west of a line drawn from Helmsdale on the northern coast to Lossiemouth on the south coast (Figure 2) and was designated in 2005 under the European Habitats Directive (92/42/EEC). Analysis of photo-identification data taken within coastal Scottish waters suggests a population along the east coast of around 195 individuals (Cheney et al. 2013). This population are highly mobile and usually range from the Moray Firth, including within the SAC, to Berwick-upon Tweed, though sightings of individuals from this population have been recorded in the Netherlands[13], along the eastern English coastline[14] and the Republic of Ireland (Robinson et al. 2012). There are also two discrete populations of bottlenose in the Hebrides, with around 45 individuals in total, and sightings mainly around Skye and the Northern Hebrides (Cheney et al. 2013).

Moray Firth

Bottlenose dolphin photo-identification surveys have been conducted within the Moray Firth SAC since 1989 by the University of Aberdeen Lighthouse Field Station (AULFS) (Cheney et al. 2012, Cheney et al. 2014, Cheney et al. 2018). Effort and sightings data for the surveys are presented within SNH Site Condition Monitoring Reports, e.g. Cheney et al. (2018). For the purposes of this report, we present sightings and effort data from 2002 to 2016, where there were a total of 1,527 bottlenose dolphin encounters recorded during a total of 241 trips (Figure 62). None of these surveys covered the DPOs sites within the Moray Firth, with encounters tending to be very coastal, and within the Inner Moray Firth.

[13] https://www.bbc.co.uk/news/uk-scotland-highlands-islands-49128866
[14] https://www.belfasttelegraph.co.uk/news/viral/dolphins-spotted-off-east-yorkshire-coast-37983649.html

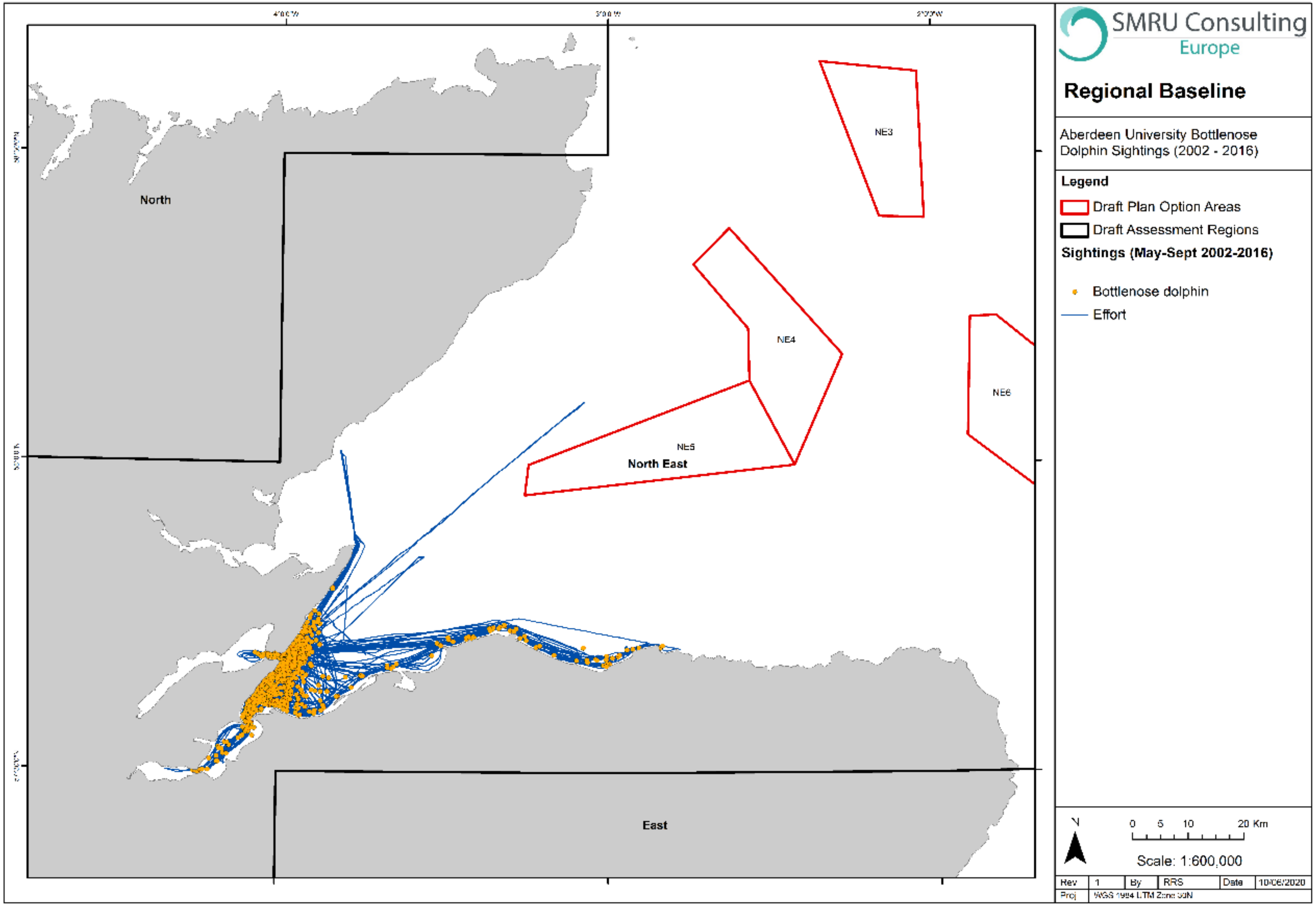


Figure 61: Bottlenose dolphin encounter locations during photo-identification surveys conducted by Aberdeen University Lighthouse Field Station 2002-2016. Data provided by Barbara Cheney.

Extensive surveys of the Moray Firth (for seismic work and offshore windfarm projects), has resulted in a large visual and PAM dataset for bottlenose dolphins in the area. PAM data were collected using C-PODs, which are static hydrophones that passively monitor acoustics in the water, and are fully automated to detect odontocete echolocation clicks. Using a combination of the visual and acoustic data, Thompson et al. (2014) estimated the predicted probability of bottlenose dolphin occurrence within the Moray Firth (Figure 63). This was further adapted as part of the Moray West EIA (Moray Offshore Windfarm (West) Limited 2018). The analysis of the ECOMMAS C-POD data by Palmer et al. (2017) highlighted that the predicted probability of dolphin occurrence presented in Thompson et al. (2014) was likely to have overestimated the probability of bottlenose dolphin occurrence along the northern coast of the Moray Firth. Therefore, the density surface was adjusted to provide a more realistic density surface for bottlenose dolphins in the Moray Firth. This was done by re-distributing the dolphins in the grid cells located along the coast north of, and surrounding, Helmsdale and Latheron to other grid cells within the Moray Firth, based on the proportion of the total each cell contained (Figure 64). In terms of the DPO sites, the predictions made by Thompson et al. (2014) estimate a very low probability of dolphin occurrence within the Inner Moray Firth sites (Figure 63). Even following the updated version in light of analysis by Palmer et al. (2017), bottlenose dolphin occurrence is still predicted to be low in the Inner Moray Firth DPO sites (Figure 64).

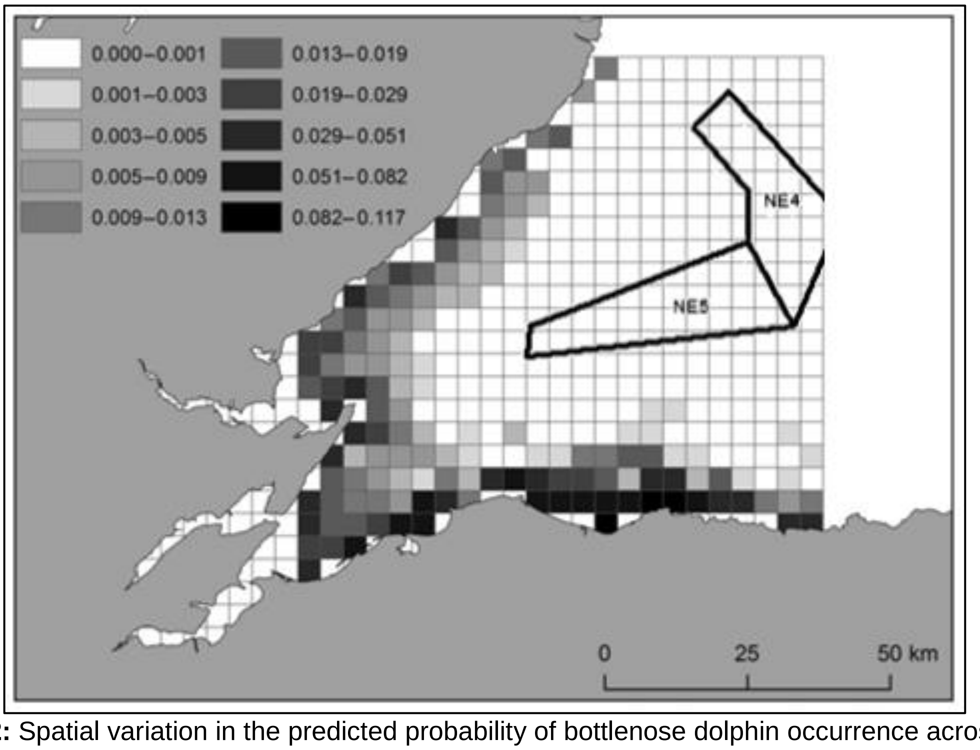


Figure 62: Spatial variation in the predicted probability of bottlenose dolphin occurrence across the Moray Firth. Predictions for each cell are based on the outputs from both the GEE and the classification tree analyses, and represent the probability of bottlenose dolphins occurring in that cell in any given hour (Thompson et al. 2014). Approximate DPO sites are Overlaid for reference.

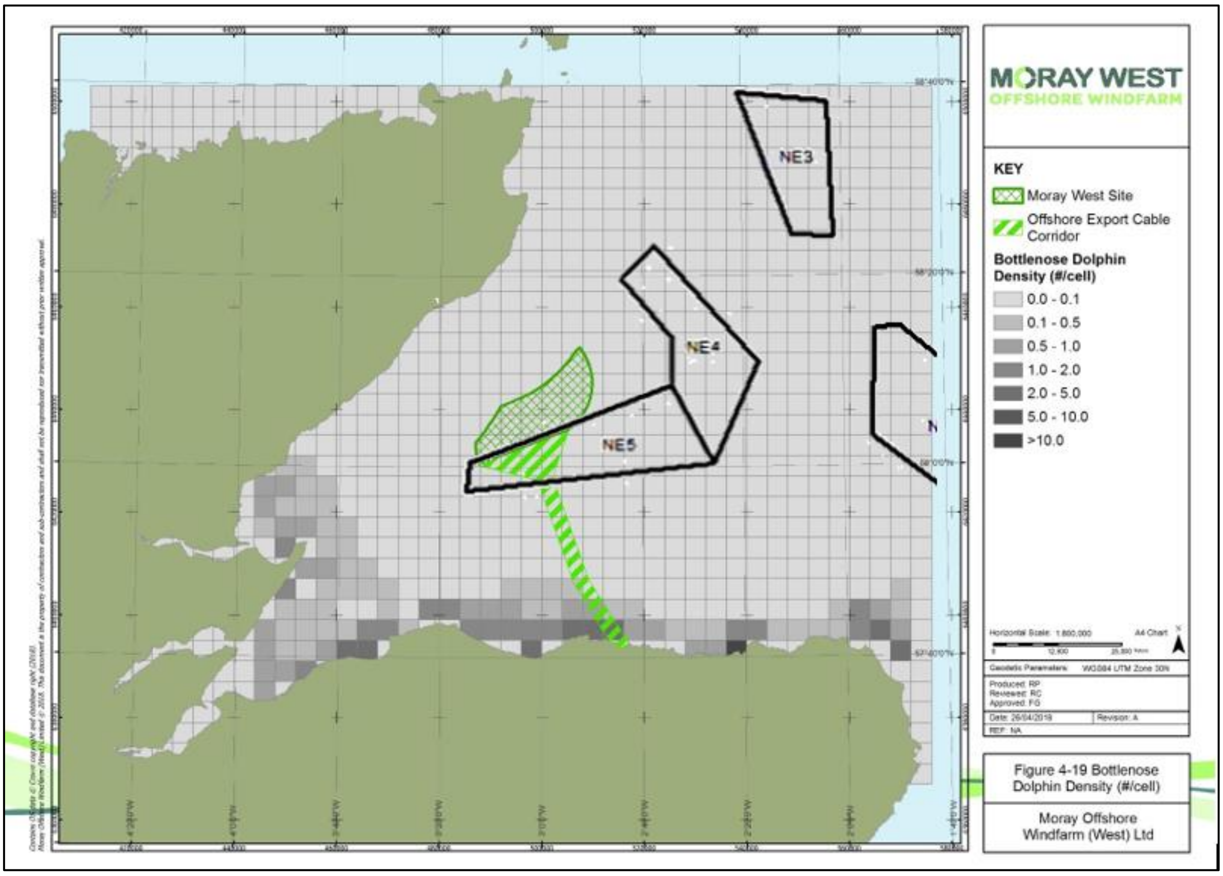


Figure 63: Spatial variation in bottlenose dolphin occurrence in the Moray Firth (Moray Offshore Windfarm (West) Limited 2018). Edited from Thompson et al. (2014) in light of ECOMMAS data presented in Palmer et al., 2017. Overlaid for reference are the approximate regional and DPO areas.

Tay Estuary and St Andrews Bay area

The SAC population of bottlenose dolphins also regularly use the Tay Estuary and St Andrews Bay area, which is 300 km south of the SAC. Therefore, photo-identification surveys have also been conducted by the Sea Mammal Research Unit in this area regularly since 2009, with surveys carried out between May and September (Figure 65). On average, 52.5% of the SAC population use this area (Arso Civil et al. 2019). Dolphins were frequently encountered within 2 km of the coastline, in waters usually less than 20 m deep (Quick et al. 2014). Bottlenose dolphins are also a reasonably regularly sighted cetacean in the Firth of Forth, especially during the summer months, as documented on the citizen science Facebook page the ‘Forth Marine Mammal Project’[15]. The same can be said during the summer months for Berwick-upon-Tweed and the surrounding coastline, as documented on the citizen science Facebook page ‘Berwick Dolphin Watch’[16].

[15] https://www.facebook.com/groups/377706222613082/
[16] https://www.facebook.com/groups/BDW18/

Neither the Tay, St Andrews Bay nor the Firth of Forth overlap with any DPO sites, however bottlenose dolphin use of this area may be important when considering cable landfall sites.

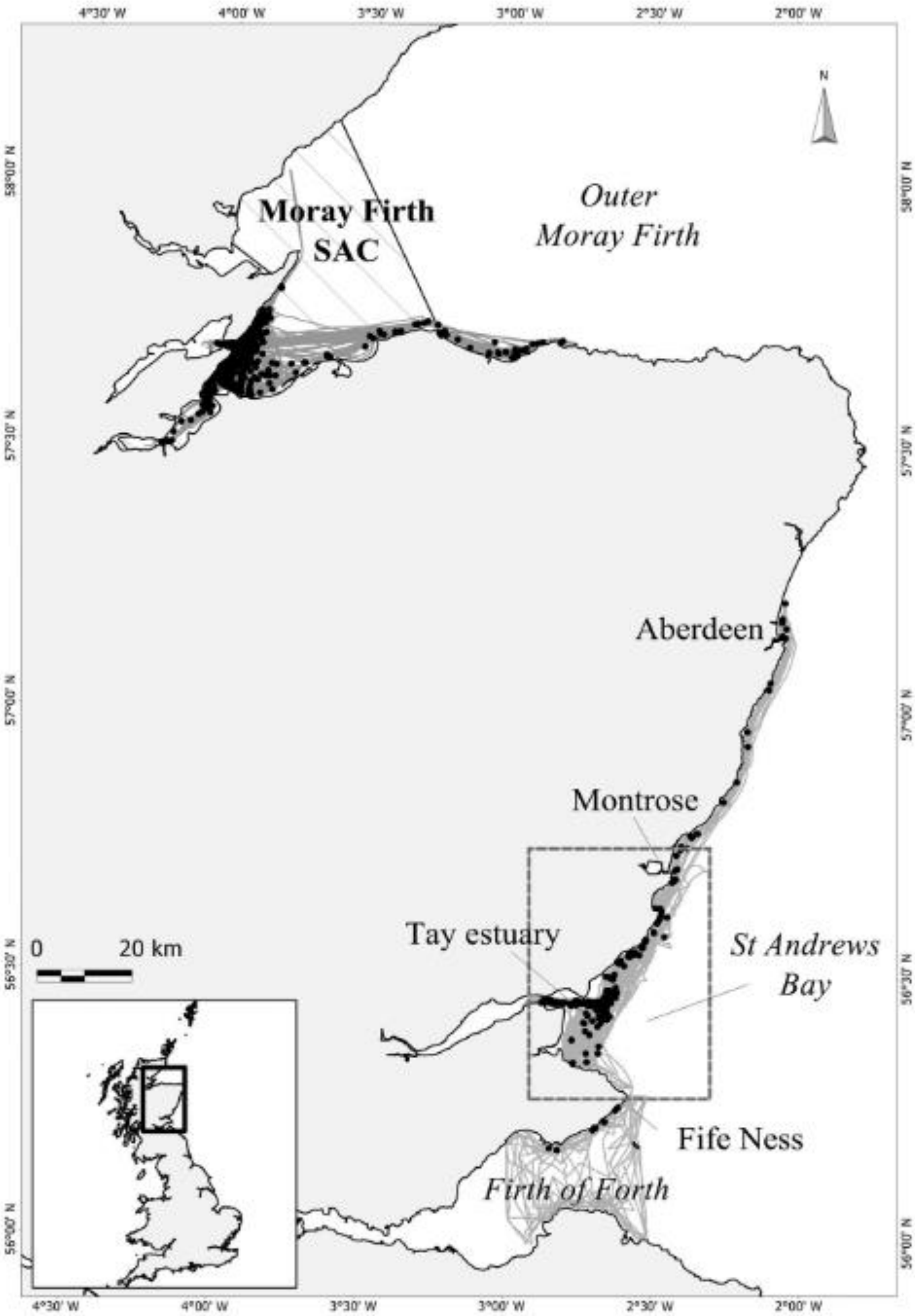


Figure 64: Overall sampling area along the east coast of Scotland between the Moray Firth and the Firth of Forth, covering the current population's main distributional range, including the subareas of St Andrews Bay and the Tay estuary (dashed box), and the Moray Firth Special Area of Conservation (SAC). Survey effort conducted from 2009 to 2015 is shown (grey lines) with locations of bottlenose dolphin encounters (black dots) (Arso Civil et al. 2019).

Dolphin acoustic detection rates were low across all ECOMMAS PAM monitoring sites, which are moored along the east coast of Scotland traversing both the North East and East DPO region (Figure 67). The highest recorded ‘dolphin species’ Detection Positive Hours per day (DPH) were at the Cromarty site, where dolphins were detected on average 3.1 hours per day across 2013-2019. Given the data presented in Quick et al. (2014) it is highly likely that only the recording stations closest to the shore in each location were regularly detecting bottlenose dolphins, and that other ECOMMAS sites were detecting other dolphin species. The data recorded by the C-PODs can be analysed to separate the C-POD ‘dolphin species’ detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency-banded echolocation clicks (made by Risso’s and white-beaked dolphins) (Palmer et al., 2017). This has shown that the more northerly sites (Latheron and Helmsdale) have predominantly frequency-banded detections (e.g. Risso’s or white-beaked dolphins). As expected, analysis of data collected at the Cromarty, St Andrews and St Abbs sites shows clicks are predominantly broad-band (e.g. bottlenose or common dolphins) (Figure 66).

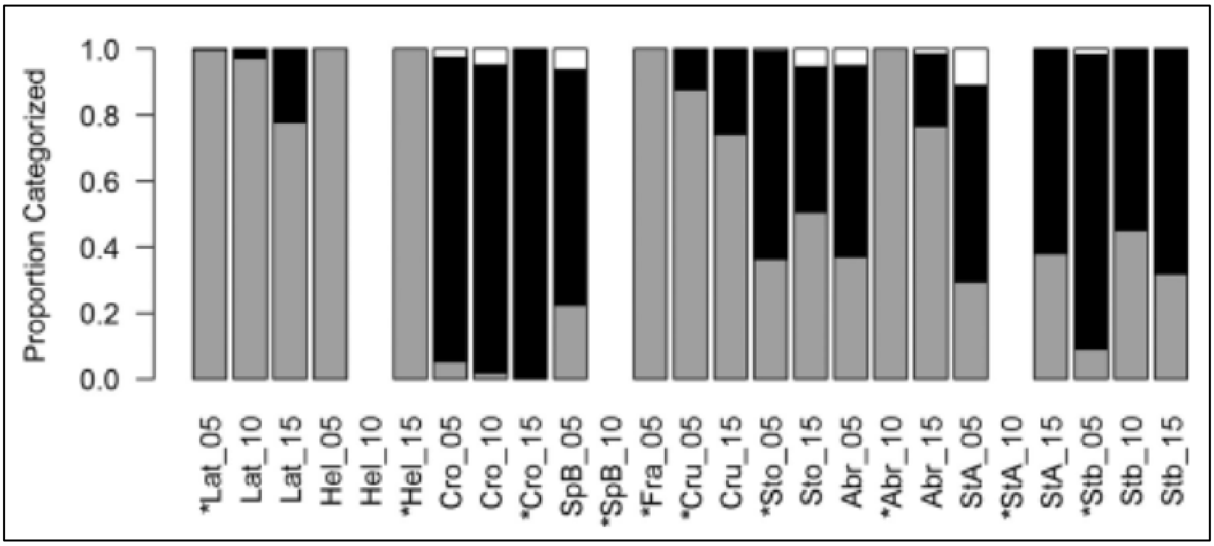


Figure 65: The proportion of click trains recorded at ECOMMAS PAM sites within the ECOMMAS study area classified as broadband (black), frequency banded (grey) or unknown (white) by the combination of the Generalised Additive model (GAM) click-train classification and the encounter likelihood ratio (Palmer et al.2017). Asterisks indicate joint C-POD/SM2M deployment locations from which training data were derived and where C-PODs were displaced no data are presented.

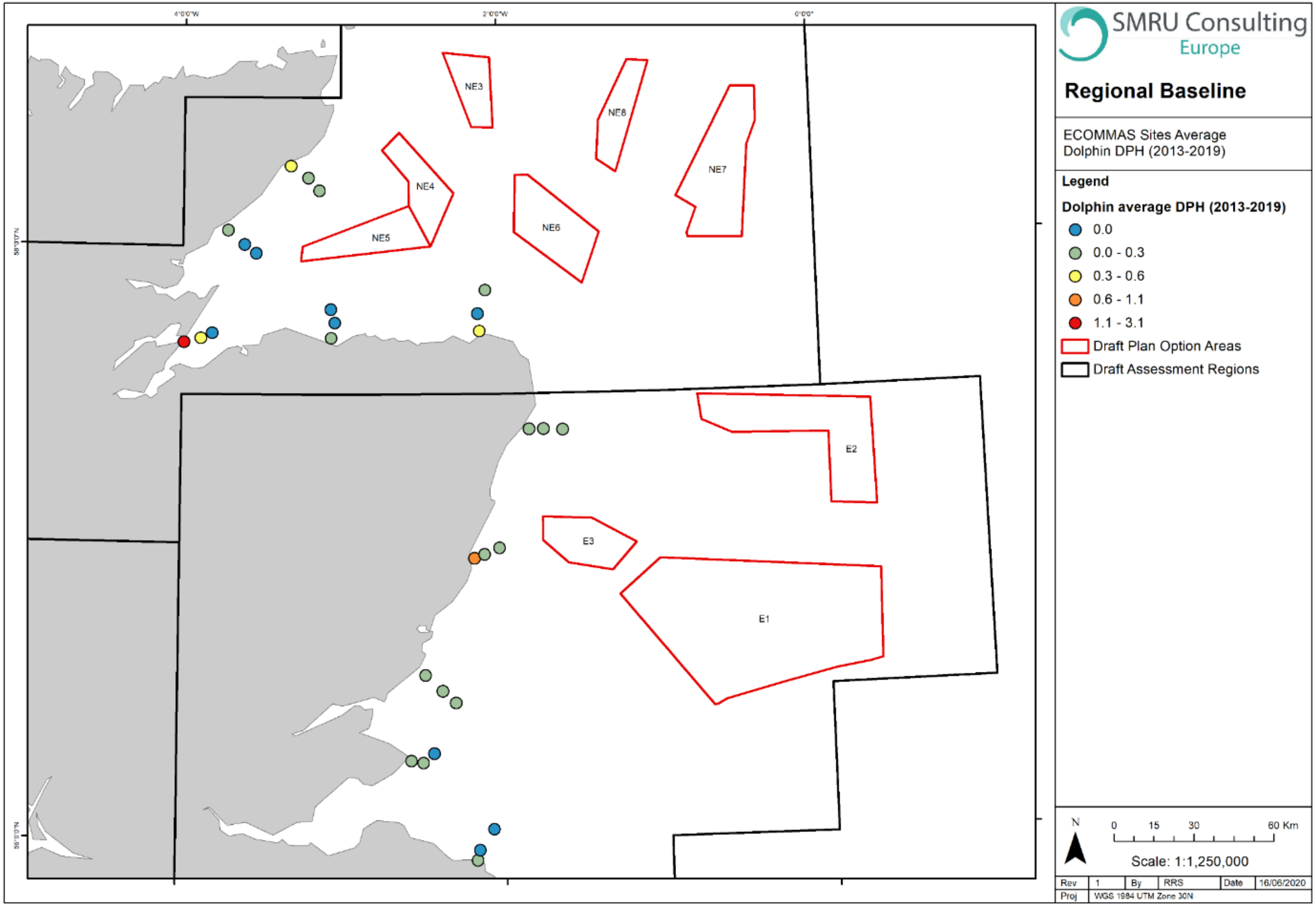


Figure 66: ECOMMAS acoustic monitoring sites along the east coast of Scotland.

Land-based Shorewatch sightings data collated by WDC recorded sightings of bottlenose dolphins mostly focused within the Moray Firth, with pockets of frequent sightings records around south west Fife, Aberdeen and Tiumpan Head on the Isle of Lewis (Figure 69). Designated Shorewatch locations are fixed, and are selected as watch sites based on high cetacean sightings probability, hence why there are some sites with such high sightings levels. Nevertheless, the data are useful to highlight the coastal distribution of bottlenose dolphins, and may be helpful when choosing cable landfall locations.

Finer scale information on sightings of bottlenose dolphins in the Pentland Firth and Orkney waters are presented in Evans et al. (2011), and are especially relevant to DPOs sites N1 and NE2. The sightings presented are from at least 12 sources, including Sea Watch Foundation, ESAS, SCANS I and SCANS II, and the John O'Groats ferry. Most of the records presented are opportunistic without associated effort, and therefore may contain biases, but can be utilised to highlight presence in these areas. Within this study area, Evans et al. (2011) reports a concentration of sightings around Lybster Point (east Caithness), Dunnet Bay and Thurso Bay, with bottlenose dolphins rarely occurring north of the Orkney Isles (Figure 68).

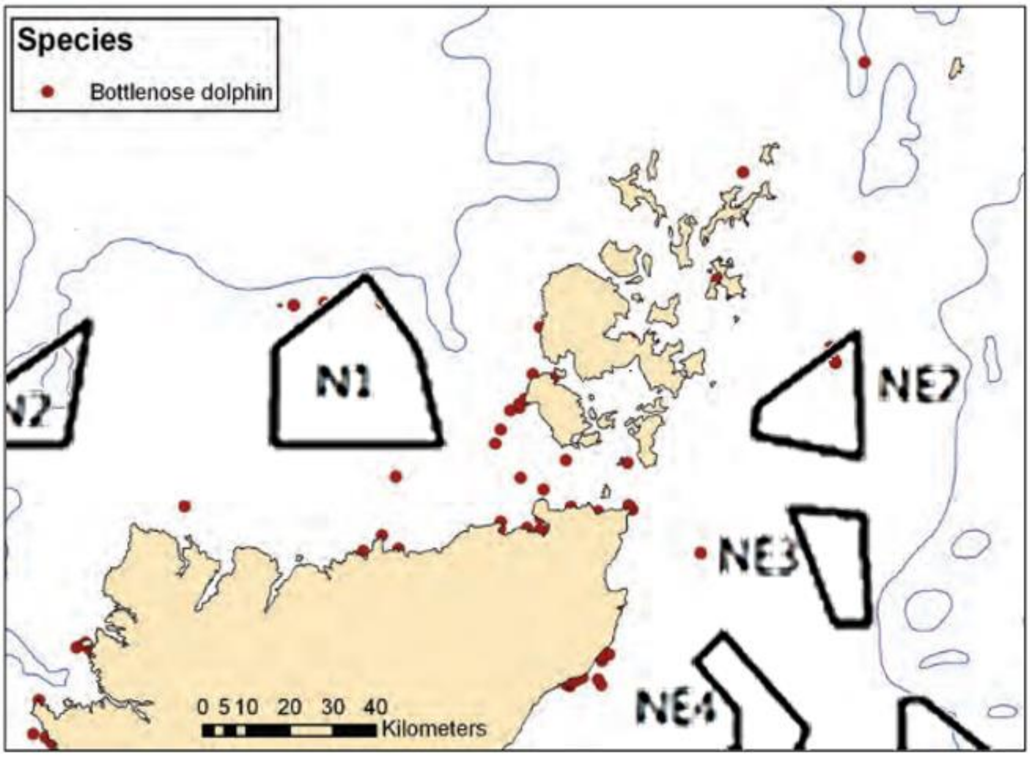


Figure 67: Distribution of sightings of bottlenose dolphins around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

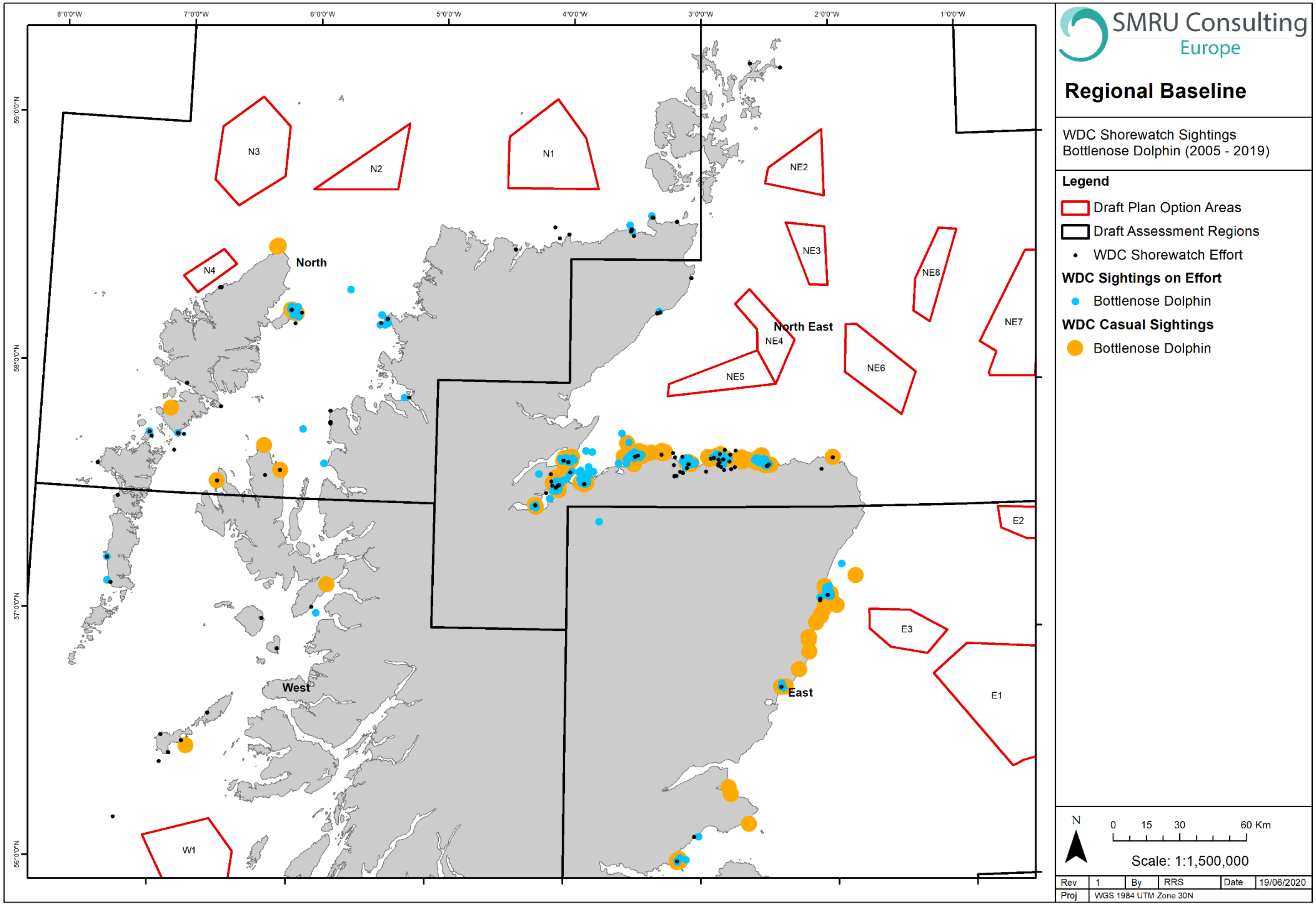


Figure 68: Sightings of bottlenose dolphins recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

Finer scale marine mammal sightings data covering the East Grampian coastline between 1973 and 2010 presented by Anderwald and Evans (2010) show little overlap of bottlenose dolphin distribution with DPO site E3, however effort was largely shore-based, so the lack of sightings in DPOs site is not necessarily indicative of distribution in that area (Figure 70).

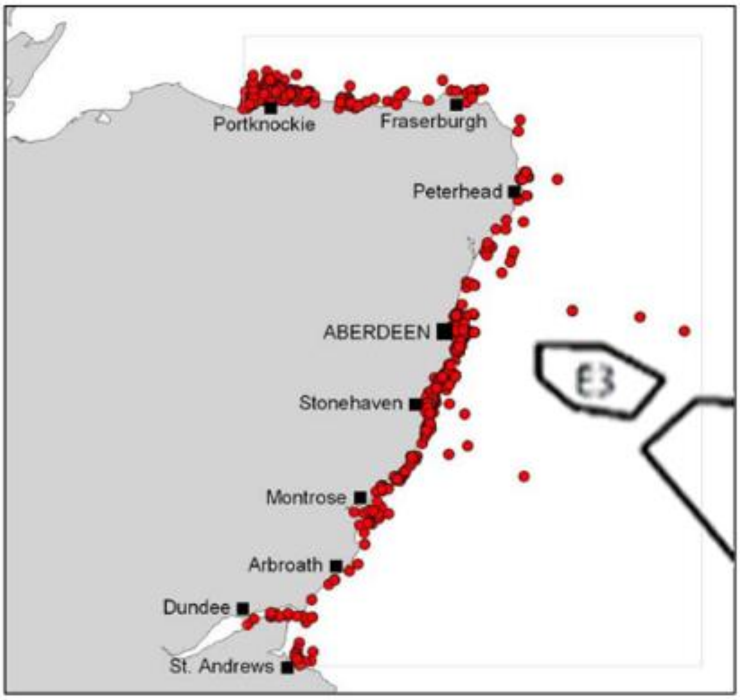
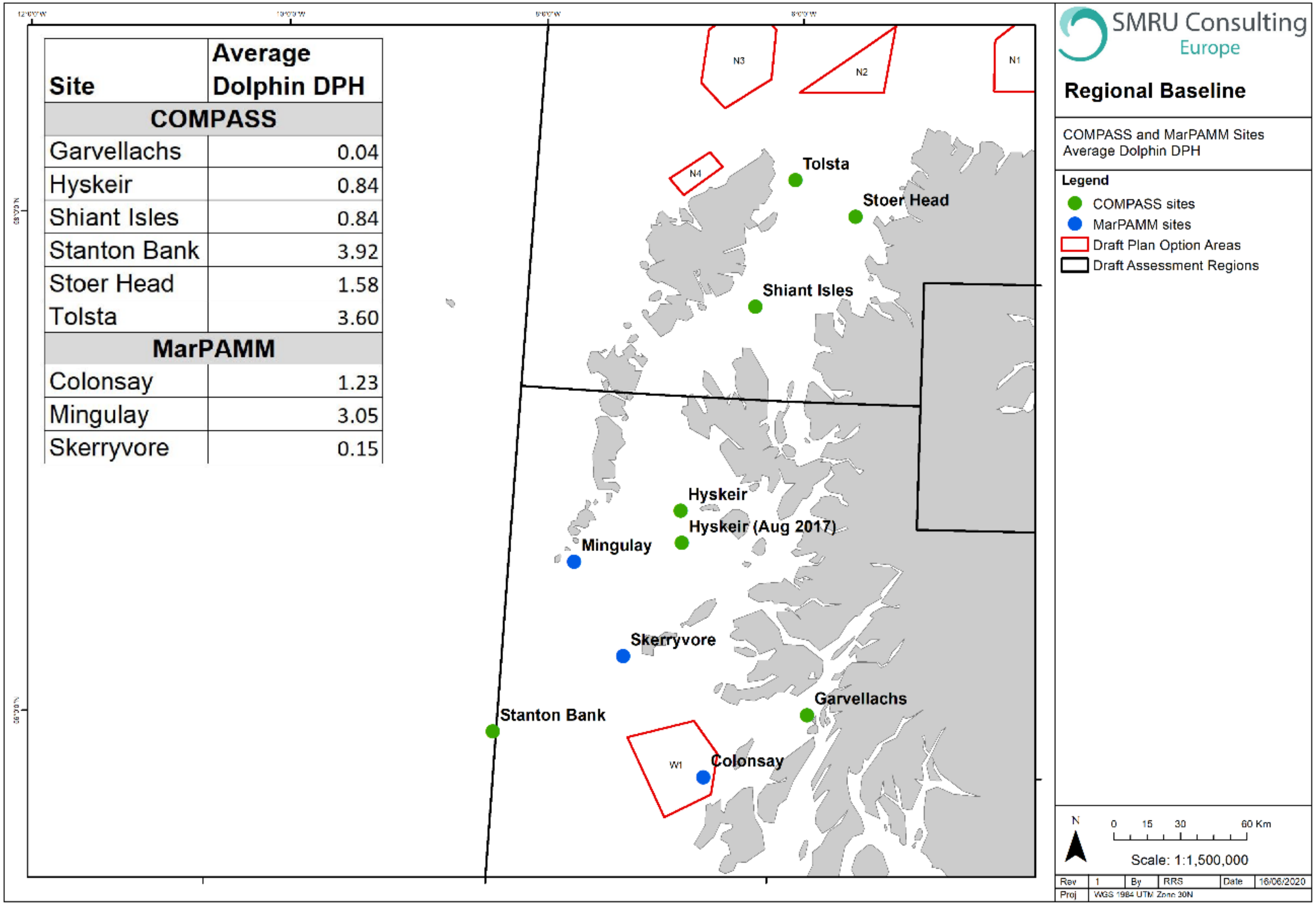


Figure 69: Distribution of bottlenose dolphin sightings in East Grampian Region (Anderwald and Evans 2010). Overlaid for reference are the approximate regional and DPO areas.

On the west coast of Scotland, dolphin detection rates were also low in both the COMPASS and MarPAMM PAM datasets, with average DPH between 0.15 and 3.92 across the sites (Figure 71). As yet, no further analysis has been conducted on these data to determine which dolphin click type was detected, in order to estimate species ID. Therefore, it is unknown what dolphin species were detected at these sites.



Site	Average Dolphin DPH
COMPASS	
Garvellachs	0.04
Hyskeir	0.84
Shiant Isles	0.84
Stanton Bank	3.92
Stoer Head	1.58
Tolsta	3.60
MarPAMM	
Colonsay	1.23
Mingulay	3.05
Skerryvore	0.15

Figure 70: COMPASS and MarPAMM acoustic monitoring sites along the west coast of Scotland, including table (inset) demonstrating average dolphin detections per hour for each site.

For the purpose of this report, the Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020).The sightings data suggest bottlenose dolphins are resident year-round around the west of Scotland, generally observed close to shore in headland and bays. Most frequent sightings are in and around the Sound of Barra and throughout the Inner Hebrides, with most sightings around Mull, the Small Isles and the Isle of Skye (Figure 72). These sightings are likely of the resident west coast population of the coastal ecotype. No sightings overlapped any of the DPOs sites.

ORCA and MARINElife undertake dedicated marine mammal watches aboard ferry and large vessels around Scottish waters, and have recorded sightings of bottlenose dolphins within all the DPOs regions, but not within any DPO site boundaries (Figure 73, Figure 74).

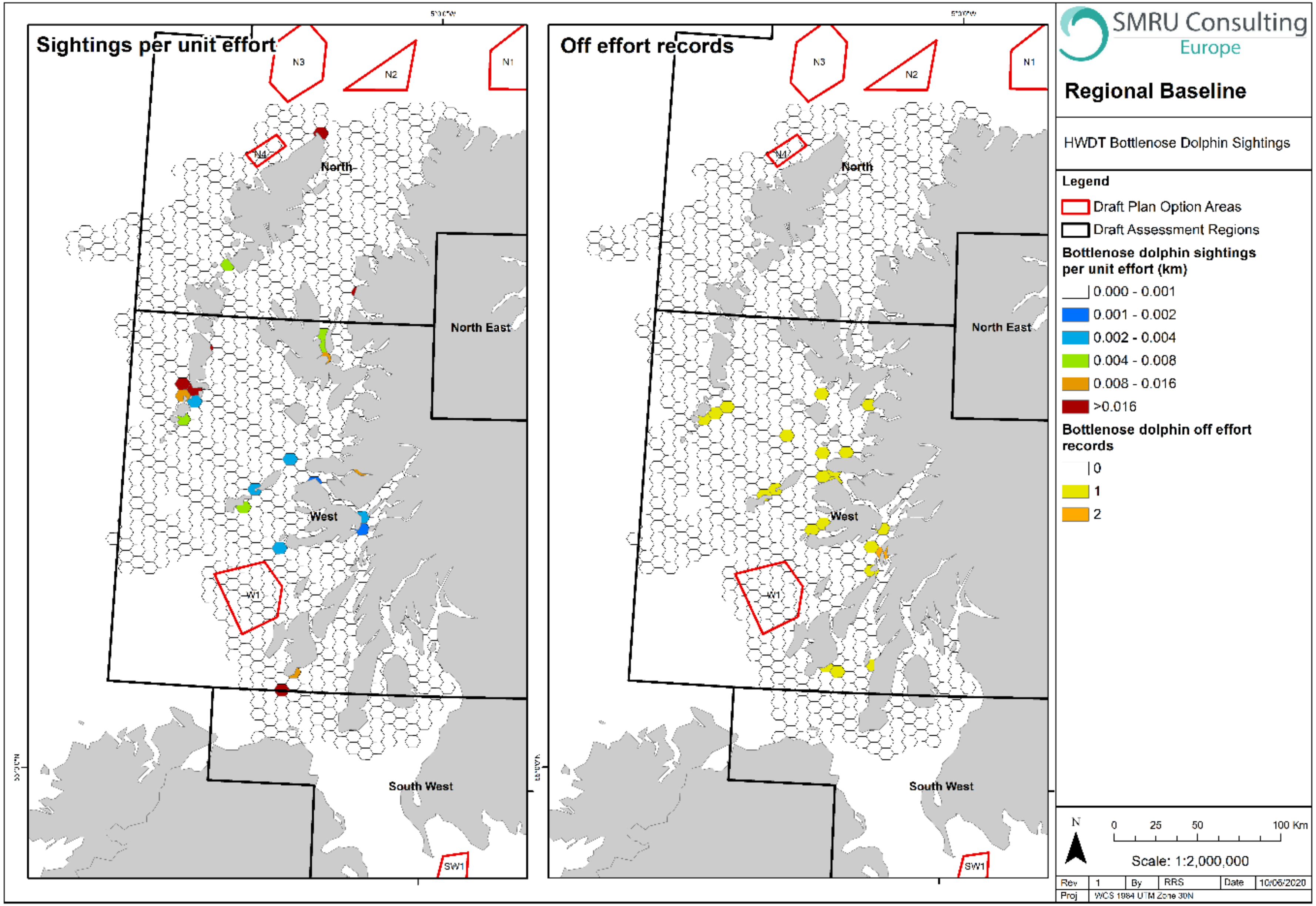


Figure 71: Sightings per unit effort, and off effort sightings, of bottlenose dolphins recorded by the Hebridean Whale and Dolphin Trust during vessel based surveys between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

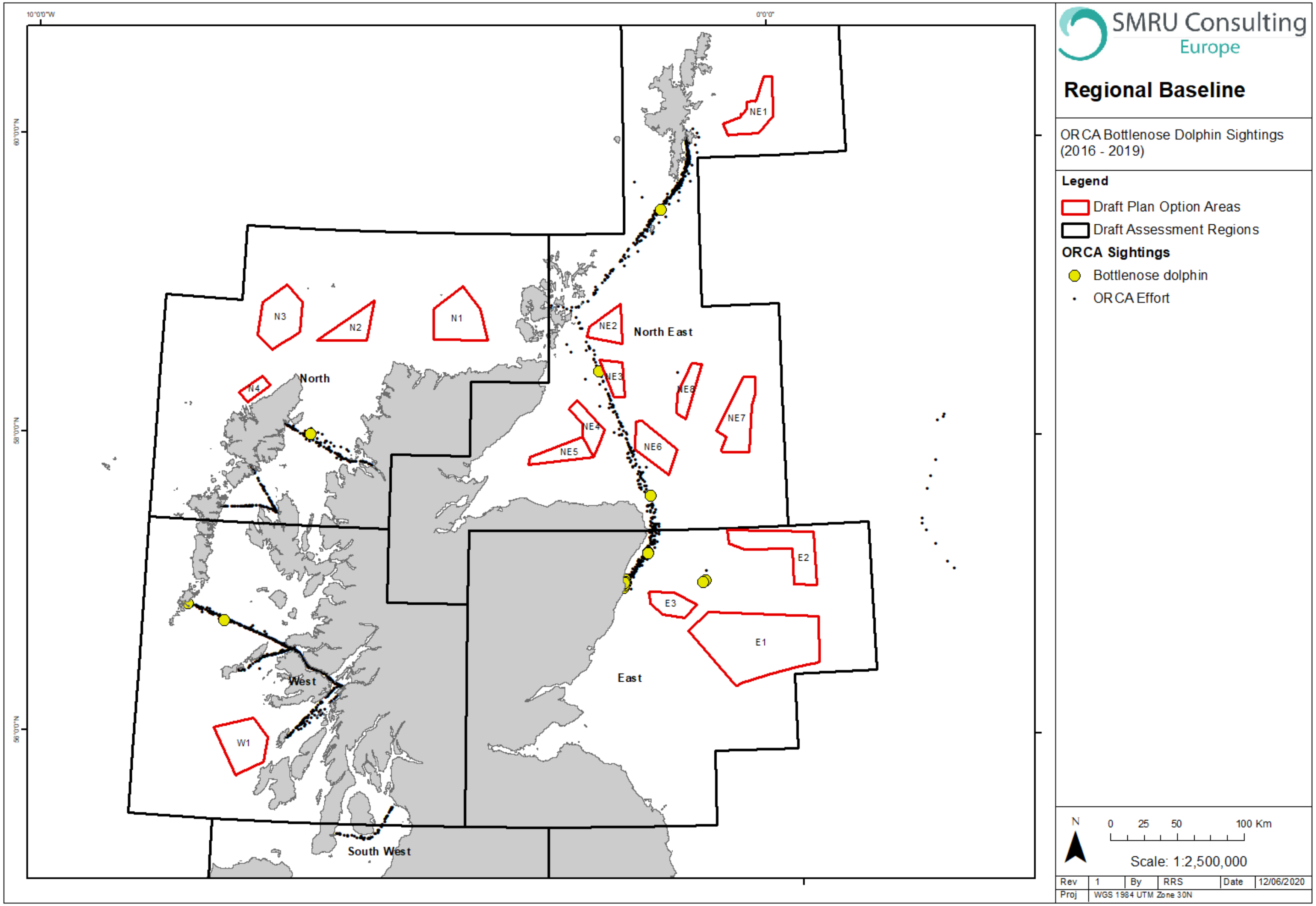


Figure 72: Bottlenose dolphin sightings (orange dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Black dots show effort. Data provided free of charge by ORCA.

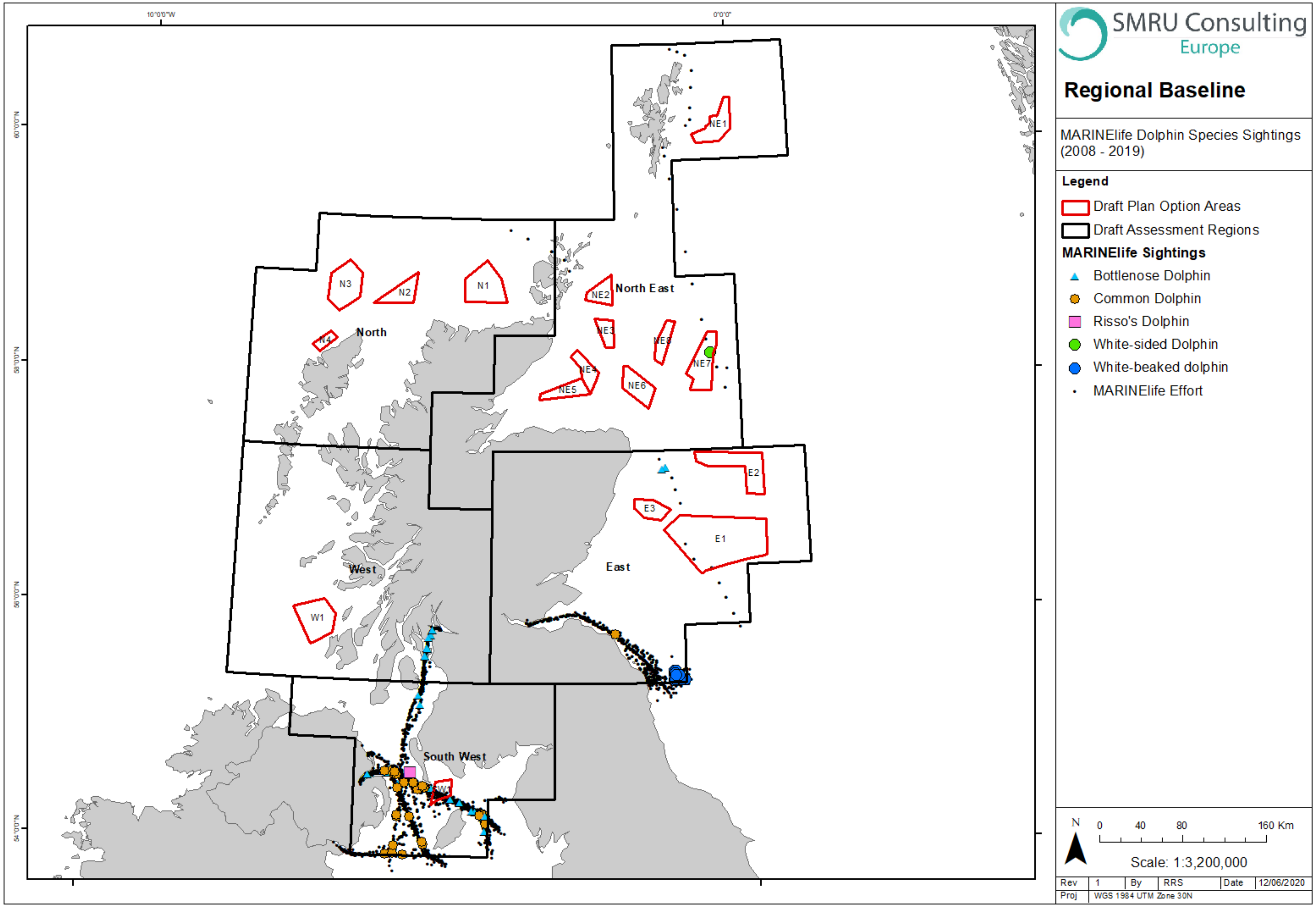


Figure 73: Dolphin sightings recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

3.3.4.2. Offshore bottlenose dolphin ecotype

In their predicted species distribution models of bottlenose dolphins, Waggitt et al. (2020) did not include any sightings of bottlenose dolphins within 30 km from the coastline. Therefore, when interpreting the data and maps presented by Waggitt et al. (2020) in terms of species coverage of DPOs sites, care should be taken as the maps do not accurately reflect the distribution of coastal bottlenose dolphins within Scottish waters (Figure 75). The maps instead are based on the assumption that any bottlenose dolphins encountered more than 30 km from the coastline would be the ‘offshore’ ecotype (Breen et al. 2016). The models predicted a year-round but relatively low abundance of offshore bottlenose dolphins to the north-west of Scotland (Waggitt et al. 2020), with little overlap of offshore bottlenose dolphin distribution with DPOs sites. Note: the Waggitt et al. (2020) distribution maps are available for all months, however, only January and July are presented here for illustrative purposes.

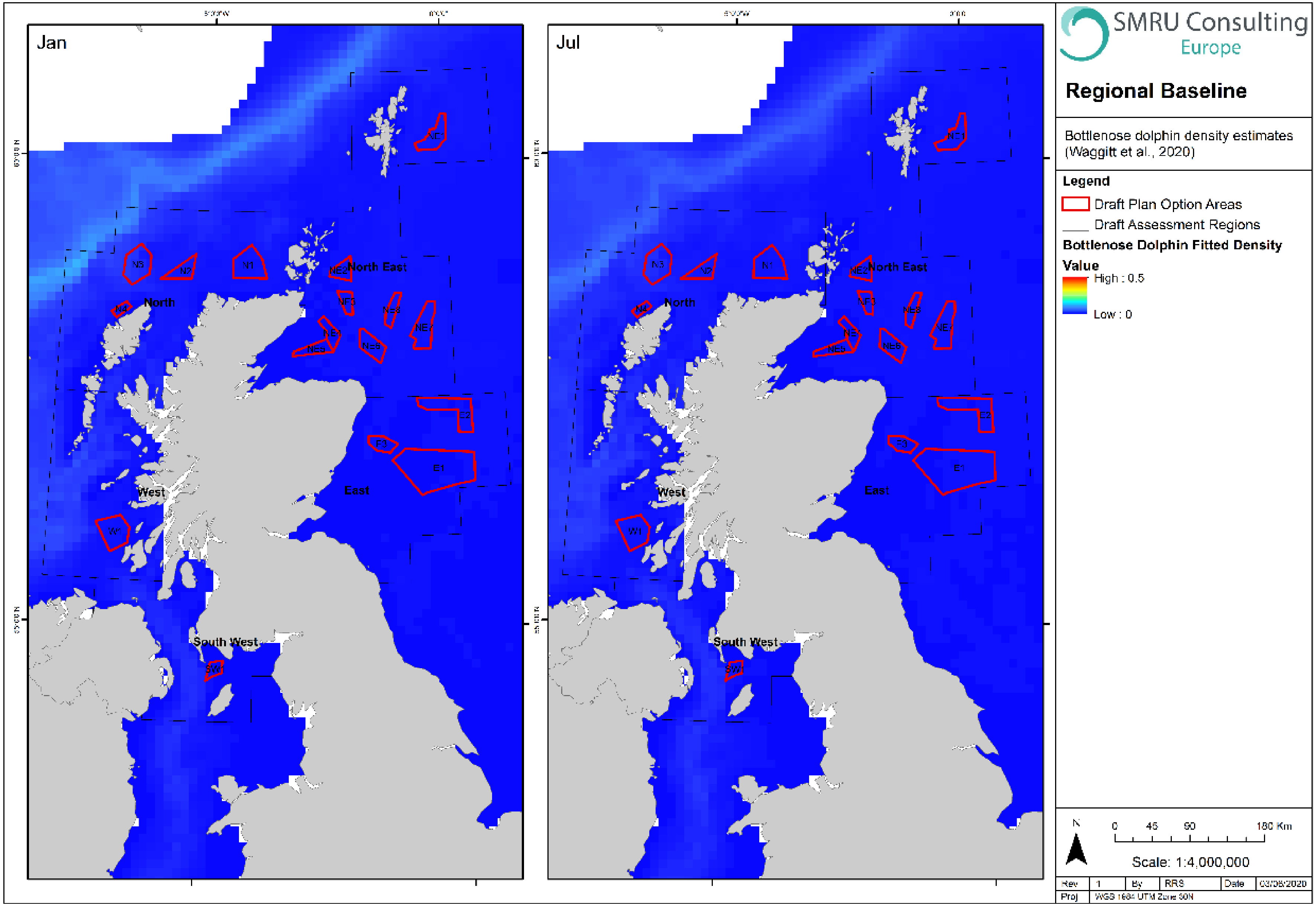


Figure 74: Spatial variation in predicted bottlenose dolphin densities (animals per km^2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

3.3.5. Risso's dolphin

Based on the information presented below, Risso's dolphins (coastal ecotype) are resident year-round in Scottish waters, but at higher densities during the summer months. Risso's dolphins have a preference for deeper waters, and so prefer shelf waters, or areas where water is deeper closer to land, such as around the Isle of Lewis. There is little expected overlap with DPO areas due to this habitat preference.

The most recent assessment of Risso's dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019h).

The most recently collected broad-scale data on Risso's dolphin abundance and distribution are available from the SCANS III survey. Risso's dolphins were sighted in Scottish waters in both SCANS II and SCANS III, with sightings concentrated in more offshore waters. The SCANS III survey block with the highest estimated density was block J (western Outer Hebrides) where the block wide uniform density estimate was 0.192 Risso's dolphins/km^2. SCANS sightings data show little overlap with DPOs sites, with site N4 and SW1 showing highest predicted densities (Figure 76).

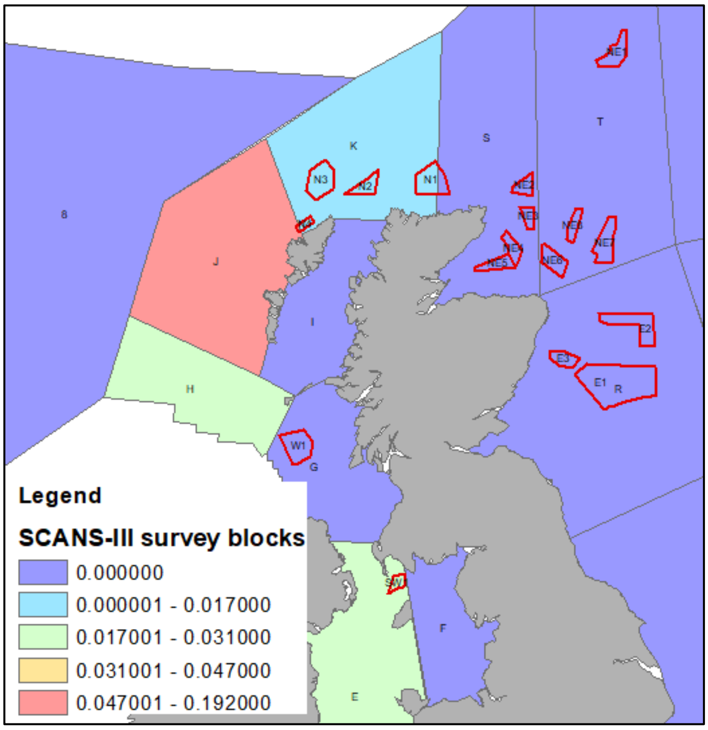


Figure 75: SCANS III block-wide uniform density estimates for Risso's dolphins in Scottish waters (Hammond et al. 2017). Overlaid for reference are the regional and DPO areas.

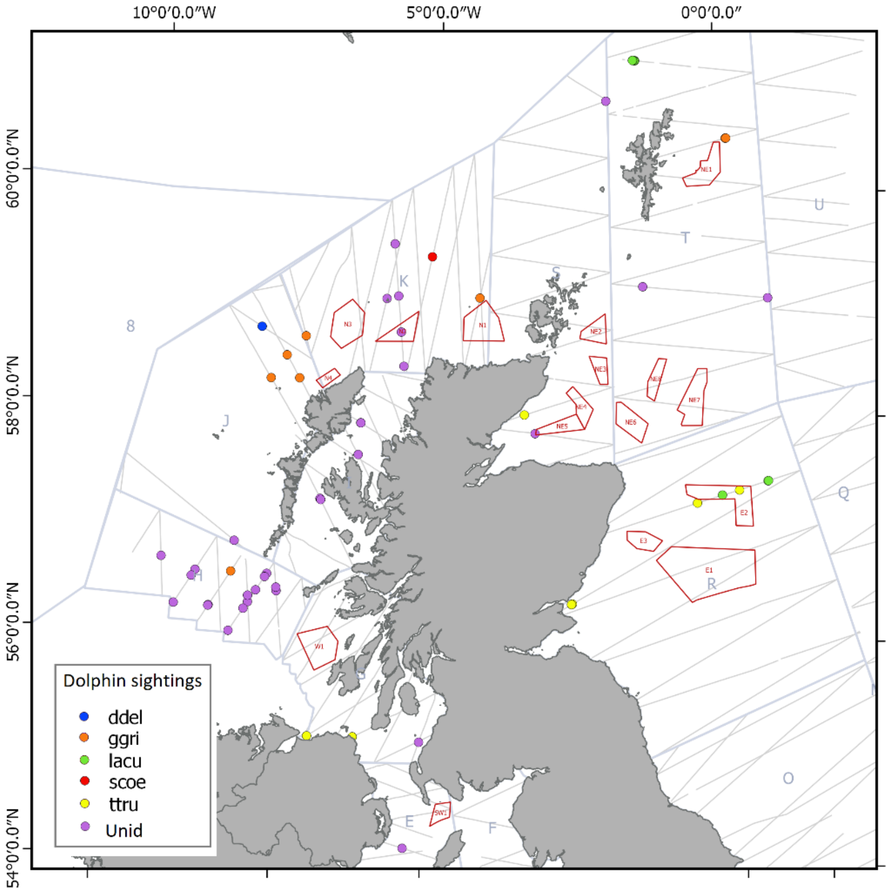


Figure 76: Sightings of dolphin species seen during the SCANS-III survey blocks containing DPO Areas (red). Ddel = Common dolphin (Delphinus delphis), ggri= Risso's dolphin (Grampus griseus), lacu= white-sided dolphin (Lagenorhynchus acutus), scoe = striped dolphin (Stenella Stenella coeruleoalba), ttru= bottlenose dolphin (Tursiops truncatus). Unid= dolphins not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The species distribution maps presented by Waggitt et al. (2020) for Risso's dolphin predict that densities are higher along the continental shelf than in more coastal waters, and that there is seasonality to their distribution, with considerably lower densities in January compared to July (Figure 78). The predictions by Waggitt et al. (2020) are particularly relevant to the North and West DPOs regions. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

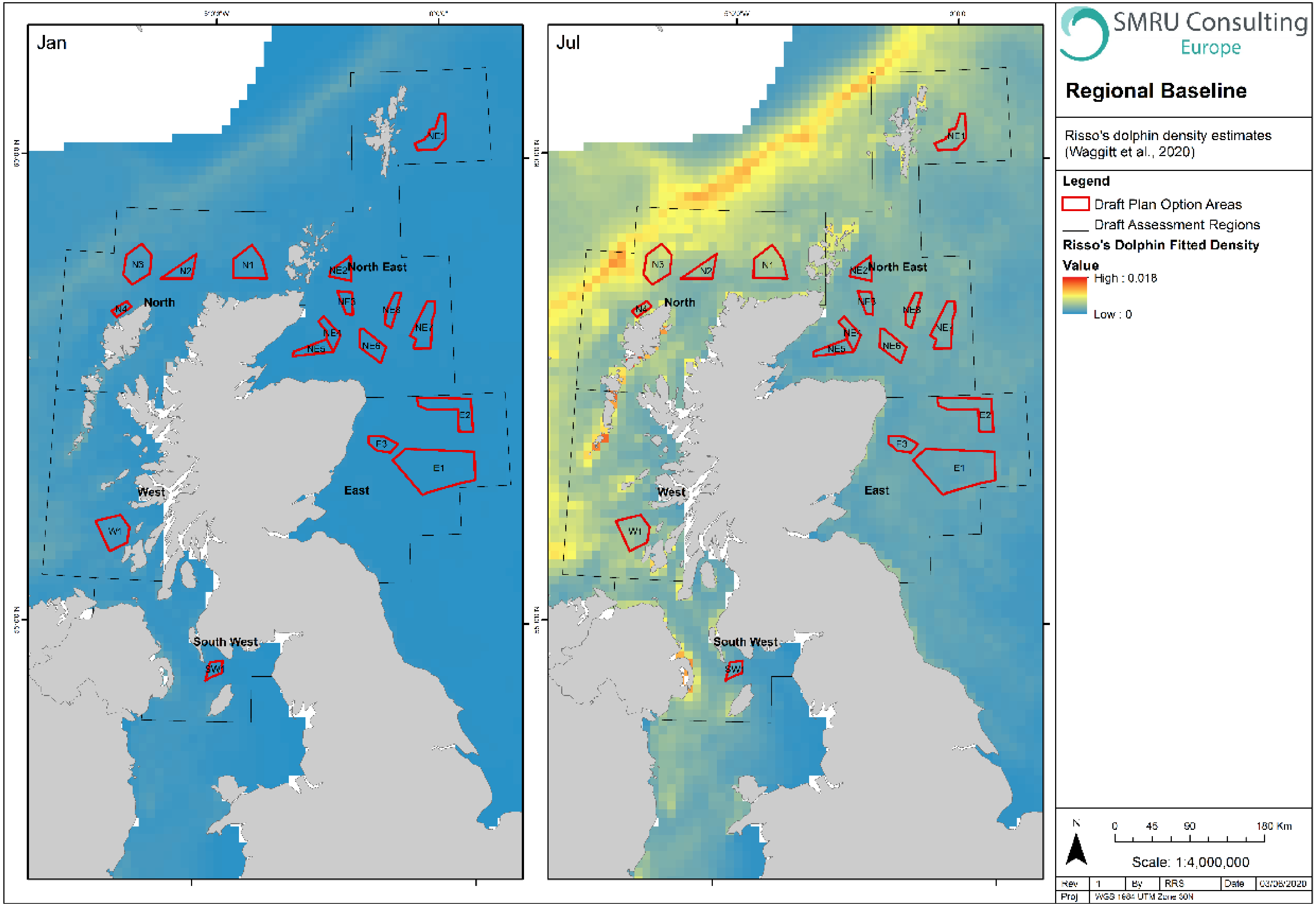


Figure 77: Spatial variation in predicted Risso's dolphin densities (animals per km2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Paxton et al. (2014) estimated the relative density for Risso's dolphins in Scottish waters in order to inform MPA designations, using the JCP dataset[17] in addition to data provided by SNH to estimate densities covering 1994-2012. Risso's dolphins were mainly recorded in the summer months with patchy distribution, located mainly in the northwest, with increasing records in the northern North Sea in the more recent years (Figure 80) (Paxton et al. 2014). The model identified the area north of Lewis and Harris as having higher than average densities of Risso's dolphins compared to the rest of the Scottish territorial waters (Figure 80), and this has led to the proposed designation of the North-east Lewis pMPA (Figure 79).The pMPA is particularly close in proximity to DPO areas N2 and N4. Furthermore, the index of predicted persistence was particularly high in DPOs sites N2, N3, N4 and SW1. Risso's dolphin presence was associated with sea surface temperature, which is a dynamic variable with annual variations, suggesting that their distribution will change annually.

(ii)

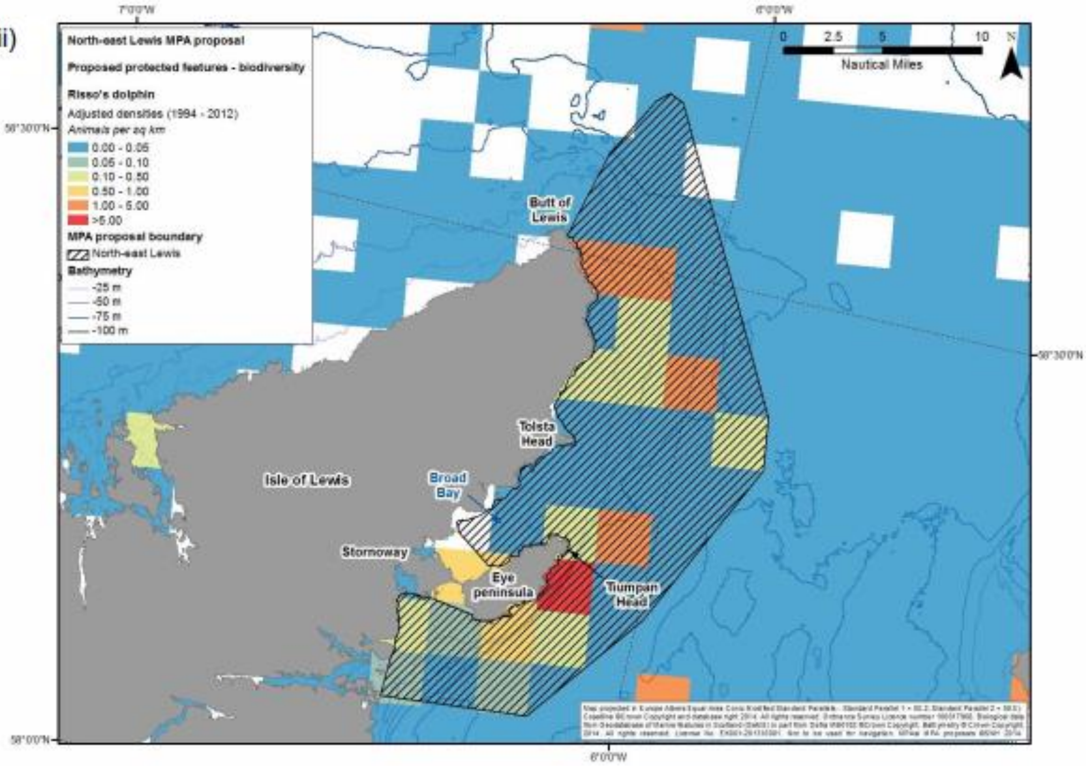


Figure 78: Adjusted densities of Risso's dolphin (1994-2012), and the North-east Lewis MPA proposal boundary. Risso's dolphin data from Paxton et al. (2014), MPA proposal map taken from the North-east Lewis MPA Proposal available on the SNH website[18]

[17] See Paxton et al. (2014) for a full list of acknowledgements of organisations that collected, compiled and provided data.
[18] https://www.nature.scot/sites/default/files/2017-11/Marine%20Protected%20Area%20-%20Data%20confidence%20assessment%20-%20North-east%20Lewis%20MPA%20proposal.pdf

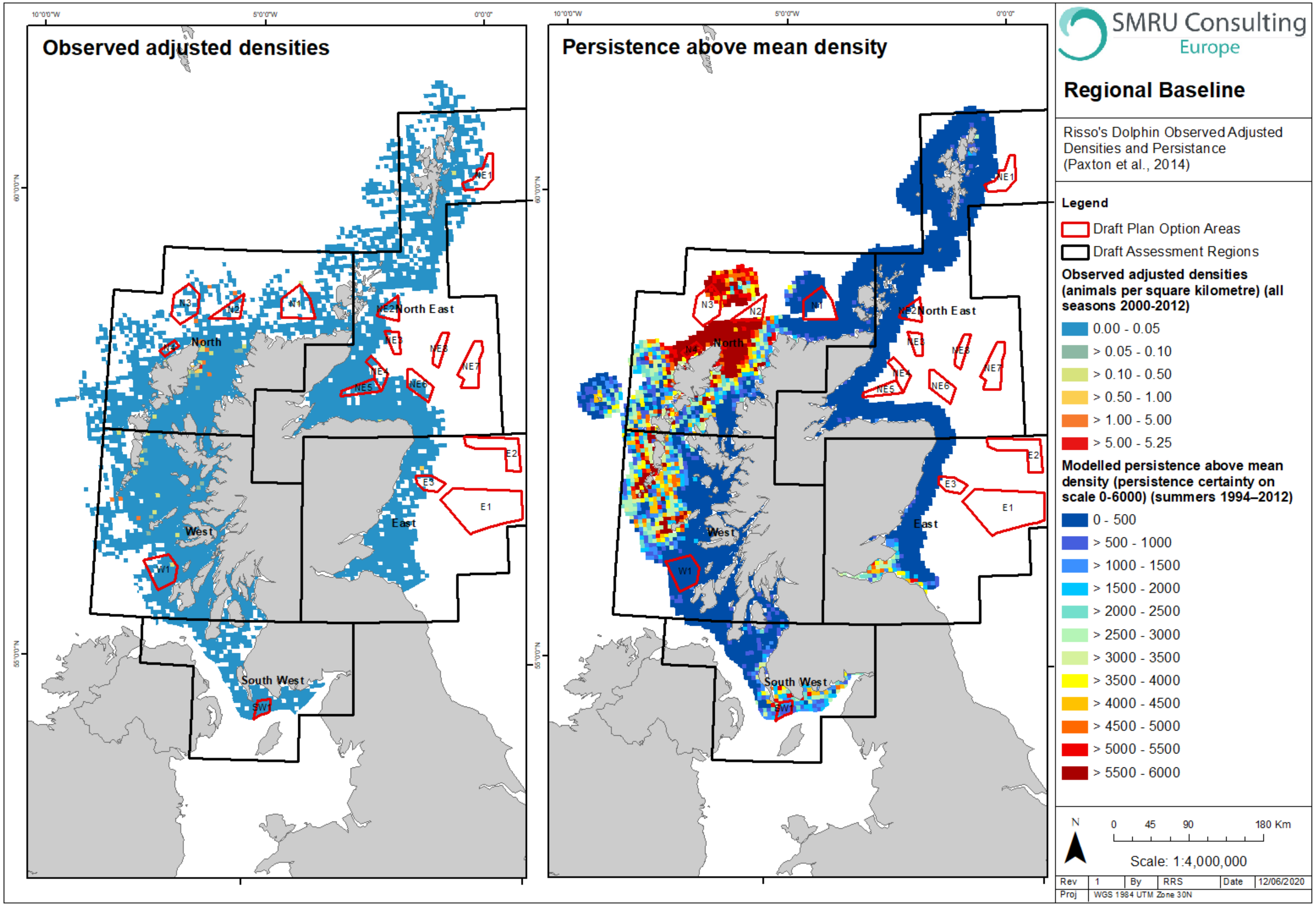


Figure 79: Left: Observed adjusted densities (animals per square kilometre) of Risso's dolphins recorded across all seasons 2000 to 2012. Each cell is 5 by 5 km. Right: Index of predicted Risso's dolphin persistence-certainty summers 1994-2012. Colours indicate persistence of above mean density on a score 0 to 6000. Each cell is 5 by 5km. Both: Paxton et al. (2014). Overlaid for reference are the regional and DPO areas.

Data from HWDT contributed to the proposed designation of the North-east Lewis pMPA. The deeper water close to land is suggested to be an important calving and feeding area for Risso's dolphins. For the purpose of this report, HWDT provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Sightings from HWDT suggest Risso's dolphins are present year-round around the west of Scotland, usually inhabiting deeper waters, such as those around Tiumpan Head on the Isle of Lewis. Sightings around the Hebrides are off north east Lewis in the Outer Hebrides, and around Coll, Tiree, Mull and Skye, although sightings were also distributed around the HWDT survey area (Figure 81). Sightings data from HWDT between 2003 and 2019 showed sightings recorded along the boundary of DPO site W1, where there were >0.007 Risso's dolphin sightings per unit effort (km) (Figure 81).

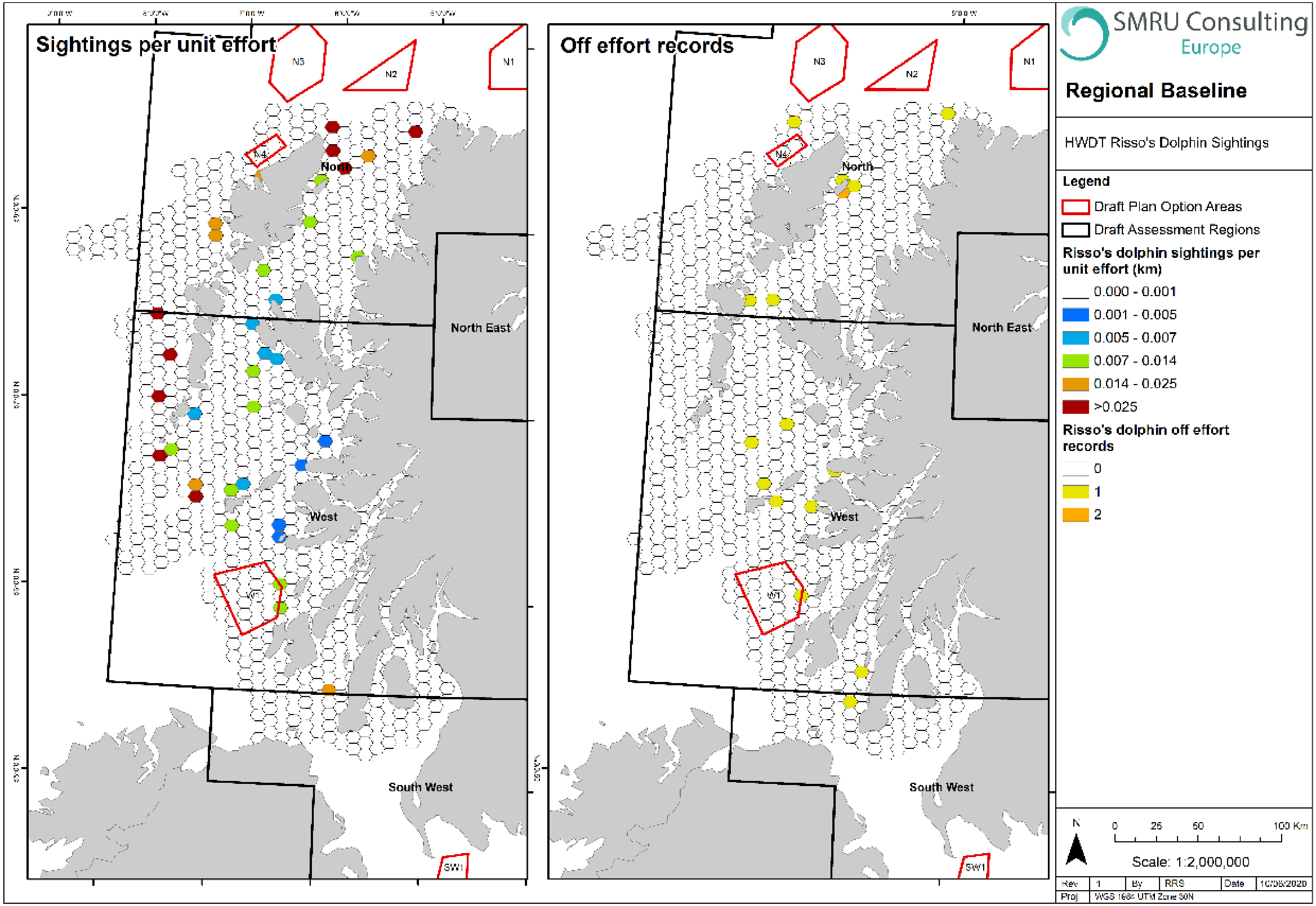


Figure 80: Sightings per unit effort, and off effort sightings, of Risso's dolphins during vessel based surveys 2003-2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

The Scottish Marine Atlas describes Risso's dolphin habitat as open coast, straits and sounds, sea lochs and offshore with a preference for areas with steep sloping sea bed. Sightings are mostly around the Outer Hebrides, and occasionally from the Northern Isles and off the east coast (Baxter et al. 2011). Mapped encounter rates show higher encounter rates in the North and West DPOs regions, with especially high encounter rates in DPOs site N4 (Figure 82).

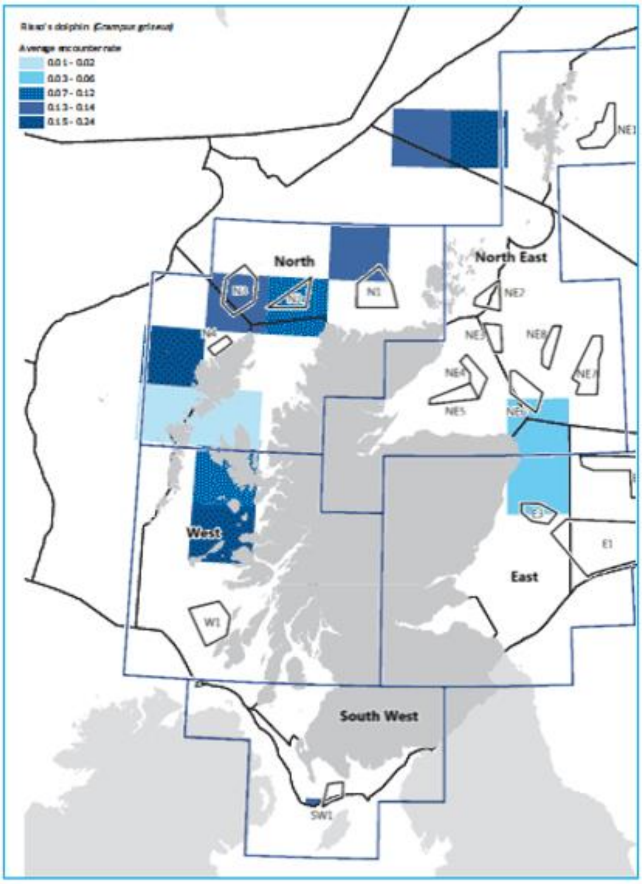


Figure 81: Risso's dolphin average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Older survey data are presented in Reid et al. (2003) and Weir et al. (2001), and show similar patterns of distribution as more recent modelled distributions previously discussed. For example, the 'Atlas of cetacean distribution in north-west Europe' recorded Risso's dolphins as a mainly a continental shelf species, with most sightings in Scottish waters located in west Scotland (Figure 83) (Reid et al. 2003). The Atlas suggested there is some evidence of seasonality to their distribution, with high sightings in the Minches between May and September and then an increase at the continental shelf edge in winter, however, inference was limited by uneven effort throughout the year.

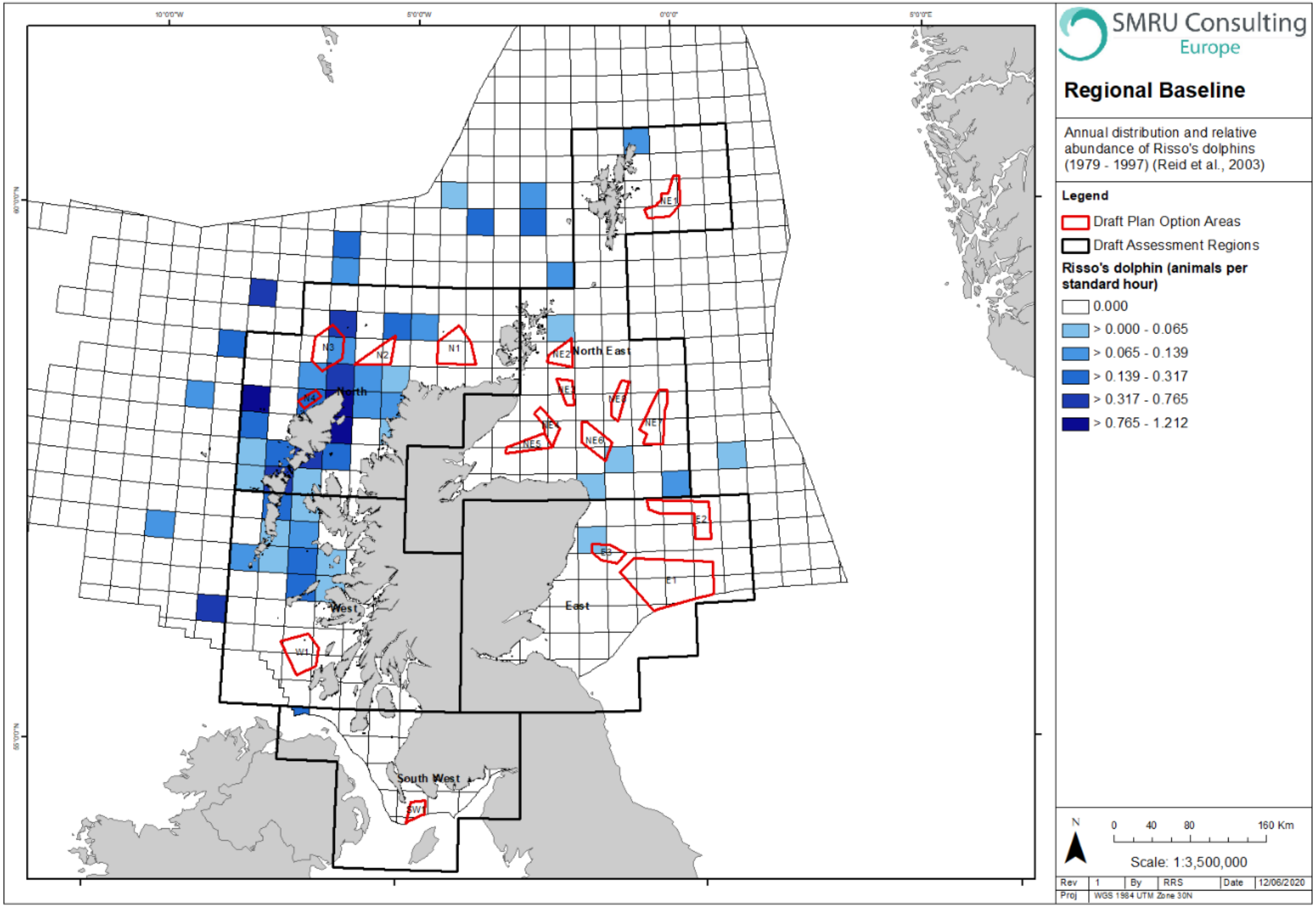


Figure 82: Aggregated annual distribution and relative abundance of Risso's dolphins (1979 - 1997) based on data presented in Reid et al. (2003).

In the Cetaceans of the Atlantic Frontier surveys presented by Weir et al. (2001), Risso's dolphins had a widespread distribution through northern and western Scottish shelf waters, and around Orkney and Shetland (Figure 84), though were uncommon overall. They were most commonly seen in water less than 200 m deep, though were also recorded along the shelf edge between July and November. Sightings were highest between July and September, and lowest between December and May. Sightings are particularly high within or proximal to DPOs site N3 and N4. Risso's dolphins were also 'possibly' recorded on three occasions during the Outer Hebrides surveys conducted by Macleod et al. (2003) in 1998, with sightings again mainly within the continental shelf and encounters only to the west of the Outer Hebrides.

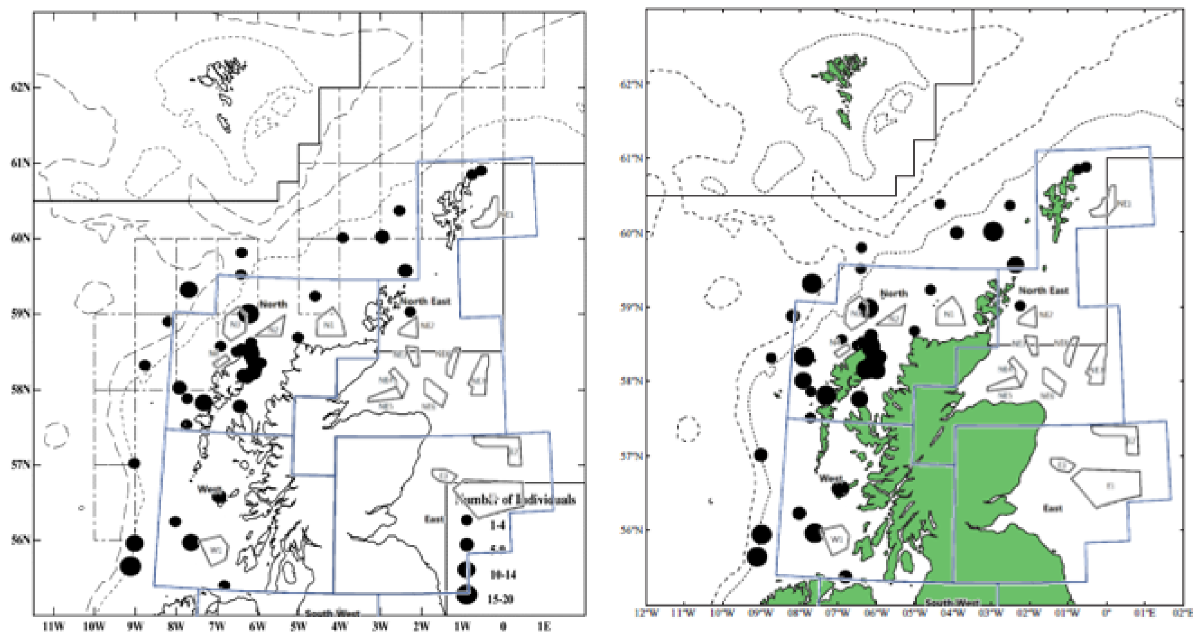


Figure 83: Left: Distribution of Risso's dolphin sightings presented in the Cetaceans of the Atlantic Frontier (1979–1998) Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants).) (Weir et al. 2001). Right: Distribution of Risso's dolphin sightings (1979-999) (Pollock et al. 2000). Note, legend applicable to both figures. Overlaid for reference are the approximate regional and DPO areas.

Analysis of sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010 again suggested Risso's dolphin tended to prefer shelf edge and deeper waters (Stone 2015). In terms of the DPOs regions, Risso's dolphins were sighted only in the North East region, with no sightings overlapping any DPO sites (Figure 85).

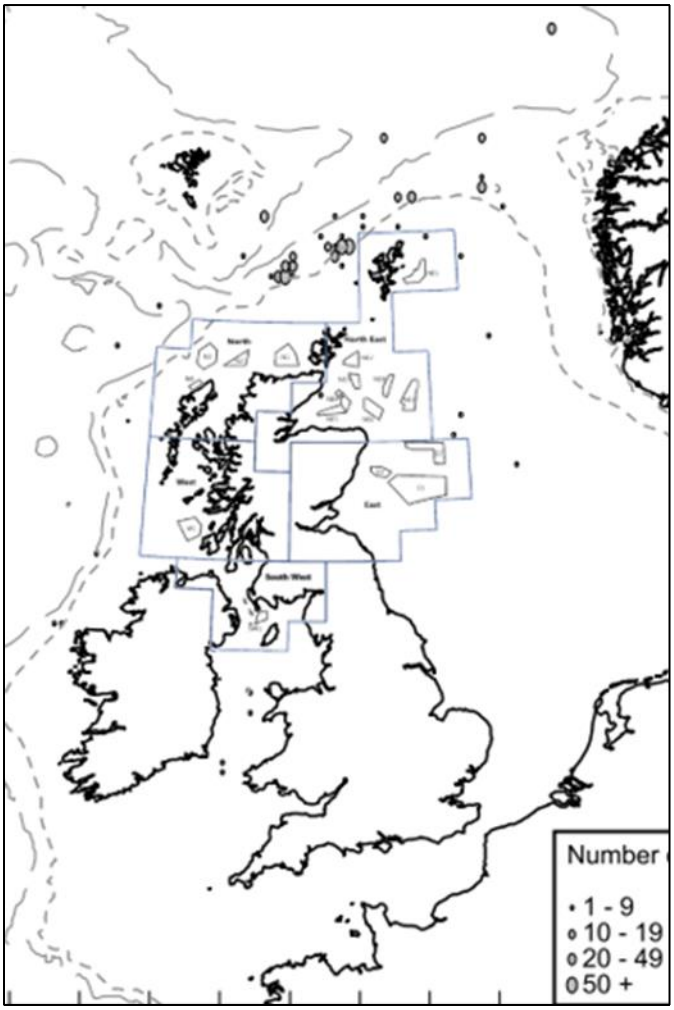


Figure 84: Risso's dolphins encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Overlaid are the approximate locations of the DPO areas and regions.

MARINElife vessel based surveys recorded sighting Risso's dolphins only once, with the sighting within the South West DPO region but not overlapping the boundary of site SW1 (Figure 86). Land-based Shorewatches recorded sightings of Risso's dolphins mainly around the Isle of Lewis, north mainland coastline, with casual sightings also reported around the Orkney Isles, with sightings also reported within the Moray Firth (Figure 87). Whilst these coastal watch sightings reports do not overlap DPO sites, they are useful to gain an understanding of species distribution closer to shore, and may be useful when choosing cable landfall locations.

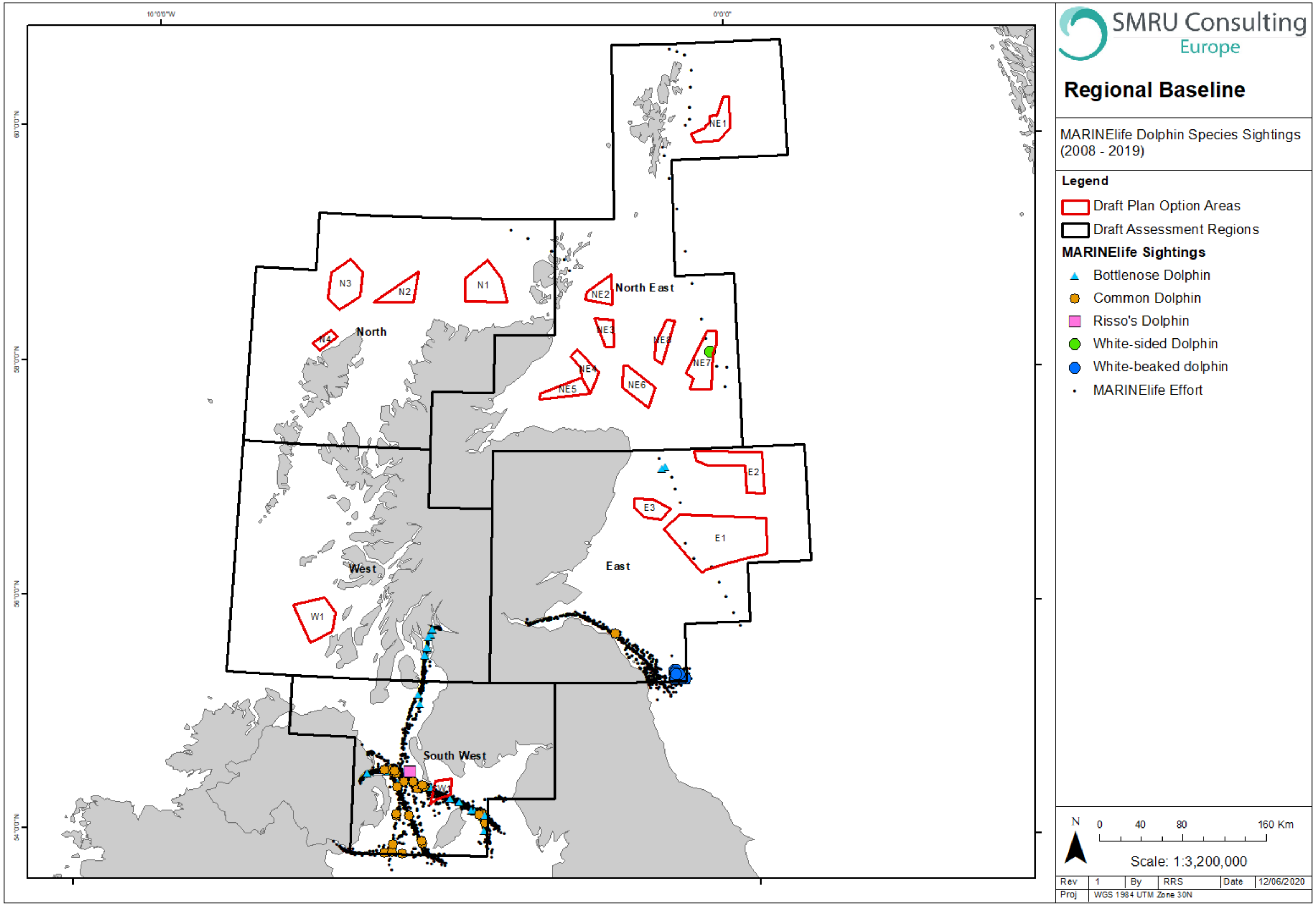


Figure 85: Dolphin sightings recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

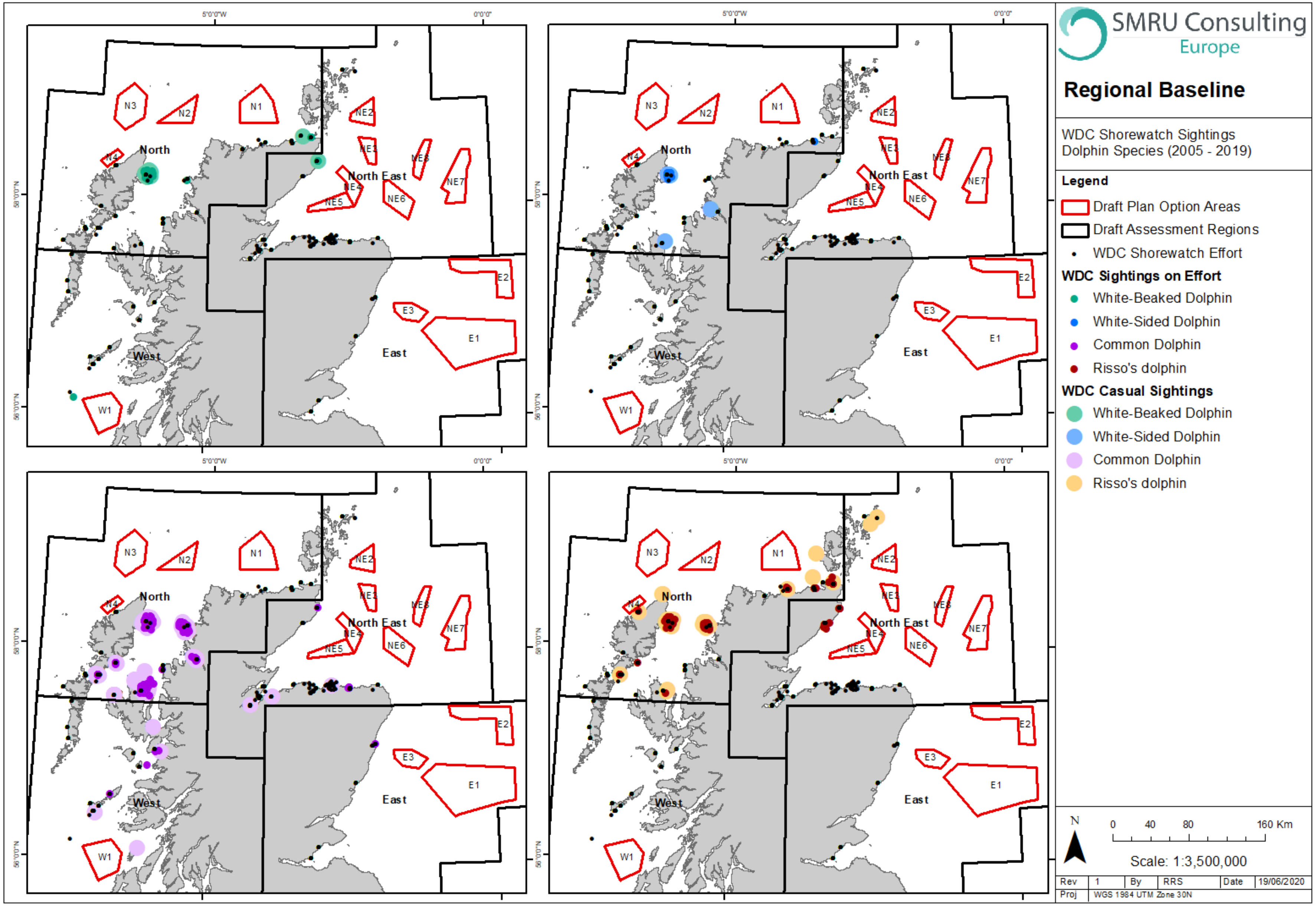


Figure 86: Sightings of white-beaked, white-sided, common and Risso's dolphins recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

Sightings data around the Pentland Firth and Orkney Isles show a coastal distribution, although this is likely an artefact of watch effort (Figure 87) (Evans et al. 2011). Risso's dolphins have been sighted within the N1 DPO site boundary. Just to the south of Pentland Firth, boat-based photo-identification surveys carried out between 2002 and 2016 by the University of Aberdeen Lighthouse Field Station have not recorded any Risso's dolphin sightings during 241 trips.

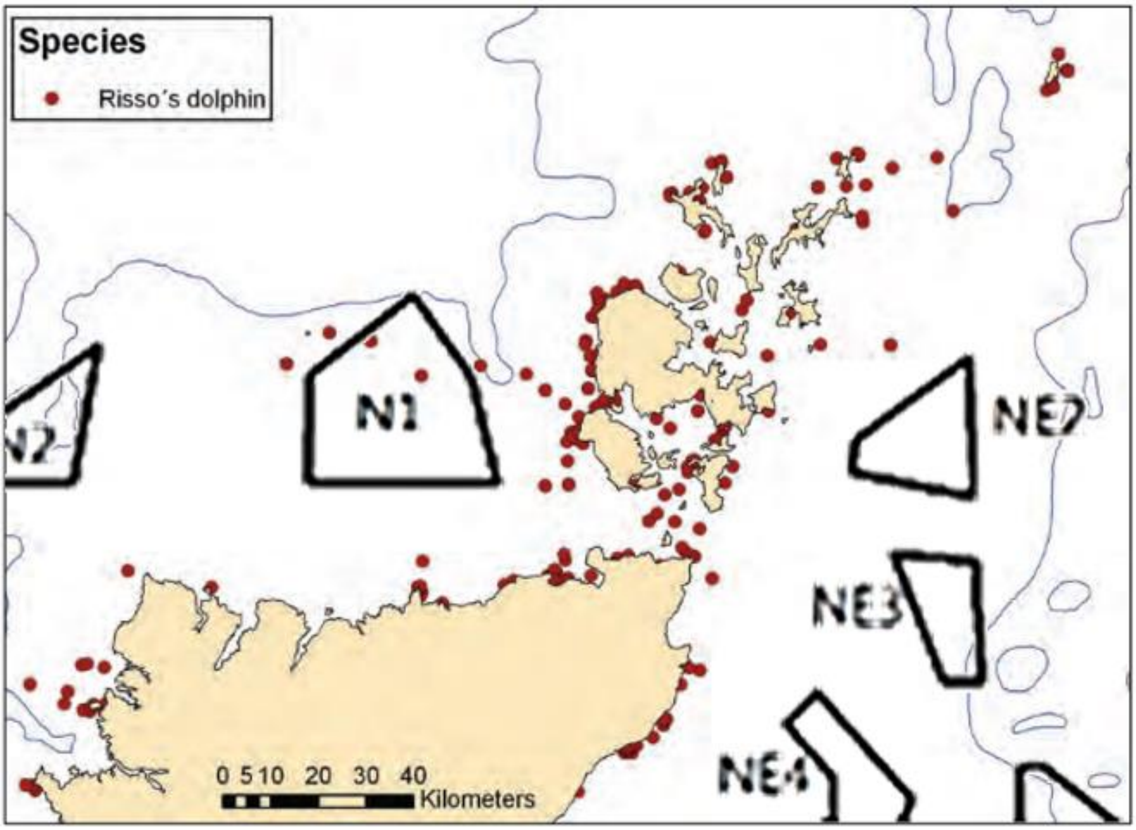


Figure 87: Distribution of sightings of Risso's dolphins around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.3.6. White-beaked dolphin

Based on the information presented below, white-beaked dolphins are resident and abundant year-round in Scottish waters, with their distribution fairly widespread. White-beaked dolphins tend to occupy near- to offshore waters, and are present in the central and northern North Sea and around north west of Scotland. Sightings rates tend to be higher in the summer months. Due to this distribution, there may be some overlap with DPO sites.

The most recent assessment of white-beaked dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019j). In Scottish waters, white-beaked dolphin distribution is mainly across the central and northern North Sea and north-west Scotland, mainly within waters of 50-100 m depth (Evans et al. 2011). Coastal sightings are rare between November and April, though sightings have been reported in every month except January, with a peak between June and October. Since the 1990s, Sea Watch and SCANS data suggest a distributional shift northwards (Evans et al. 2011).

The most recently collected broad-scale data on white-beaked dolphin abundance and distribution are available from the SCANS III survey. White-beaked dolphins were sighted in Scottish waters in all three SCANS surveys. The SCANS III survey blocks with the highest estimated densities were Block H (offshore west Scotland), K (north of the Hebrides and north coast) and R (east coast) with density estimates in Scottish waters ranging from 0.000 to 0.316 white-beaked dolphins/km^2 (Figure 89). These blocks of predicted high density overlap with the North and East DPOs regions and the associated sites within them. White-beaked dolphins were sighted during the SCANS III surveys in all DPOs regions, and within DPOs sites N1 and E2 (Figure 90).

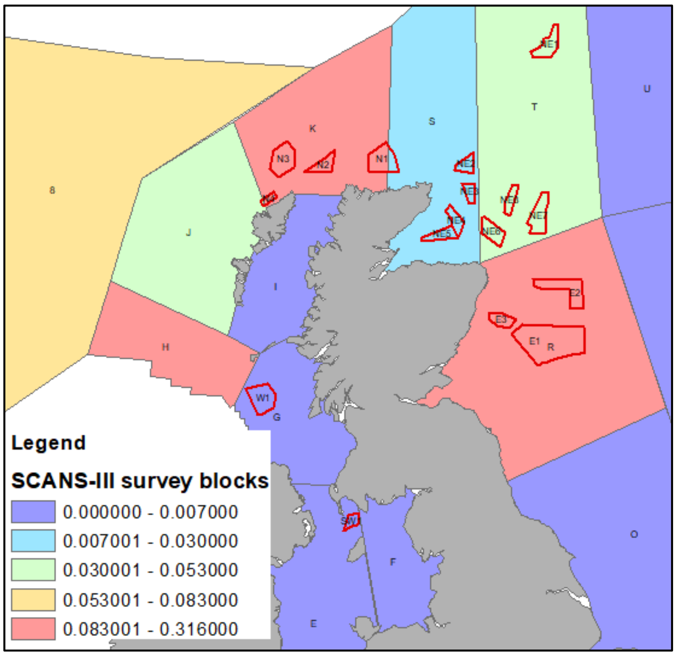


Figure 88: SCANS III block-wide uniform density estimates for white-beaked dolphins in Scottish waters (left) (Hammond et al. 2017). Overlaid for reference are the DPO areas.

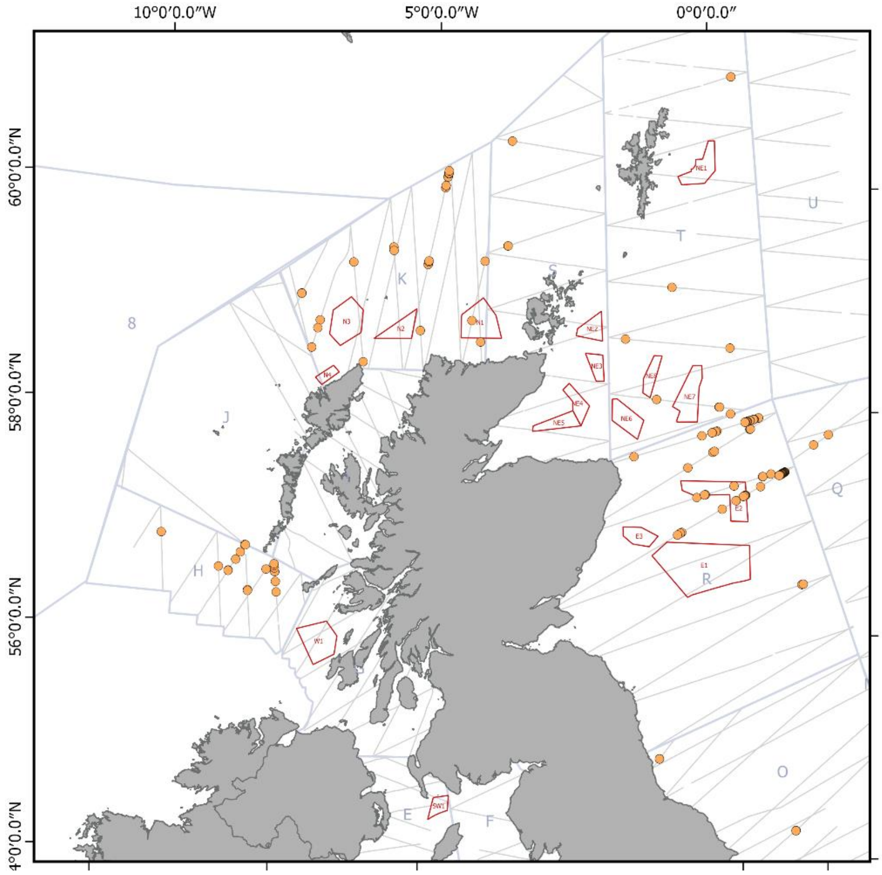


Figure 89: Sightings of white-beaked dolphin during the SCANS-III survey in blocks containing DPO Areas (red). Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

For the purpose of this report, Hammond & Lacey (Appendix 3: SCANS surveys) have provided predicted density surfaces for white-beaked dolphins with Scottish waters using SCANS III survey data. White-beaked dolphin density prediction per km^2 were reasonably high across all Scottish waters, with an exception in the West and South West DPO regions and in waters around the Shetland Isles, where predictions were lower. Density predictions are particularly high in the E2 and NE8 DPO sites, with densities of >0.15 animals per km^2 predicted (Figure 91).

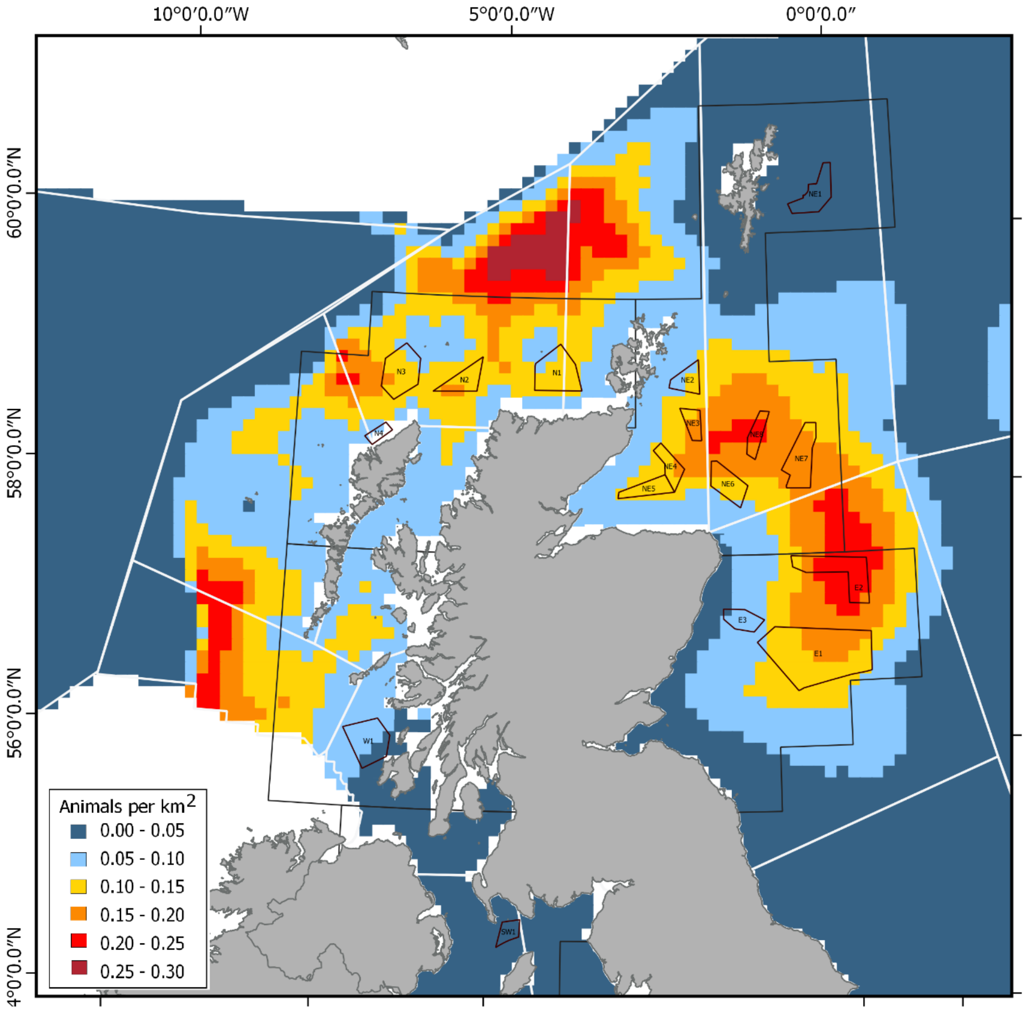


Figure 90: Predicted density surface for white-beaked dolphins in 2016 using SCANS III data. The colour scale is in units of animals per km^2. DPO Areas are outlined in black for reference. SCANS-III survey block areas are marked in white. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The most recent analysis of data seeking to provide estimates of white-beaked dolphin distribution within the North-East Atlantic, including Scottish waters, is presented in Waggitt et al. (2020). Over the entire North-East Atlantic study area, Waggitt et al. (2020) suggested white-beaked dolphins move into the area during the summer months, with this pattern mirrored in Scottish waters (Figure 92). During the summer months, white-beaked dolphin distribution overlaps highly for almost all DPOs sites, with especially high usage across the North and North East regions. Only the DPO site SW1 shows low white-beaked dolphin distribution year-round. In the winter months, white-beaked dolphins are still present in Scottish waters, and usage of the North DPO region remains relatively high. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

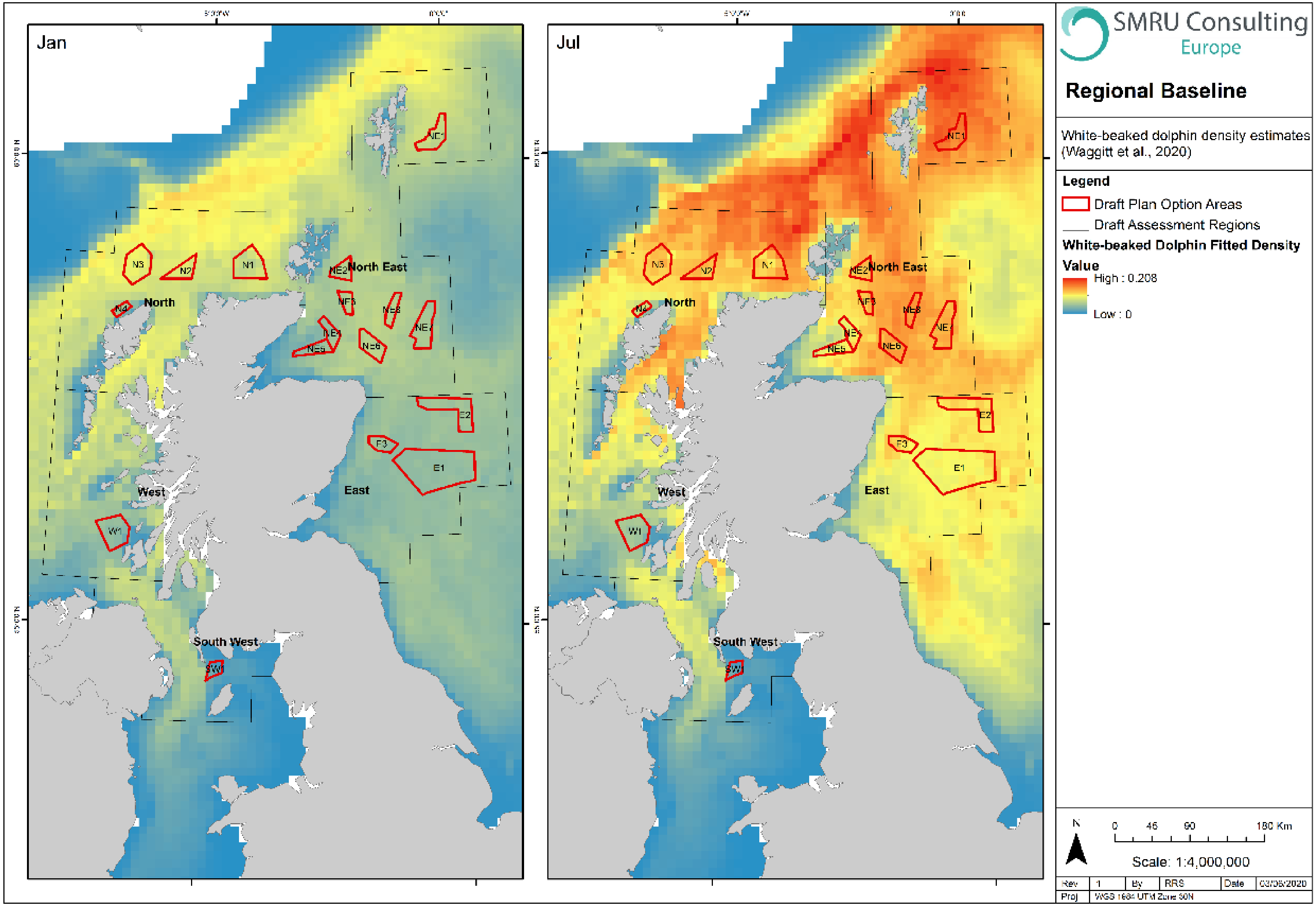


Figure 91: Spatial variation in predicted white-beaked dolphin densities (animals per km2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Paxton et al. (2014) estimated the relative density of white-beaked dolphins in Scottish waters in order to inform MPA designations and used the JCP dataset[19] in addition to data provided by SNH, with data on white-beaked dolphins covering 1994-2012. White-beaked dolphins were mainly recorded in deeper offshore waters (Figure 93). The model predicted higher densities in the north of the Minch and off Angus and east Aberdeenshire, however, due to the dispersion in this species, the persistence map was not deemed to be particularly informative. The density maps suggest some overlap with DPOs sites, particularly in the East region. There was no evidence that the distribution of white-beaked dolphins varies annually.

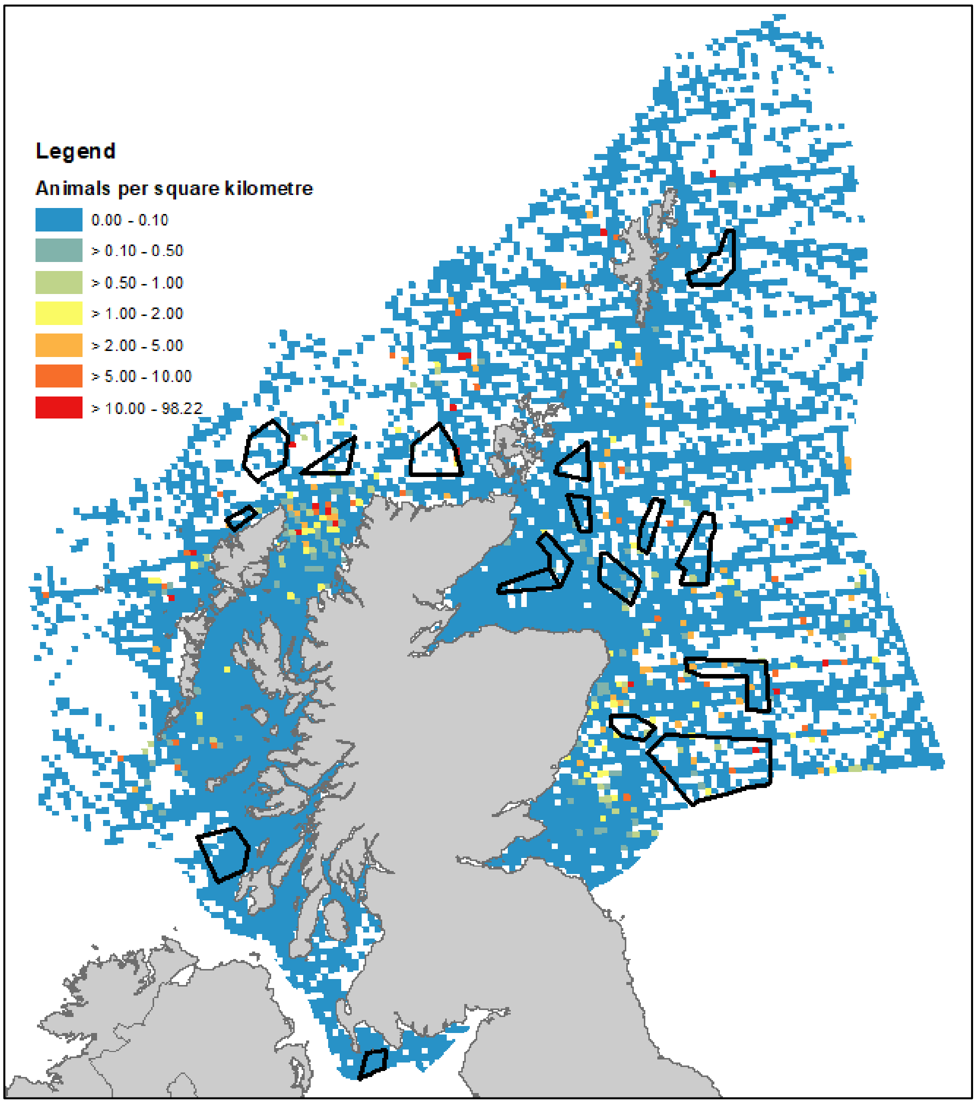


Figure 92: Observed adjusted densities (animals per square kilometre) of White-beaked dolphin recorded across all seasons 2000 to 2012, as reported in Paxton et al. (2014). Overlaid for reference are the DPO areas.

[19] See Paxton et al. (2014) for a full list of acknowledgements of organisations that collected, compiled and provided data.

White-beaked dolphins were observed on only one of the three HiDef aerial surveys conducted by Webb et al. (2018) covering the Sea of Hebrides pMPA survey area in 2016 (Figure 94).

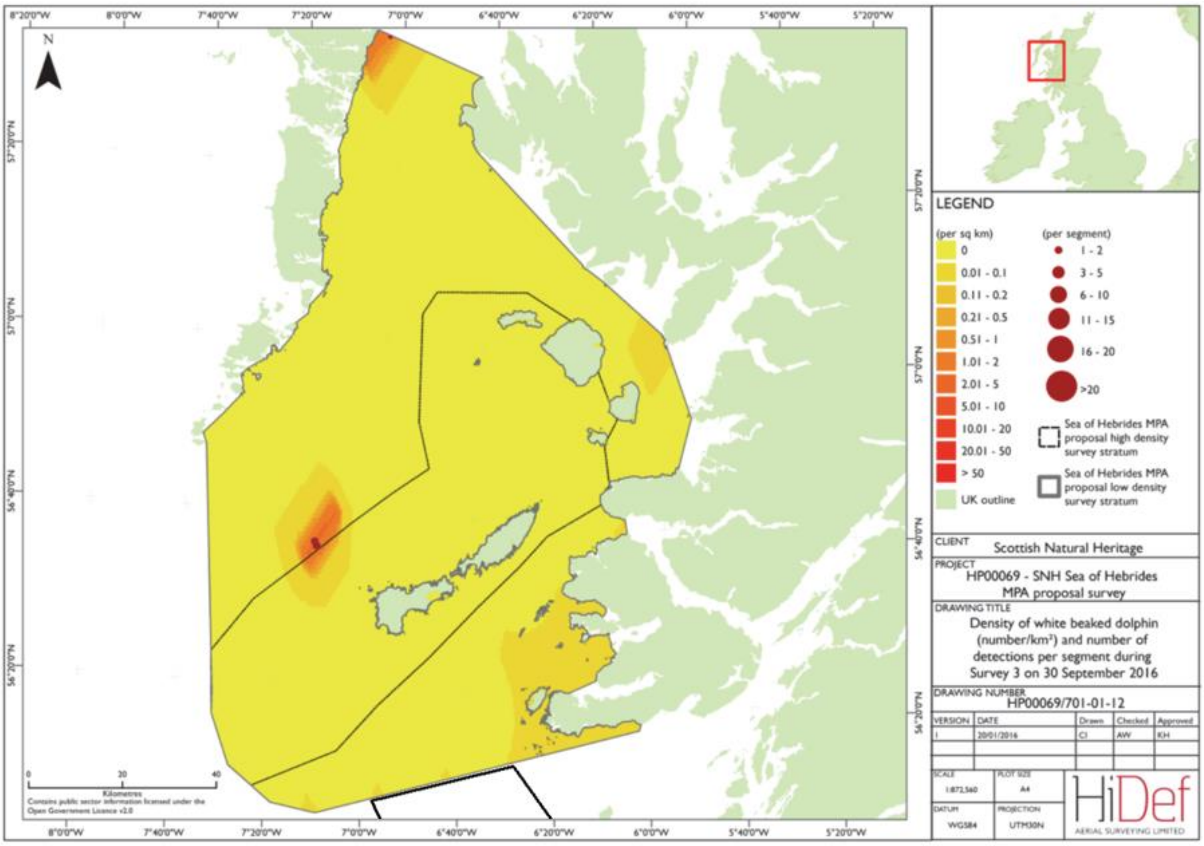


Figure 93: Density of white-beaked dolphins (number/km^2) and number of detections per segment during the HiDef aerial surveys for the Sea of Hebrides pMPA survey (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

For the purpose of this report, the Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Sightings suggest white-beaked dolphins are present year-round around the west of Scotland, with sightings usually in open water further from the coast, and around the Outer Hebrides and the north Minch (Figure 95). White-beaked dolphins were sighted within DPO site N4, in some areas at a minimum rate of >0.035 white-beaked dolphin sightings per unit effort (km) (Figure 95).

White-beaked dolphins were sighted within the North East DPO region during NAMMCO surveys undertaken in 1989, 1995, 1998, 2004, 2009, with sightings overlapping with the boundary of sites NE2, NE3 and NE8 (Figure 96).

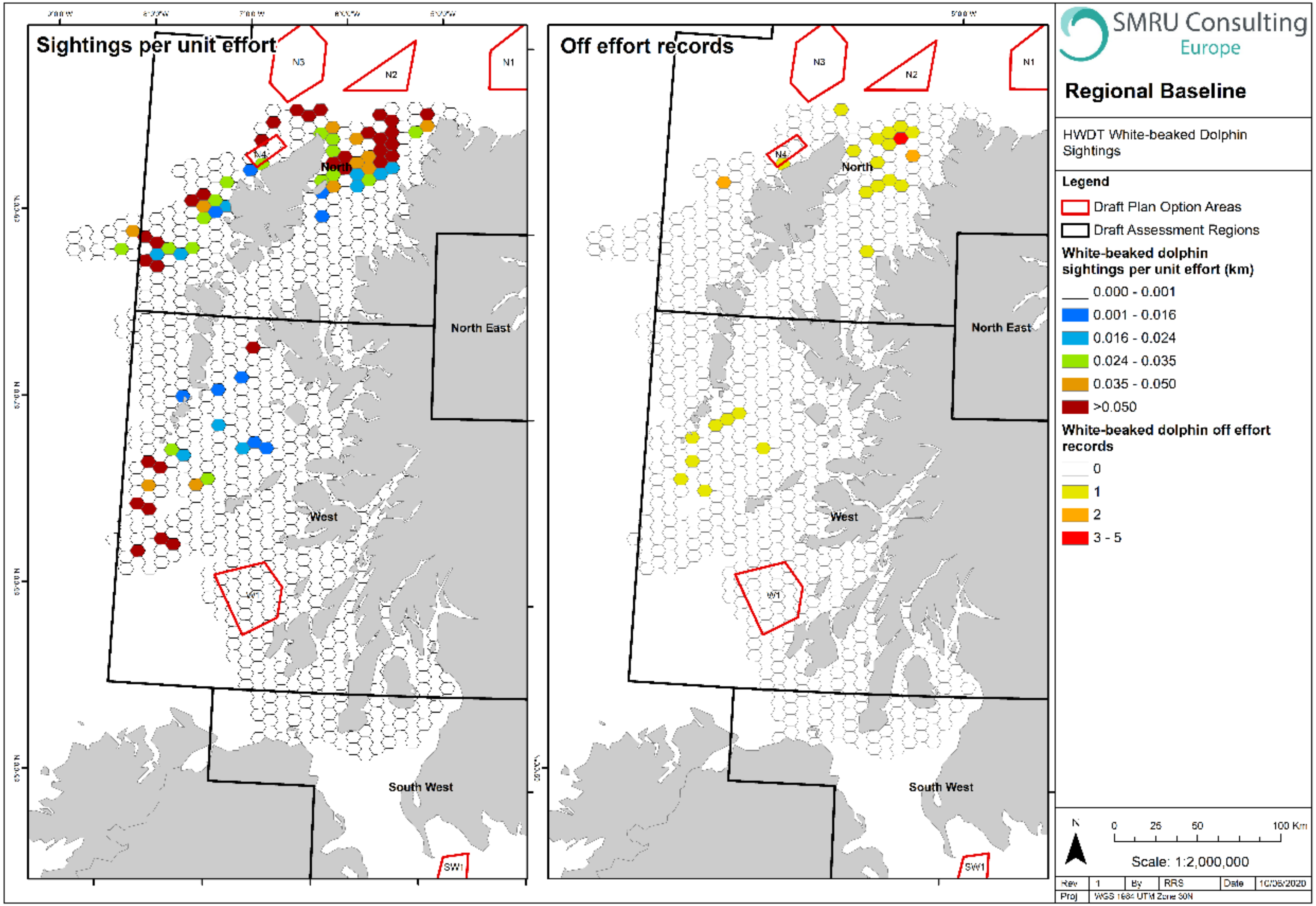


Figure 94: Sightings per unit effort, and off effort sightings, of white-beaked dolphins recorded by the HWDT during vessel based surveys 2003-2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

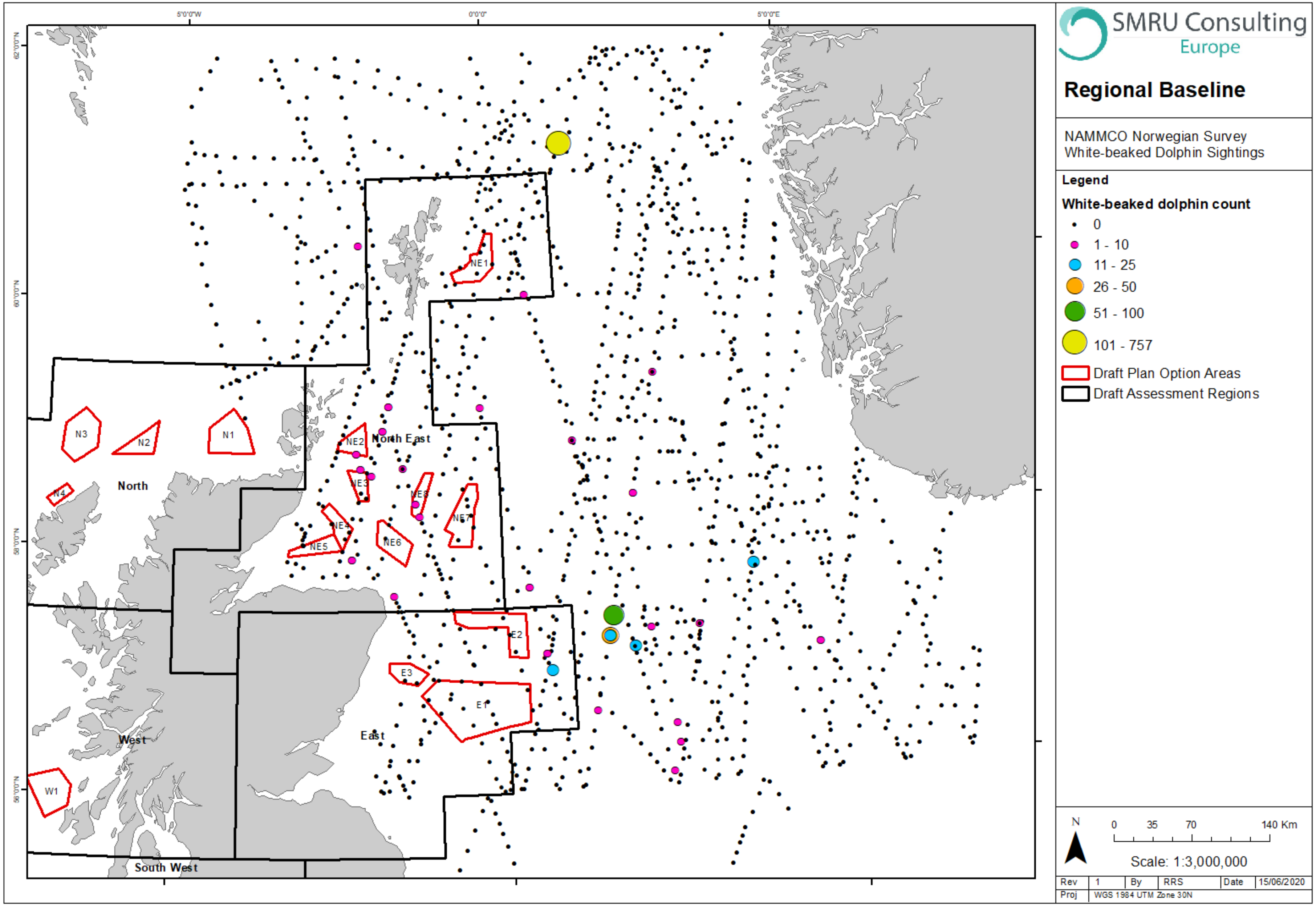


Figure 95: White-beaked dolphin sightings (coloured dots) during NAMMCO surveys in 1989, 1995, 1998, 2004, 2009. Data provided free of charge.

White-beaked dolphins were frequently recorded by marine mammal observers working on seismic survey vessels between 1994-2010, with data analysis suggesting a preference for shelf waters, and with a distribution centred on an area in the central and northern North Sea and outer Moray Firth (Stone 2015). In terms of the DPOs regions, white-beaked dolphins were sighted in all regions apart from the South West region, but by far were sighted most frequently in the North East Region (Figure 97). Sightings overlapped DPO sites N1, NE3, NE4, NE6, NE7, NE8, E1 and E2 (Figure 97).

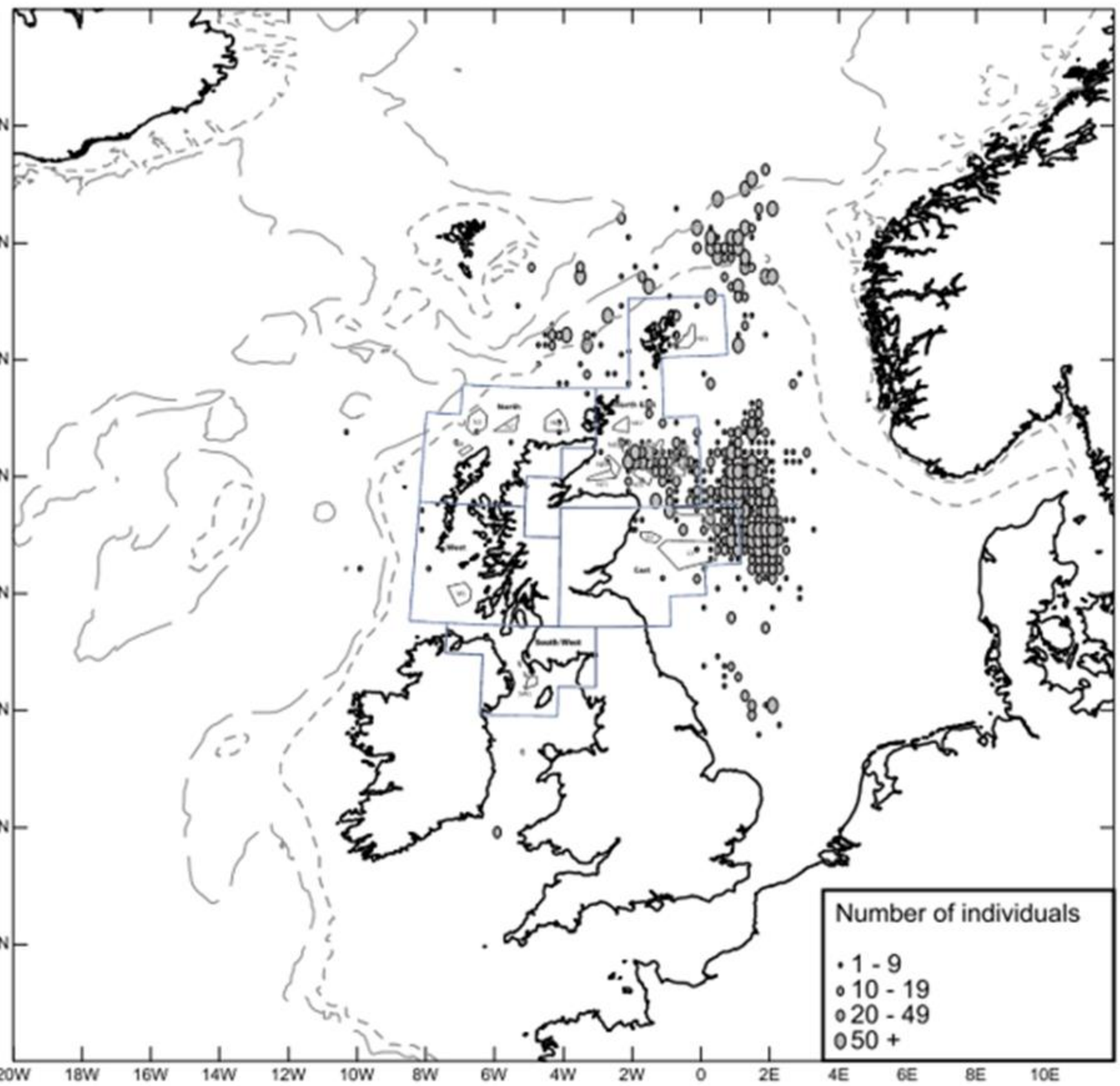


Figure 96: White-beaked dolphins encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

Between 1983 and 1998, the Seabirds at Sea Team (SAST) surveys record white-beaked dolphins distributed across most Scottish waters during the summer months (May-Oct), with sightings in water temperatures ranging from 8.1 to 17.2°C (mean: 12.5°C; SD: 1.2°C) (MacLeod et al. 2008). Sightings of white-beaked dolphins were higher, in comparison to short-beaked common dolphins, in waters <13°C. In terms of the DPOs sites, white-beaked dolphins were sighted in all sites expect SW1 (Figure 97).

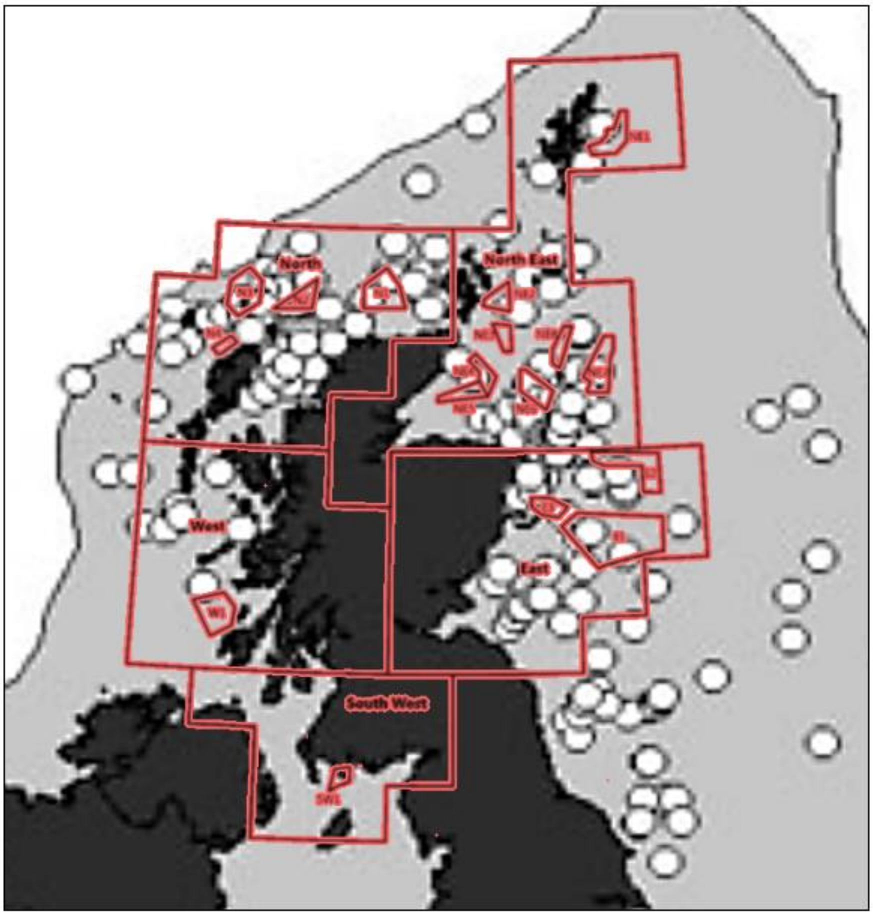


Figure 97: Distribution of white-beaked dolphin sightings, from the Seabirds at Sea Team database, for shelf waters in summer months (May –October) 1983-1998. Grey shading: shelf waters of less than 200 m depth. Note: sightings recorded in non-shelf waters are not shown on this figure. Approximate DPO regions and sites are Overlaid for reference.

The Scottish Marine Atlas describes white-beaked dolphin habitat as open coast, sea lochs and with a preference for waters shallower than 200 m and along the shelf edge. The Atlas describes white-beaked dolphins as being abundant in all Scottish waters, but with a concentration around the Hebrides and Northern Isles (Baxter et al. 2011). Mapped encounter rates show low to medium encounter rates across almost all Scottish waters, including all DPOs sites aside from W1 and SW1 (Figure 98).

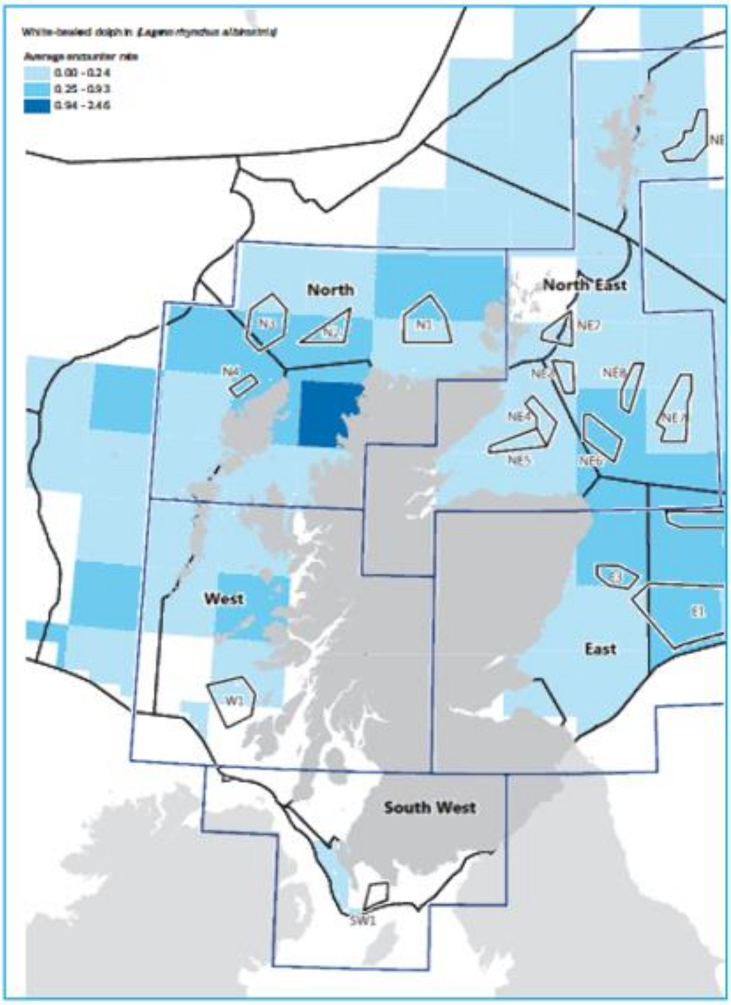


Figure 98: White-beaked dolphin average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Older data presented in the Atlas of Cetacean Distribution show white-beaked dolphins occur year-round over the continental shelf waters and near-shore waters of Scotland, sighted most frequently between June and October in the central and northern North Sea and along western Scotland (Figure 99) (Reid et al. 2003). Sightings were recorded in these surveys in all DPOs sites, except for site SW1.

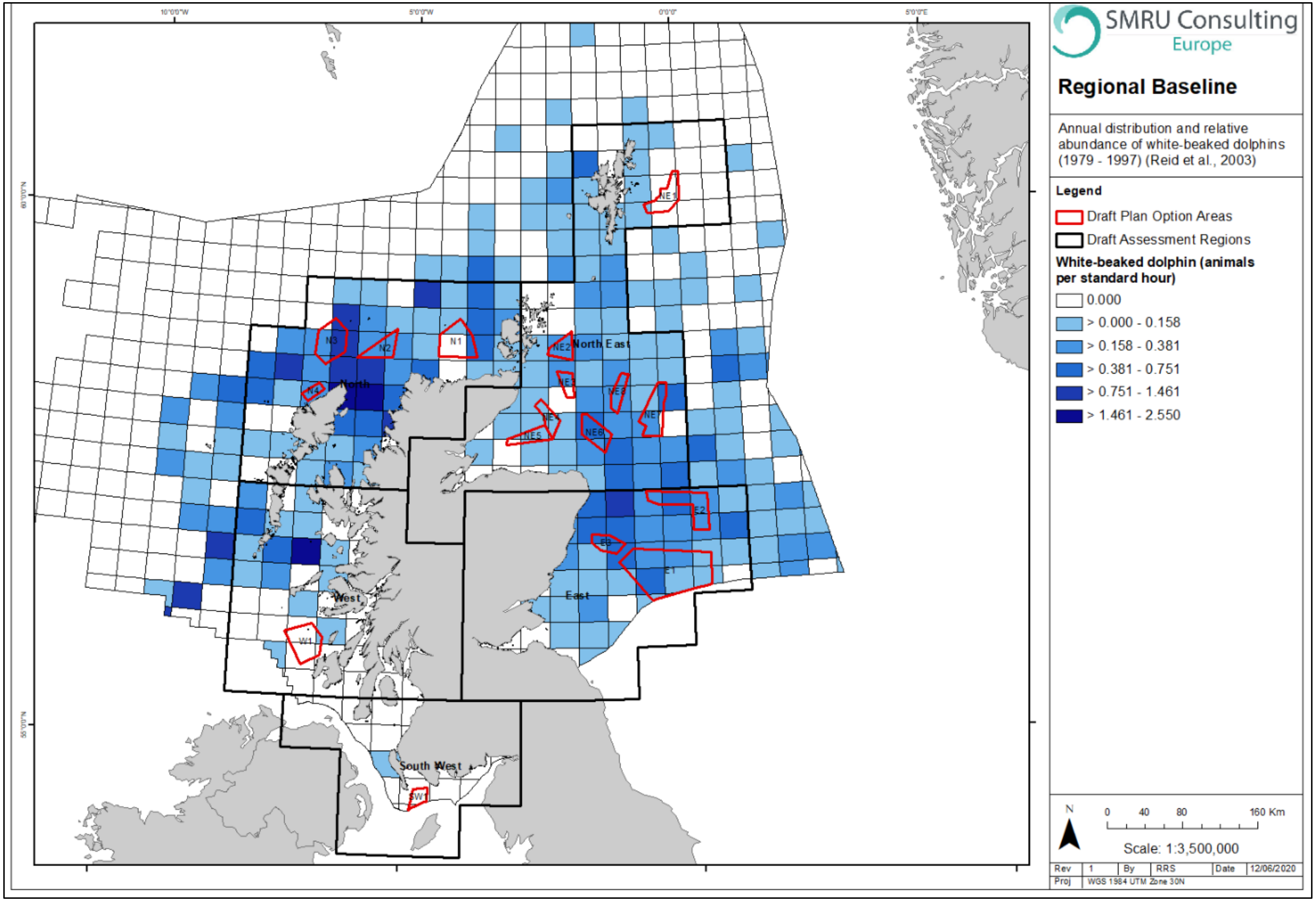


Figure 99: Aggregated annual distribution and relative abundance of white-beaked dolphins (1979-1997) based on data presented in Reid et al. (2003).

Another now quite dated data source showed that in inshore waters, white-beaked dolphins were the most frequently sighted cetacean of the Cetaceans of the Atlantic Frontier surveys (Weir et al. 2001). Distribution was almost entirely confined to shelf areas within the 200 m isobath, and sightings occurring in every month of every year, with again an increase in numbers between May and September, peaking in August potentially associated with concentrations of spawning herring (Weir et al. 2001). Spatial use of Scottish waters varies by month, with distribution centred around northern Scotland overall but variations in numbers around the Minch, the Hebrides and the North Sea varying over the course of the year (Figure 101) (Weir et al. 2001). Weir et al. (2001) predict white-beaked dolphin abundance to be especially high in DPO site N4, especially between May and October (Figure 101) (Pollock et al. 2000).

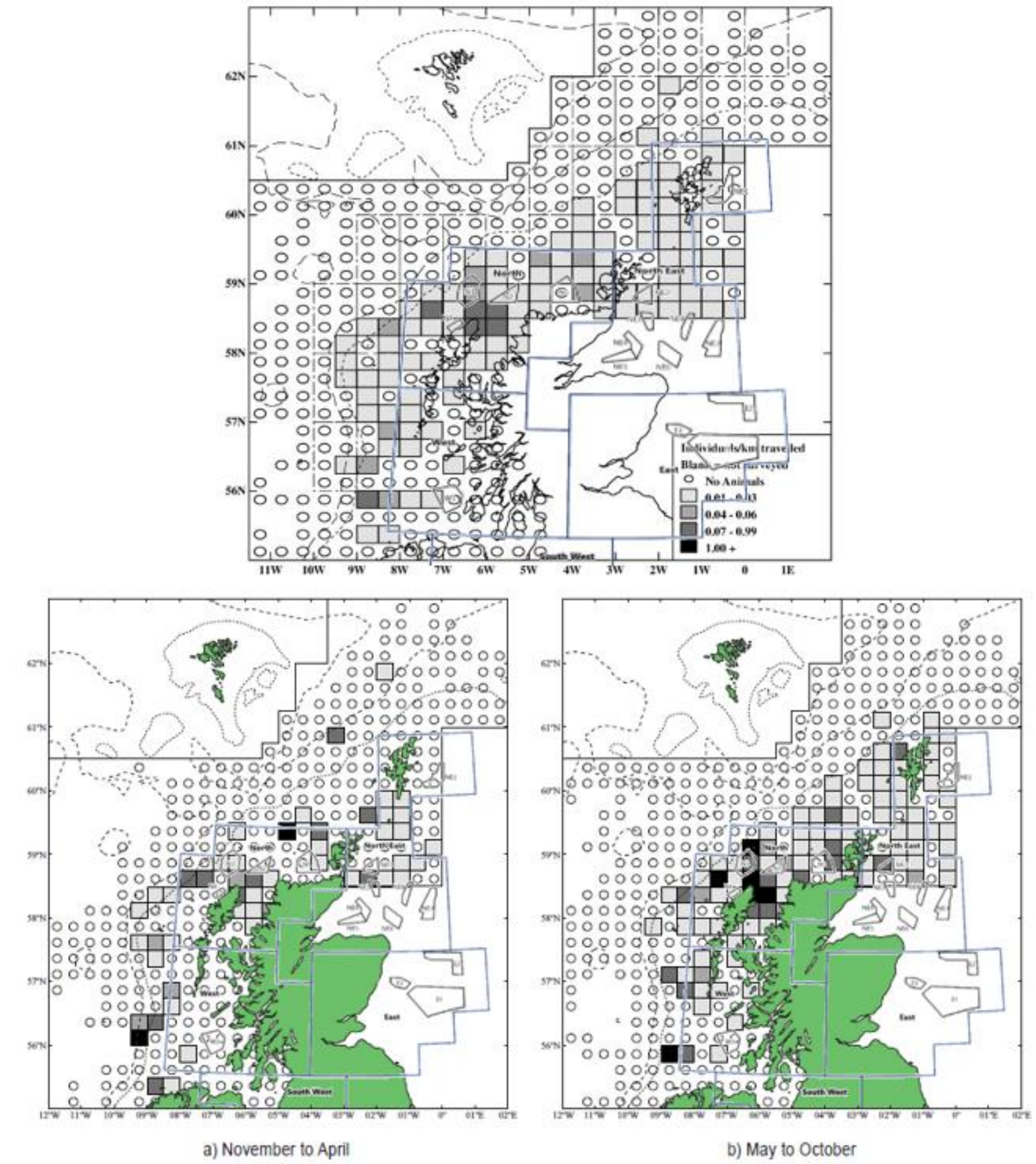


Figure 100: Above: Abundance of white-beaked dolphins (1979-1998) presented in the Cetaceans of the Atlantic Frontier surveys. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadra nts) (Weir et al. 2001) Below: Abundance of white-beaked dolphins (left) November to April and (right) May to October (1979-1999). (Pollock et al. 2000). Note, the legend is applicable to all figures. Overlaid for reference are the approximate regional and DPO areas.

Dedicated watches on ferry routes rarely recorded white-beaked dolphin sightings, with no overlap with DPO sites (Figure 97).

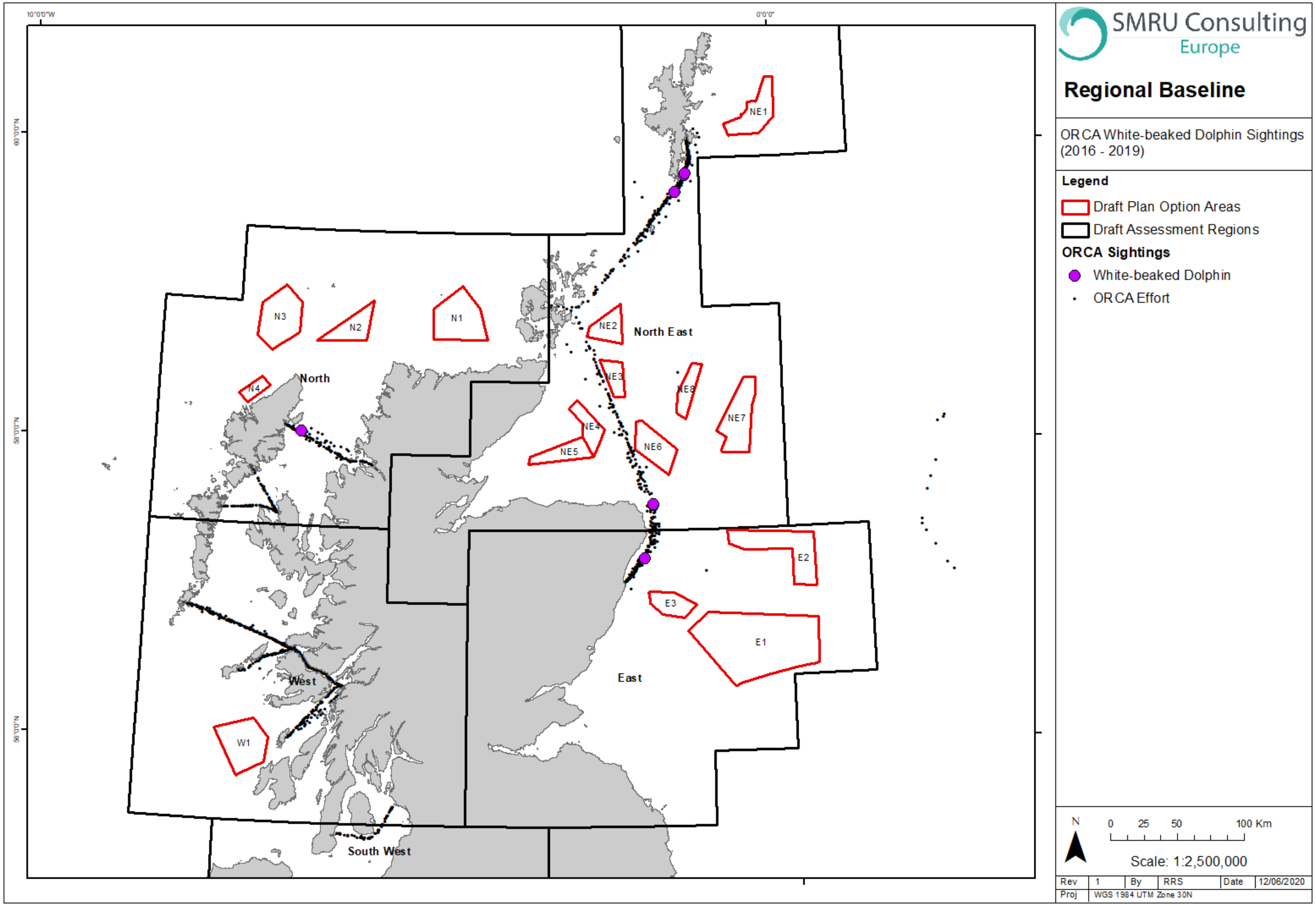


Figure 101: White-beaked dolphin sightings recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth did not record any white-beaked dolphin sightings between 2002 and 2016 during a total of 241 trips. However, further north within the Pentland Firth and Orkney Isles, fine scale sightings data over 1980-2010 show a fairly even distribution of coverage of sightings between inshore and offshore waters, with some sightings to the east and west of Orkney overlapping the DPOs sites N1, N2, NE2 and NE4 (Figure 103).

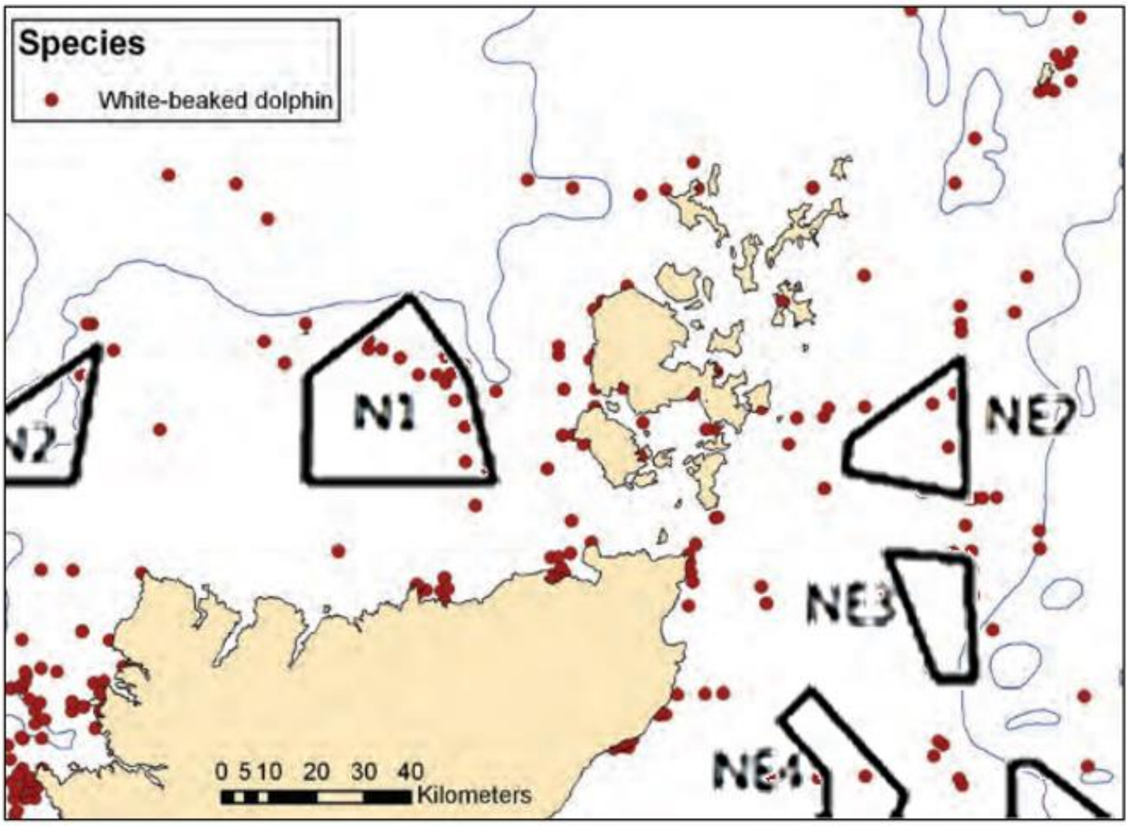


Figure 102: Distribution of sightings of white-beaked dolphins around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Extensive survey effort conducted in east Scotland for the Forth and Tay offshore windfarms (Seagreen, Neart na Gaoithe and Inch Cape) have confirmed that white-beaked dolphins are present in the Forth and Tay area (Sparling et al. 2011, Grellier and Lacey 2012, Inch Cape 2012, Neart na Gaoithe 2012, Sparling 2012, Inch Cape Offshore Limited 2018, Neart na Gaoithe 2018). All surveys confirmed that white-beaked dolphin sightings rates were higher in the summer months and that this species was more often sighted in offshore parts of the survey areas (e.g. Figure 104 and Figure 105).

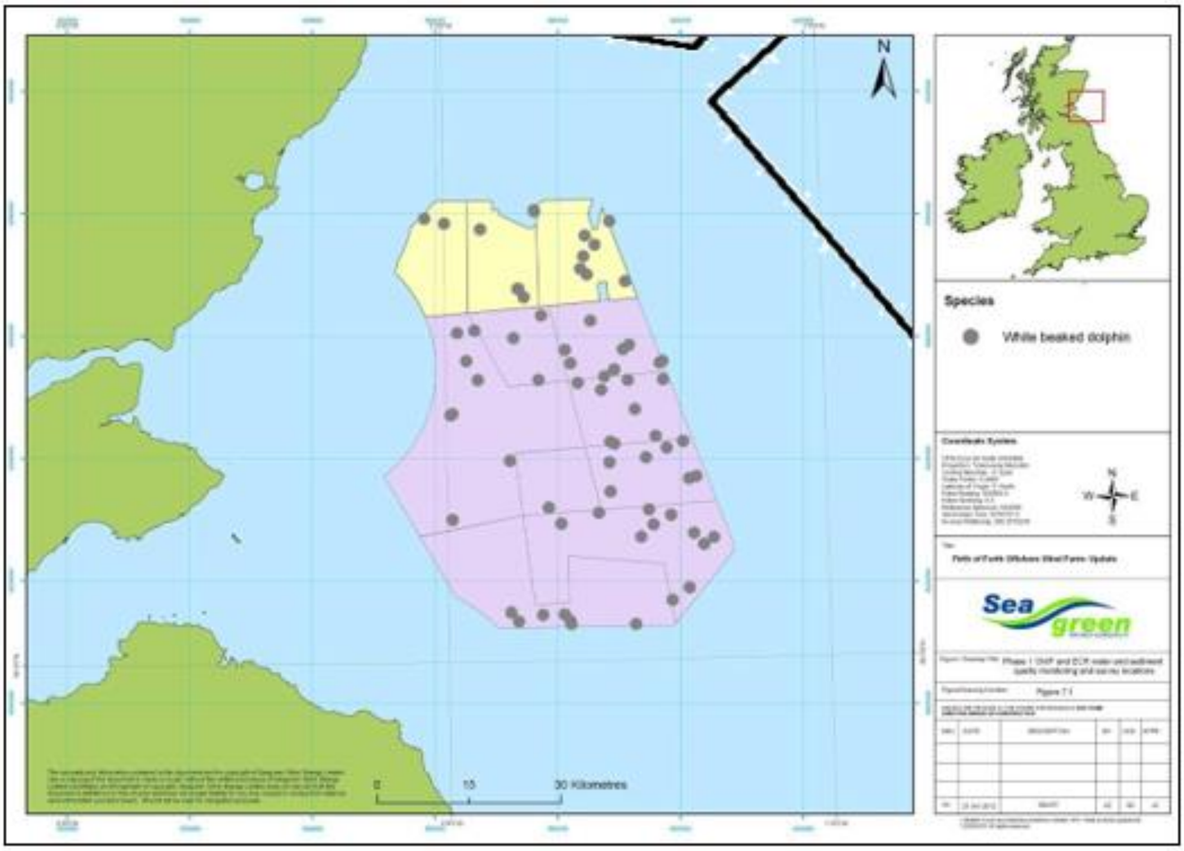


Figure 103: White-beaked dolphin sightings from the Firth of Forth Round 3 Zone vessel surveys May 2010 to November 2011 (Sparling 2012). DPO sites are Overlaid for reference, with the boundaries of sites E1 and E3 to the north east of the survey area.

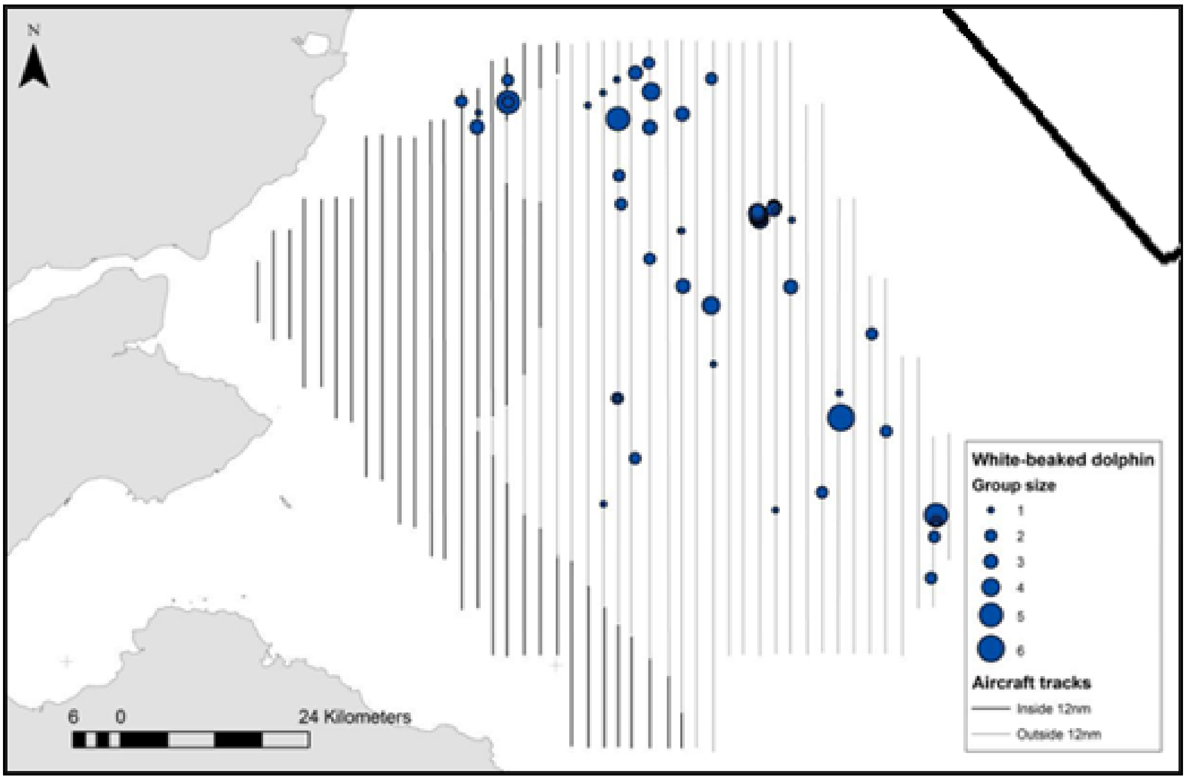


Figure 104: White-beaked dolphins sighted during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPO sites are Overlaid for reference, with the boundaries of site E1 to the north east of the survey area.

Sightings data covering the East Grampian coastline between 1973 and 2010 presented by Anderwald and Evans (2010) show a potential overlap of white-beaked dolphin distribution with DPO site E3 (Figure 105), with white-beaked dolphins seen regularly both nearshore and offshore, with sightings almost exclusively mid to late summer (Anderwald and Evans 2010).

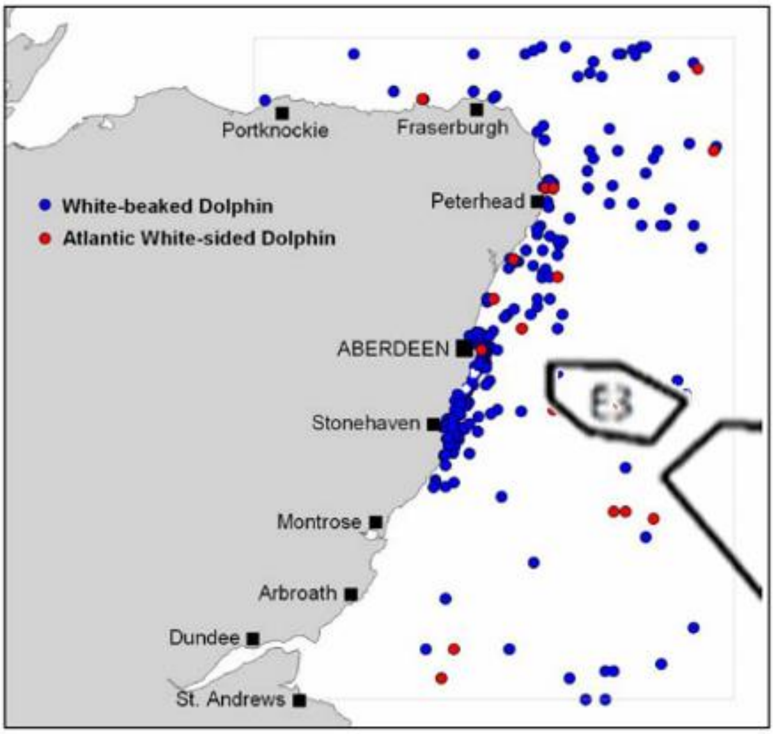


Figure 105: Distribution of White-beaked (blue dots) and Atlantic White-sided Dolphin (red dots) sightings in East Grampian Region (Anderwald and Evans 2010) (Anderwald and Evans 2010). Overlaid for reference are the approximate regional and DPO areas.

Land-based Shorewatches conducted at designated locations around the Scottish coastline recorded sightings of white-beaked dolphins infrequently, with the majority of sightings reported at Tiumpan Head on the Isle of Lewis, and around the north east tip of the Scottish mainland (Figure 106).

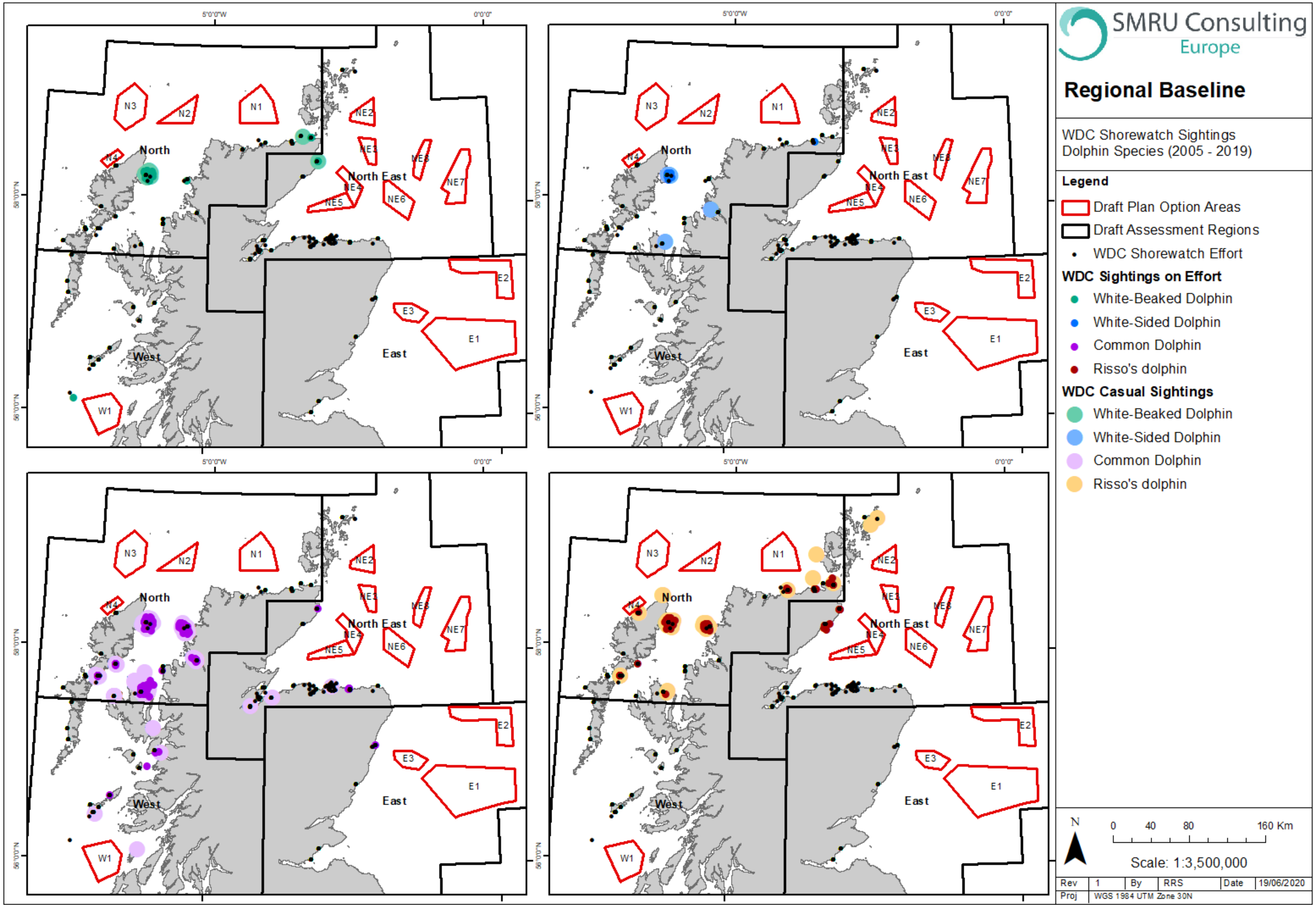


Figure 106: Sightings of white-beaked, white-sided dolphin, common dolphin and Risso's dolphins) recorded by WDC Shorewatch 2005 and 2019. Data provided free of charge by WDC.

3.3.7. Minke whale

Based on the information presented below, minke whales are present in Scottish waters primarily in the summer months and are considered to be seasonal visitors. However, sightings do occur in some areas year-round. There is some expected overlap with DPO areas, especially for those sites within the Moray Firth.

The most recent assessment of minke whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019k). Minke whale sightings are widely distributed, with sightings occurring between January and October with a peak between June and August, though minke whales are present in coastal UK waters year-round (Evans et al. 2011). In autumn there appears to be a shift offshore, potentially associated with breeding (Evans et al. 2011).

The most recently collected broad scale data on minke whale abundance and distribution are available from the SCANS III survey. Minke whales were sighted in Scottish waters in all three SCANS surveys, with sightings concentrated in coastal Scottish waters and more offshore in the North Sea. The SCANS III survey blocks with the highest estimated densities were Block G (northern Ireland and southern Inner Hebrides), T (Shetland) and R (east coast) with density estimates in Scottish waters ranging from 0.008 to 0.039 mike whales/km^2 (Figure 107, Figure 108). Whilst there were sightings of minke whales during the SCANS III survey in all DPOs regions, no sightings were within any DPO sites (Figure 109).

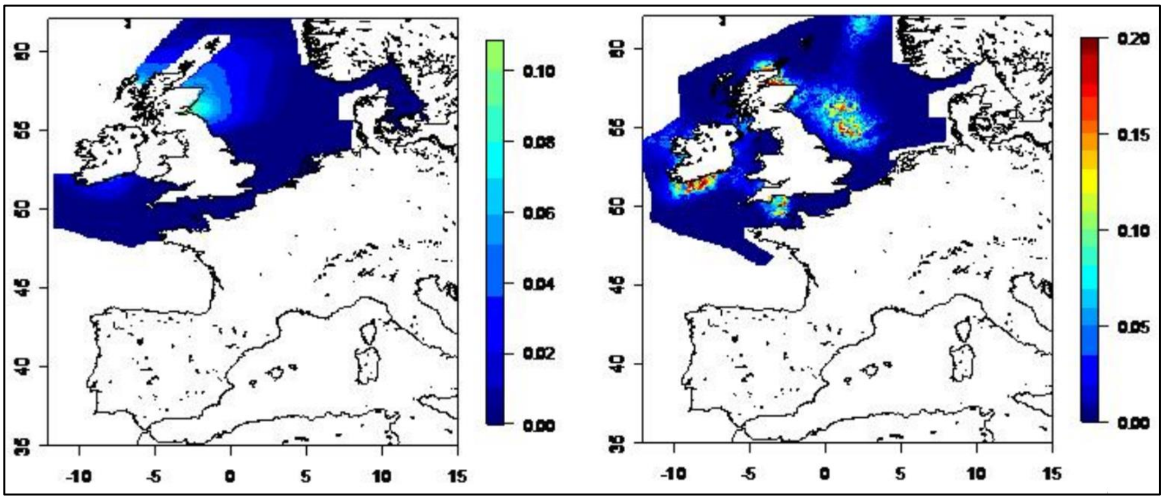


Figure 107: Minke whale estimated density surface (animals per km2) (left) in 1994 and (right) in 2005 (Hammond et al. 2006).

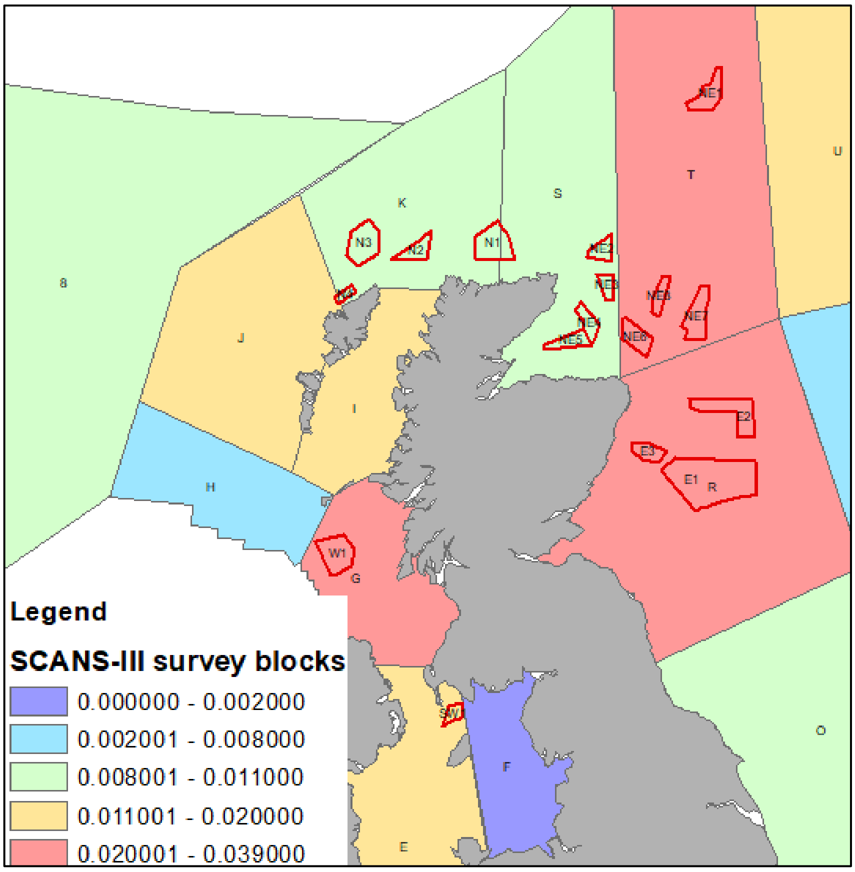


Figure 108: SCANS III block-wide uniform density estimates for minke whales in Scottish waters (Hammond et al. 2017). Overlaid for reference are the DPO areas.

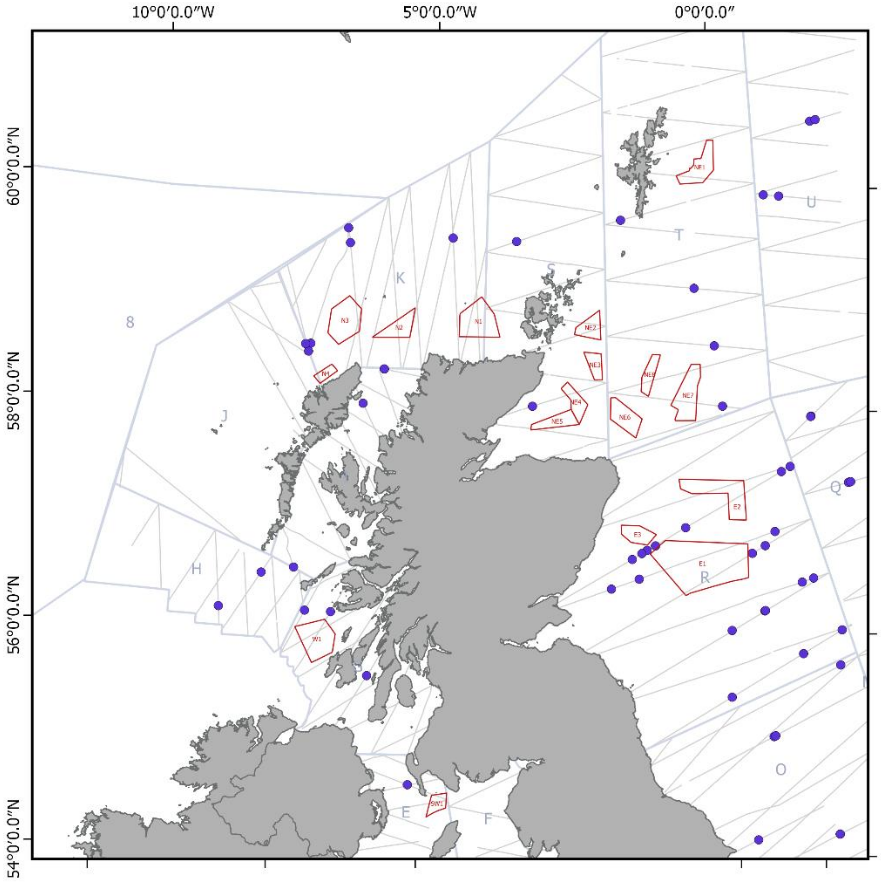


Figure 109: Sightings of minke whale during the SCANS III surveys, in blocks containing DPOs areas (red). Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

For the purpose of this report, Hammond & Lacey (Appendix 3: SCANS surveys) have provided predicted density surfaces for minke whales within Scottish waters using SCANS III survey data. Minke whale density predictions per km^2 were reasonably high across Scottish waters, with lower densities predicted on the west coast, around the Hebrides, and the Fair Isle channel. Density predictions are particularly high in the North and East DPO regions, especially site NE4, NE5 and E1 (Figure 110). At sites NE4 and NE5 within the Moray Firth, densities of >0.04 animals per km^2 are predicted (Figure 110). Upon first inspection, sightings of minke whales recorded during the SCANS III surveys (Figure 109) do not appear to closely match the predicted density surface for minke whales using that data (Figure 110). This is because the predicted density surfaces are generated from the modelled relationships between animal presence (sightings locations) and the environmental covariates retained in generalised additive models (GAMs). Maps of predicted density may therefore differ from maps of sighting locations for a number of reasons, including: some areas receiving more effort than others; sightings being dependent on weather conditions (which are corrected for during the density modelling) and finally the density predictions in a particular area being a result of modelled density-environment relationships fitted to data from the wider area.

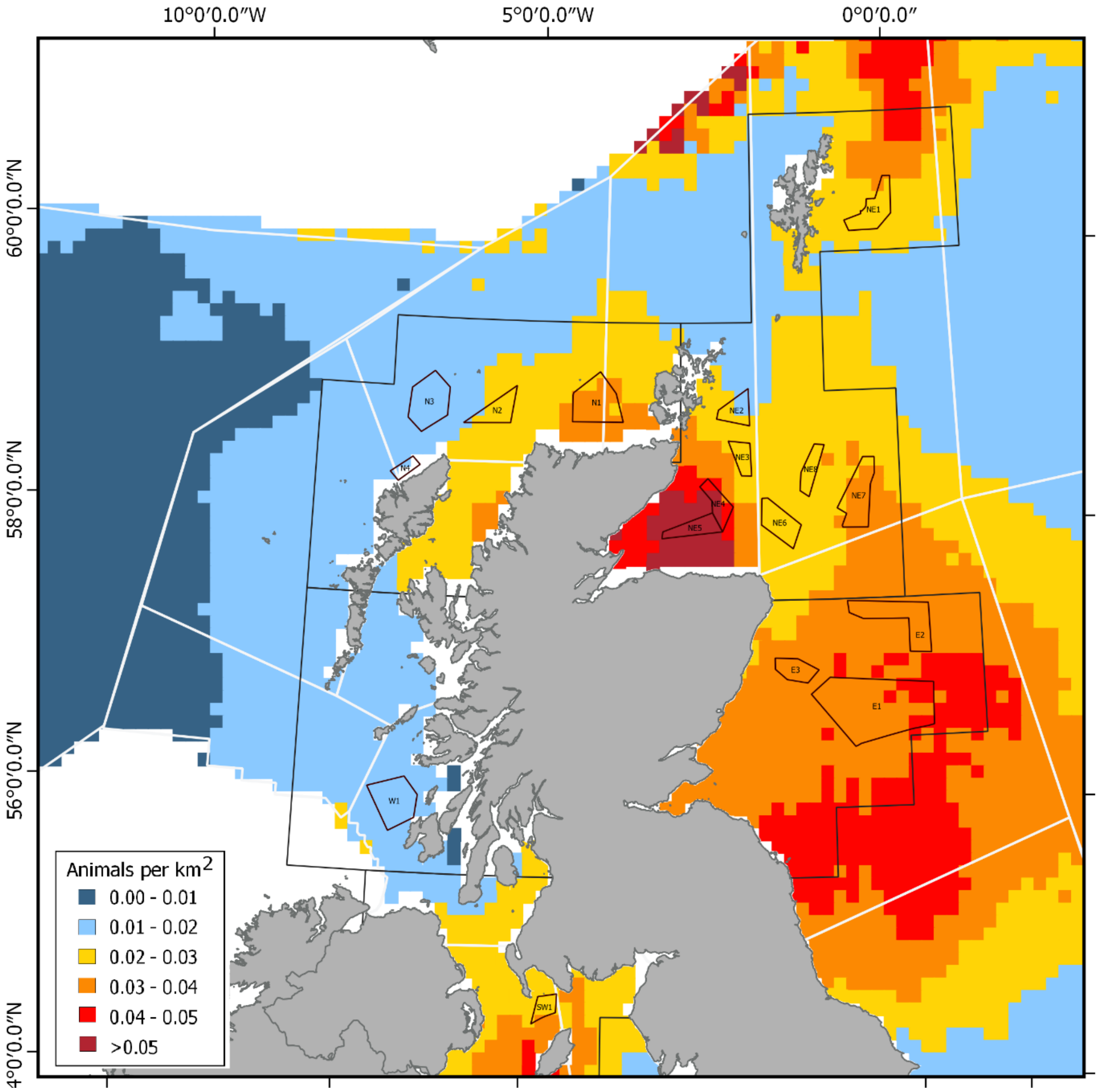


Figure 110: Predicted density surface for minke whales in 2016 using SCANS III data. The colour scale is in units of animals per km^2. DPO Areas are outlined in black for reference. SCANS-III survey block areas are marked in white. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The most recent collation of data seeking to provide estimates of minke whales distribution within the North-East Atlantic, including Scottish waters is presented in Waggitt et al. (2020). The species distribution maps produced by Waggitt et al. (2020) showed large seasonal variation in minke whale densities in Scottish waters, with low densities in winter months and much higher densities in the summer months, particularly in the Hebrides (Figure 111) (Waggitt et al. 2020). The species distribution predictions are particularly relevant to the North, North East and West DPOs regions. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

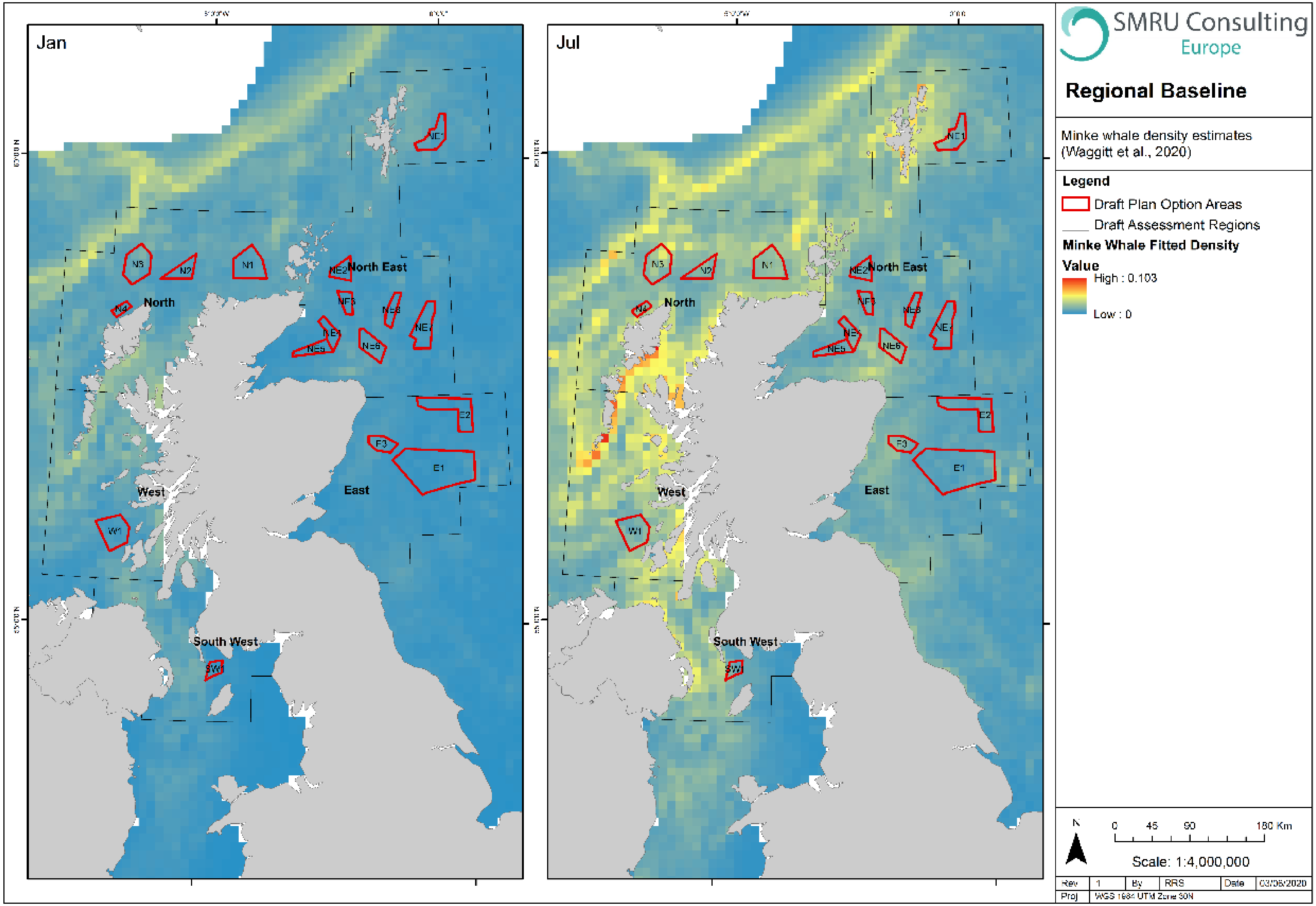


Figure 111: Spatial variation in predicted minke whale densities (animals per km²). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Paxton et al. (2014) estimated the relative density for minke whales in Scottish waters in order to inform MPA designations and used the JCP dataset[20] in addition to data provided by SNH to estimate densities for minke whale using data collected between 2000 – 2012. Sightings were mostly in the summer months, on the east, north and west coasts of Scotland especially around the Hebrides, in the Outer Moray Firth and off the coast of Angus (Figure 112) (Paxton et al. 2014). The model predicted higher densities of minke whales in the Moray Firth and around the Hebrides, as well as regions to the west and south-west of the Outer Hebrides and to the south of the Isle of Arran, however there was less effort and more uncertainty in these areas. Minke whale presence was associated with sea surface temperature and chlorophyll concentrations, both of which are dynamic variables with annual variations, suggesting that their distribution will change annually. The recommendations put forward by Paxton et al. (2014) with regards minke whale distribution were instrumental in the designation of the Southern Trench MPA (Figure 114) and the Sea of the Hebrides pMPA (Figure 115). The Sea of the Hebrides pMPA borders the W1 DPO site, whilst the Southern Trench pMPA is close to Moray Firth sites NE4, NE5 and NE6.

[20] See Paxton et al. (2014) for a full list of acknowledgements of organisations that collected, compiled and provided data.

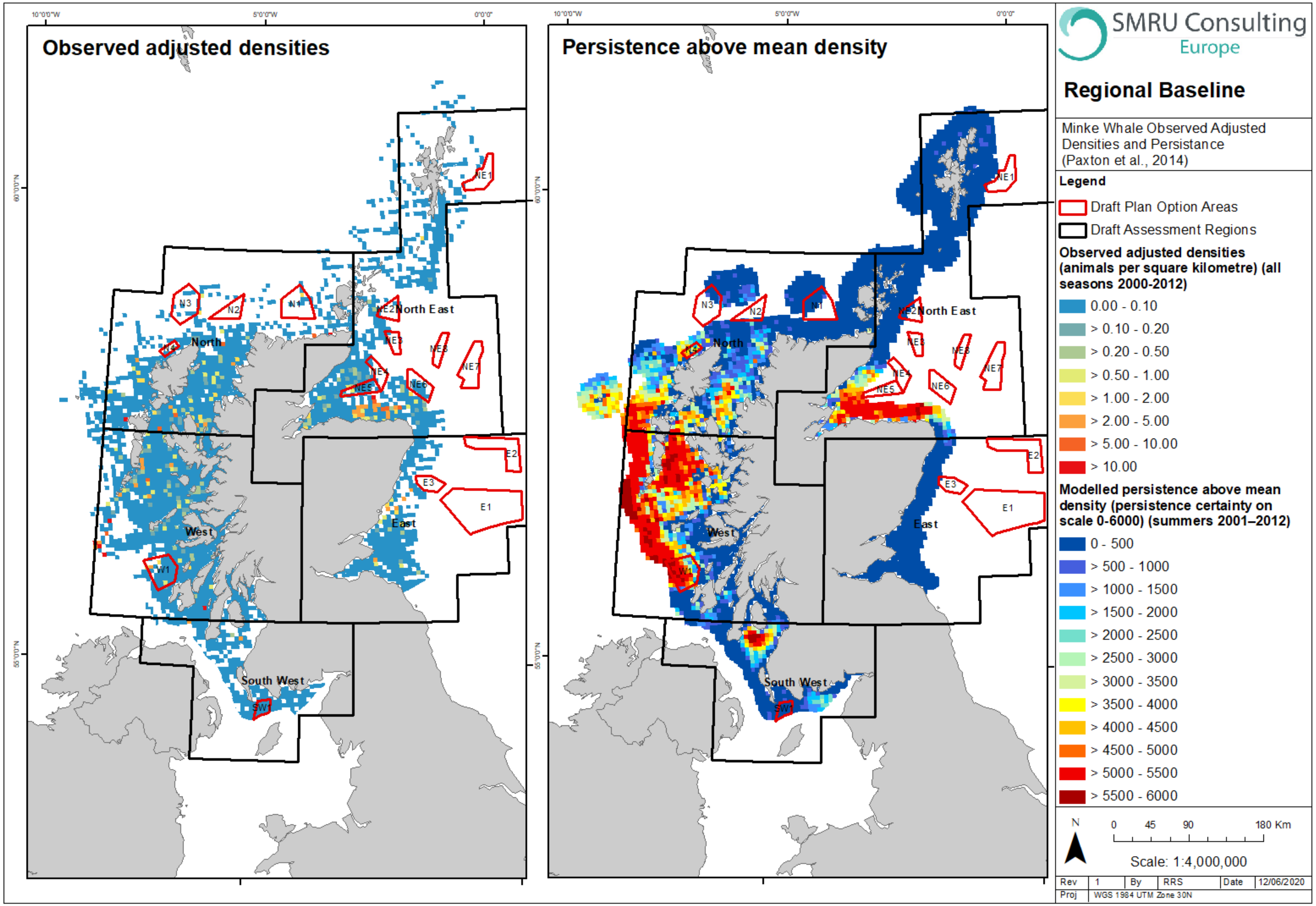


Figure 112: Observed adjusted densities and persistence above mean density of Minke whale recorded across all seasons 2000 to 2012. Each cell is 5 by 5 km. Paxton et al. (2014).

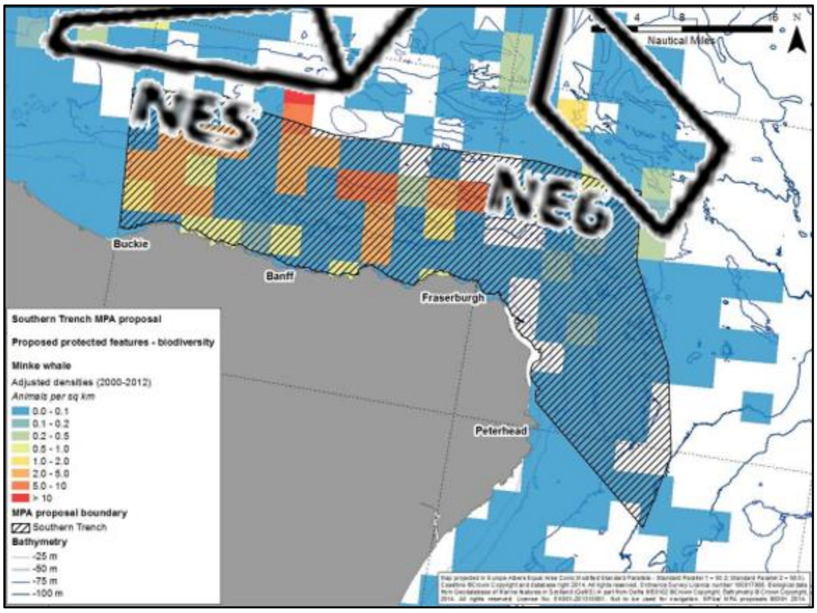


Figure 113: Minke whale adjusted densities (2000-2012) and the Southern Trench MPA proposal boundary. Minke whale data from Paxton et al. (2014), MPA proposal map taken from the Southern Trench MPA Proposal – data confidence assessment, available on the SNH website[21]. Overlaid for reference are the approximate DPO areas.

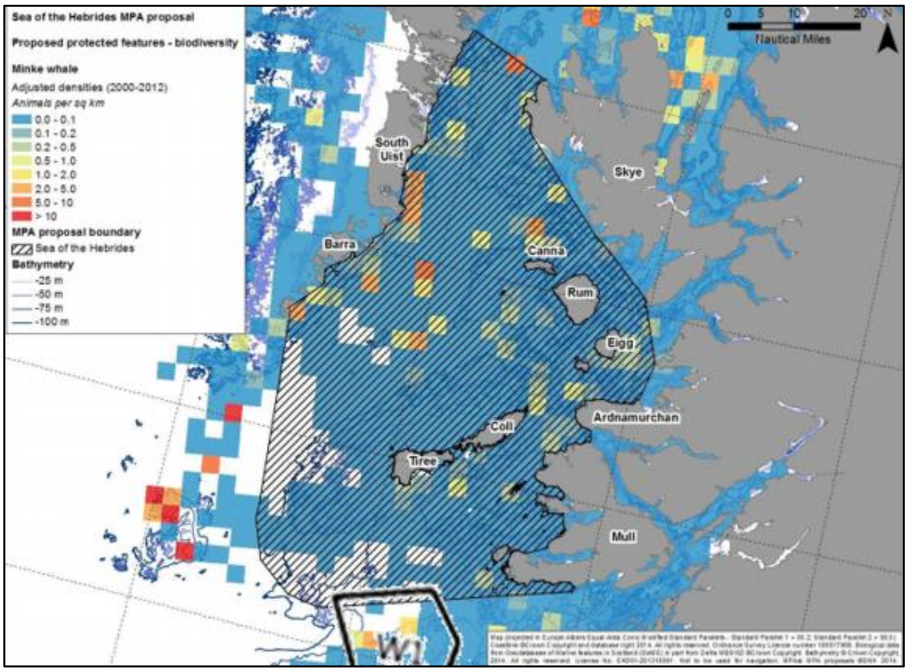


Figure 114: Minke whale adjusted densities (2000-2012) and the Sea of the Hebrides MPA proposal boundary. Minke whale data from Paxton et al. (2014), MPA proposal map taken from the Sea of the Hebrides MPA Proposal – data confidence assessment, available on the SNH website[22]. Overlaid for reference are the approximate DPO areas.

[21] https://www.nature.scot/sites/default/files/2017-11/Marine%20Protected%20Area%20-%20Data%20confidence%20assessment%20-%20Southern%20Trench%20MPA%20proposal.pdf
[22] https://www.nature.scot/sites/default/files/2017-11/Marine%20Protected%20Area%20-%20Data%20confidence%20assessment%20-%20Sea%20of%20the%20Hebrides%20MPA%20proposal.pdf

Whilst minke whales were one of the two species of focus for the Webb et al. (2018) HiDef surveys within the Sea of Hebrides pMPA survey area, they were actually sighted very infrequently (Figure 116). This led the authors to conclude that aerial surveys are an ineffctive technique for collecting data on minke whales.

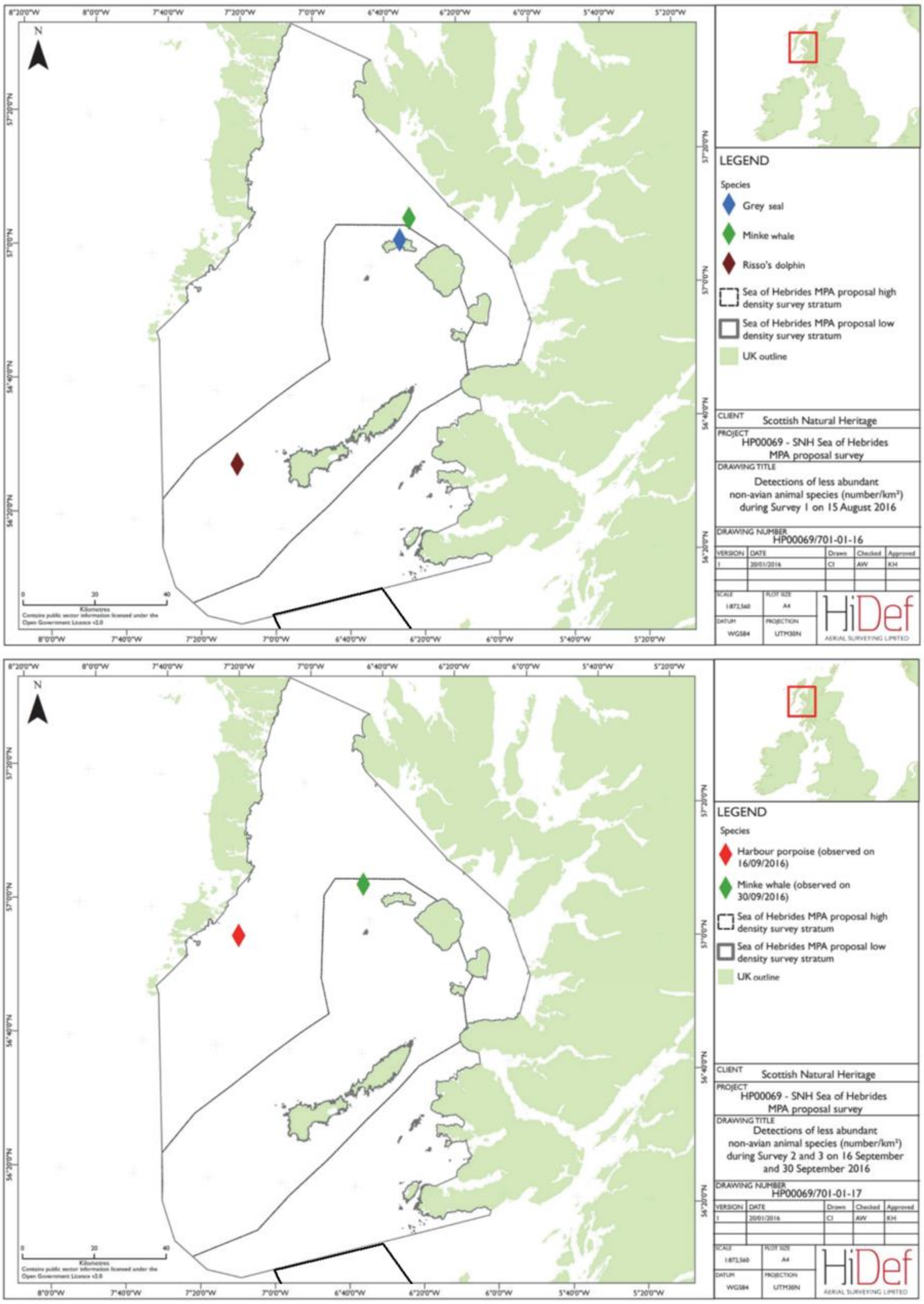


Figure 115: Top: Detections of grey seal, minke whale and Risso's dolphins during Survey 1 of 3 HiDef aerial surveys for the Sea of Hebrides pMPA survey. Bottom: Detections of minke whales and harbour porpoise during Survey 2 and 3 of three (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

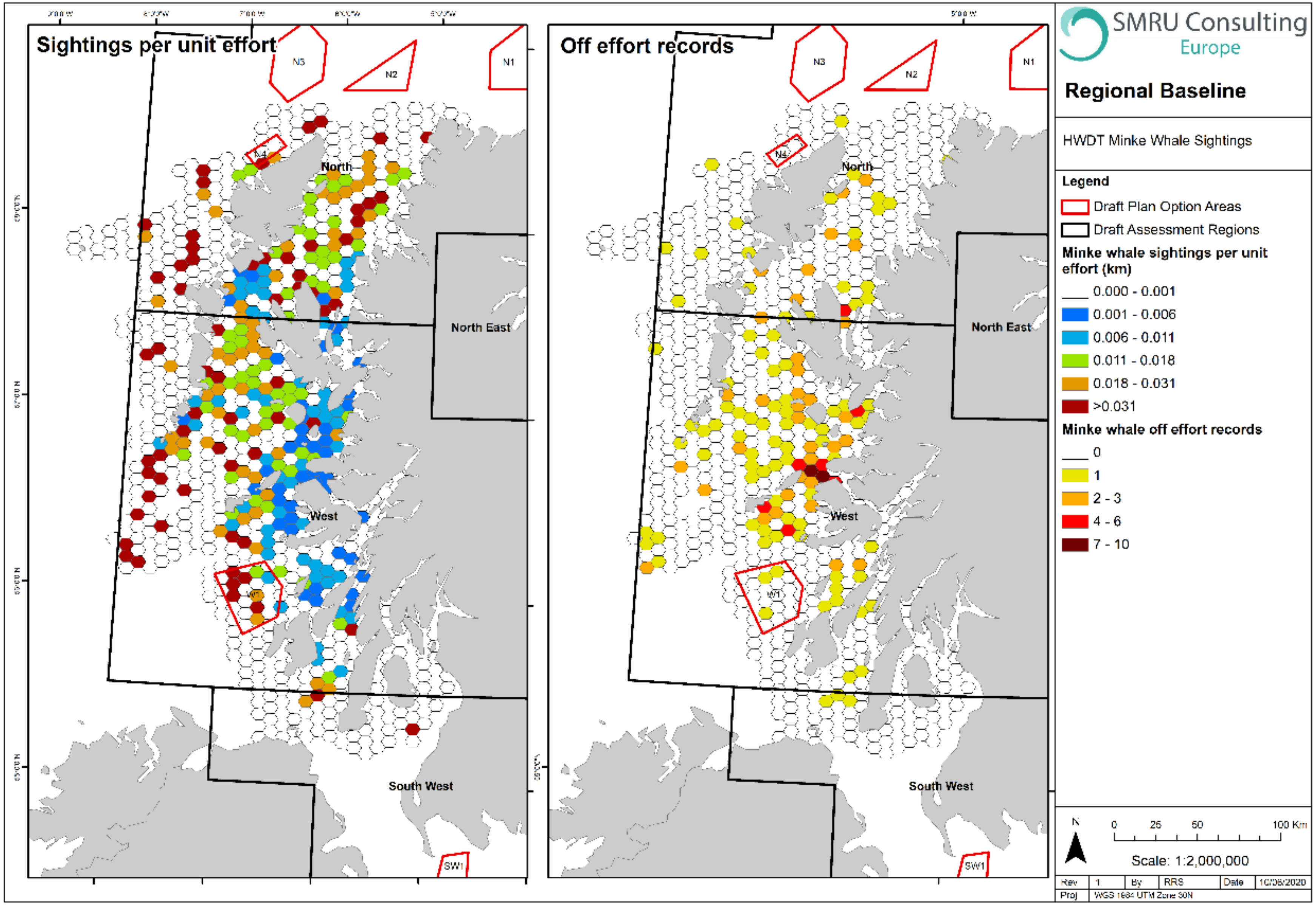


Figure 116: Sightings per unit effort, and off effort sightings, of minke whales recorded by the HWDT during vessel based surveys 2003-2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

Data from HWDT were instrumental in highlighting the densities of minke whales that use the Sea of Hebrides in order for it to be put forward as a proposed pMPA. For the purpose of this report, the Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Minke whales are sighted most frequently in coastal waters around the Hebrides between April and October of each year, with highest encounter rates around the Small Isles and the east of the Outer Hebrides throughout the Minch and the Sea of Hebrides (Figure 116). Minke whales were sighted in both DPO sites covered by the HWDT data, sites W1 and N4. Sightings rates were especially high in W1, with a proportion of the area having a minimum rate of >0.031 minke whale sightings per unit effort (km) (Figure 116).

The Scottish Marine Atlas describes minke whale habitat as open coast, straits and sounds, sea lochs and occasionally offshore, with a distribution throughout Scottish waters (Baxter et al. 2011). Mapped encounter rates show encounter rates are especially high in DPOs sites N1, N2, E1, E2 and E3 (Figure 117).

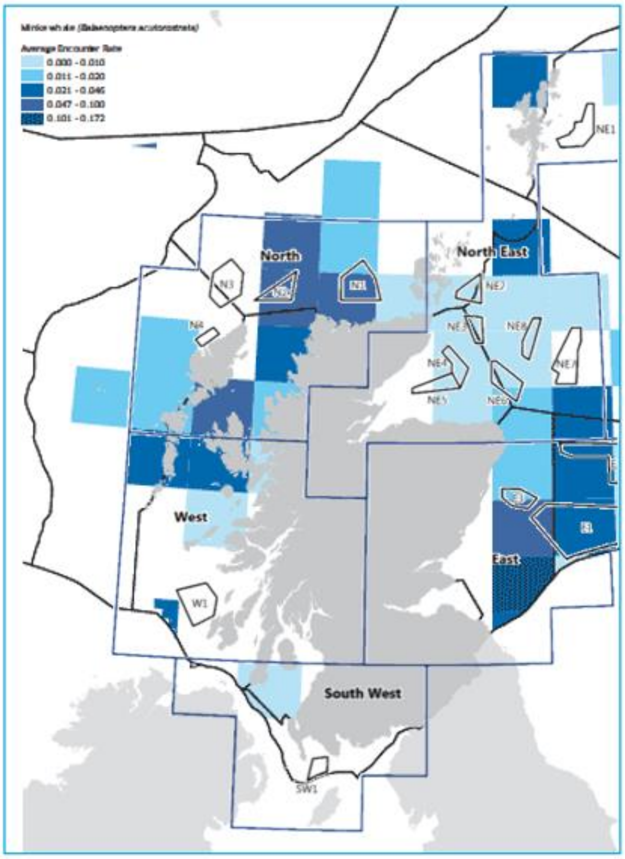


Figure 117: Minke whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Older data, which informed the Atlas of Cetacean Distribution report, found that minke whales were widely distributed along the Atlantic seaboard of Scotland with an occurrence throughout the northern and central North Sea, with potentially higher abundances in the western part of the North Sea (Reid et al. 2003). Minke whales were mainly sighted on the continental shelf in water depths of <200 m and often close to land, although sightings have been reported far from shore between north-west Scotland and the Faroes in August, and over the Rockall Bank in September, in waters of mainly 150-500 m depth (Figure 120) (Reid et al. 2003). Sightings occurred year-round, with a peak between May and September although this may be a reflection of increased detectability during the summer months. The sightings presented by Reid et al. (2003) show an overlap of minke whale distribution with almost all DPOs sites.

Similarly, the Cetaceans of the Atlantic Frontier surveys presented by Weir et al. (2001) recorded minke whales as the most common baleen whale recorded in Scottish waters, with the majority (118 of 130) of sightings occurring in depths less than 200 m. Minke whales were only sighted between May and October, with over 74% of the total number of animals recorded between June and August, and most frequent sightings occurring in the northern Minch, particularly the east coast of Lewis (Figure 119). Sightings overlap with DPO NE2.

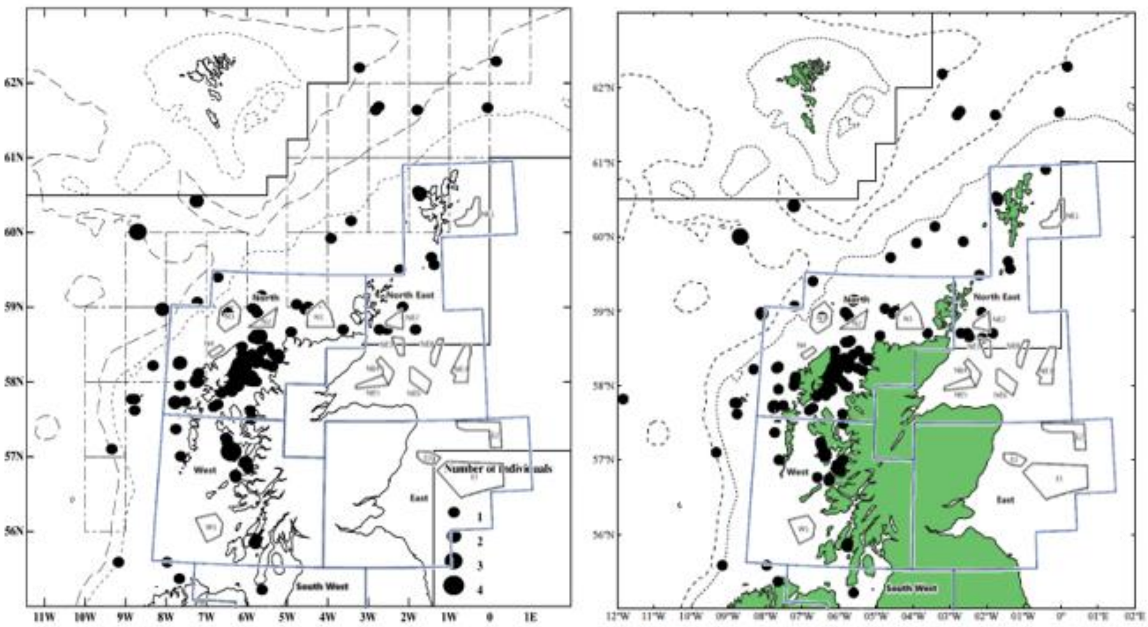


Figure 118: Left: Distribution of minke whale sightings (1979–1998) presented in the Cetaceans of the Atlantic Frontier surveys. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001). Right: Distribution of minke whale sightings (1979–1999) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

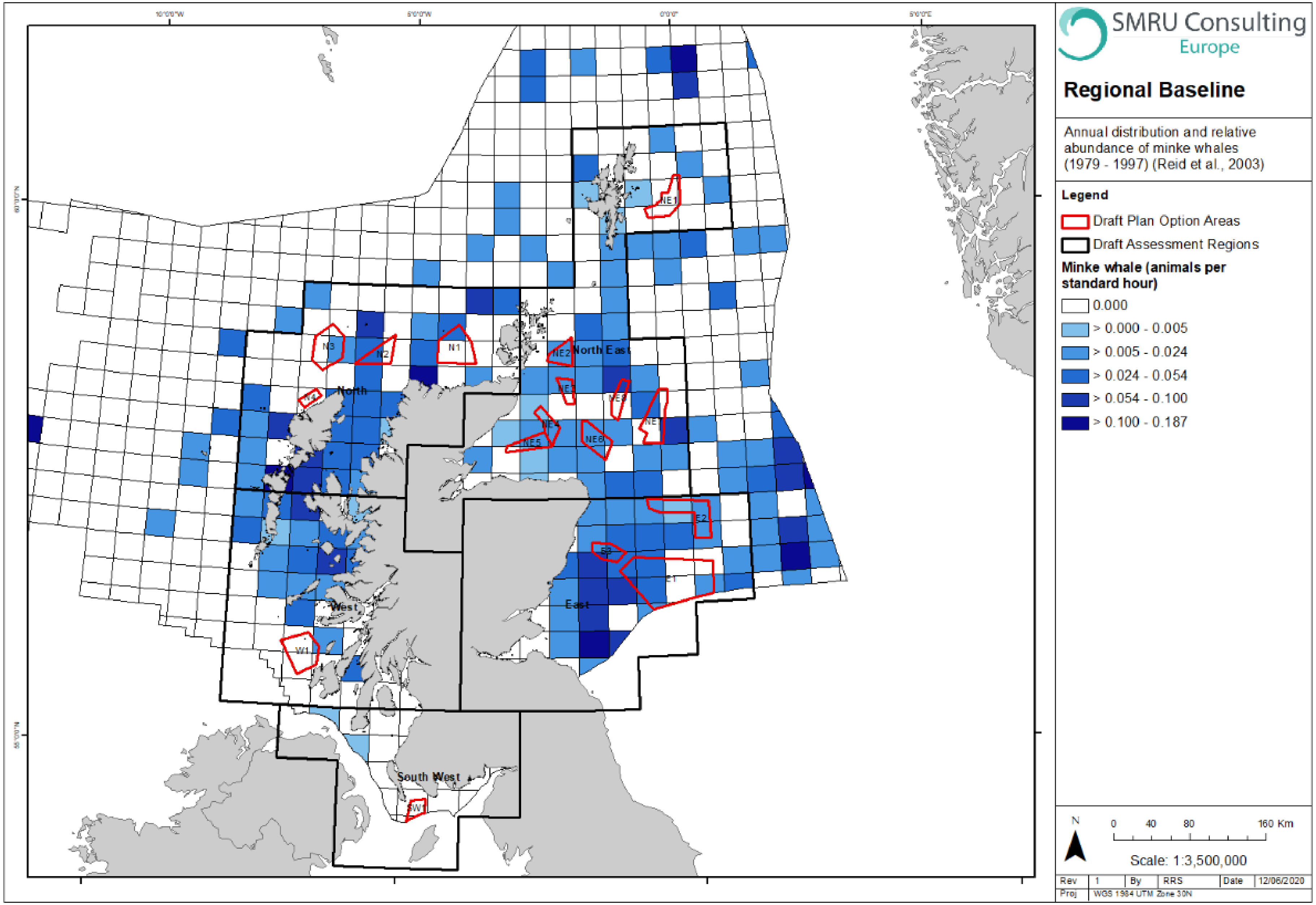


Figure 119: Aggregated annual distribution and relative abundance of minke whales (1979-1997) based on data presented in Reid et al. (2003).

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, minke whale sightings were widespread through the central and northern North Sea and to the west of Shetland, in waters of all depths (Stone 2015). In terms of the DPOs regions, minke whales were sighted in all regions apart from the South West region, but by far were sighted most frequently in the North East region (Figure 121). Sightings overlapped DPO sites NE6, NE7, NE8, E2 and E3 (Figure 121).

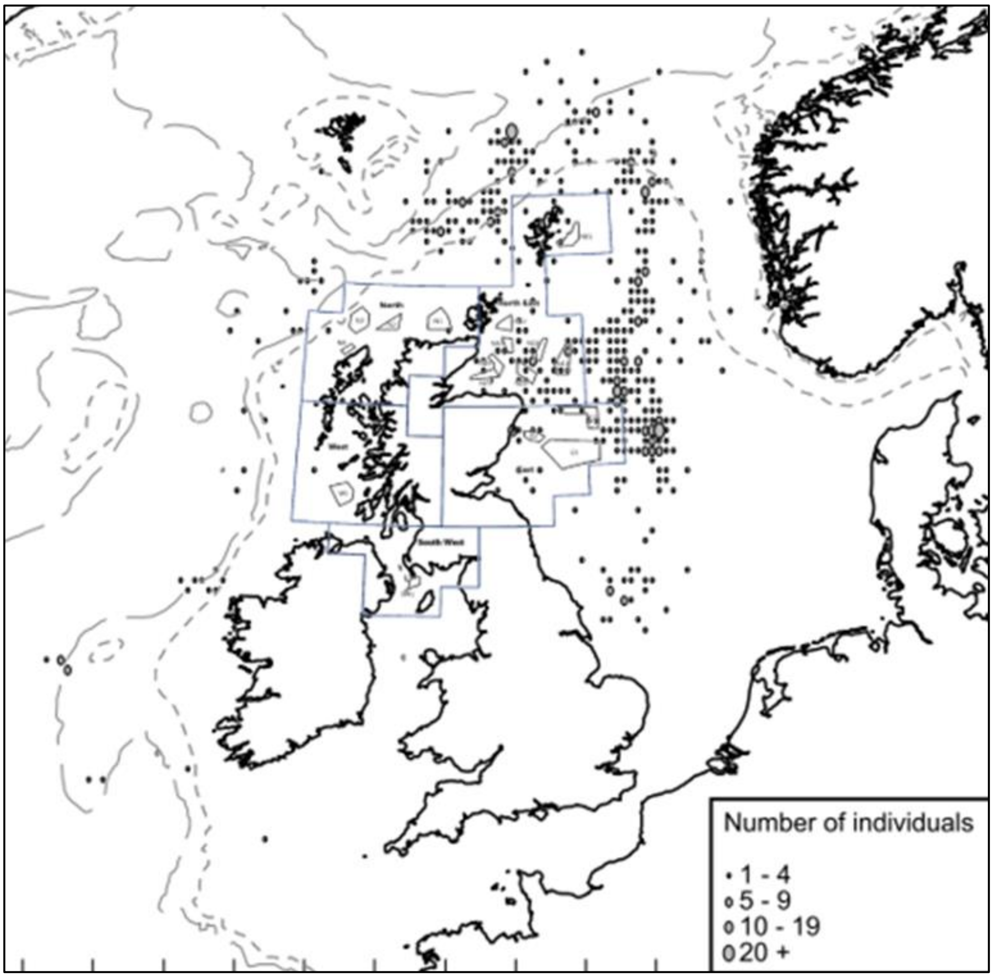


Figure 120: Minke whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

Minke whales were recorded in Scottish waters relatively frequently during NAMMCO surveys in in 1989, 1995, 1998, 2004, 2009 (Figure 122). Sightings were frequent in the North East DPO region and in the Moray Firth area in general, overlapping with sites NE3, NE4 and NE7. In the East DPO region, sightings were frequent but group size was also increased, with counts of up to 27 individuals. These sightings overlapped with all three of the East DPO sites: site E1, E2 and E3 (Figure 122).

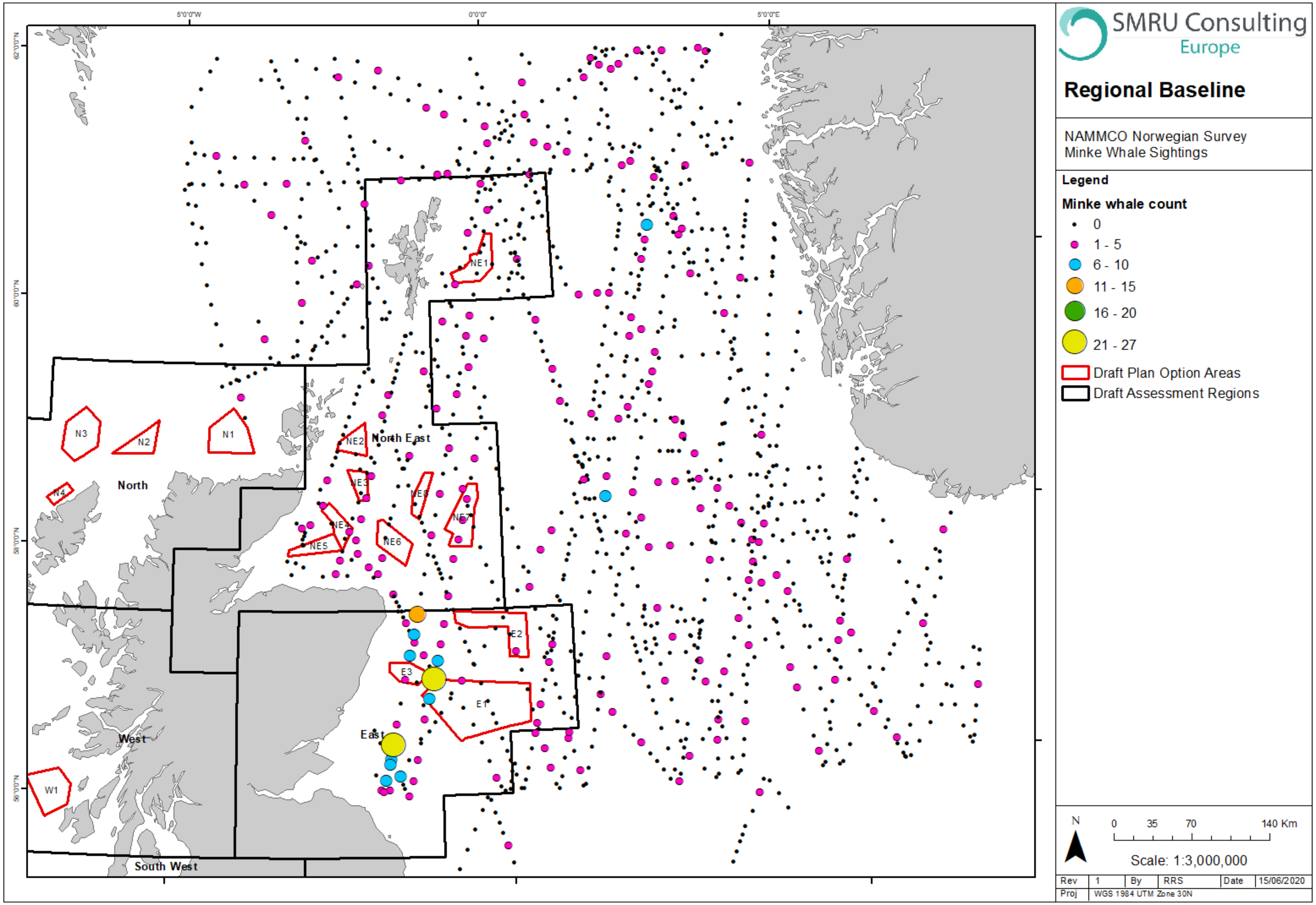


Figure 121: Minke whale sightings (coloured dots) during NAMMCO surveys in 1989, 1995, 1998, 2004, 2009. Data provided free of charge.

Dedicated surveys aboard ferries and large vessels by ORCA recorded minke whales in all but the East and South West DPO regions (Figure 123), with no overlap of sightings (or effort) with DPO sites. In contrast, dedicated surveys aboard ferries and large vessels by MARINElife recorded minke whales in only the East and South West DPO regions, though no sightings overlapped site boundaries (Figure 124).

Aerial surveys along the east coast of Scotland in 2014 did infrequently record minke whales, but no sightings overlapped DPO site boundaries (Figure 125).

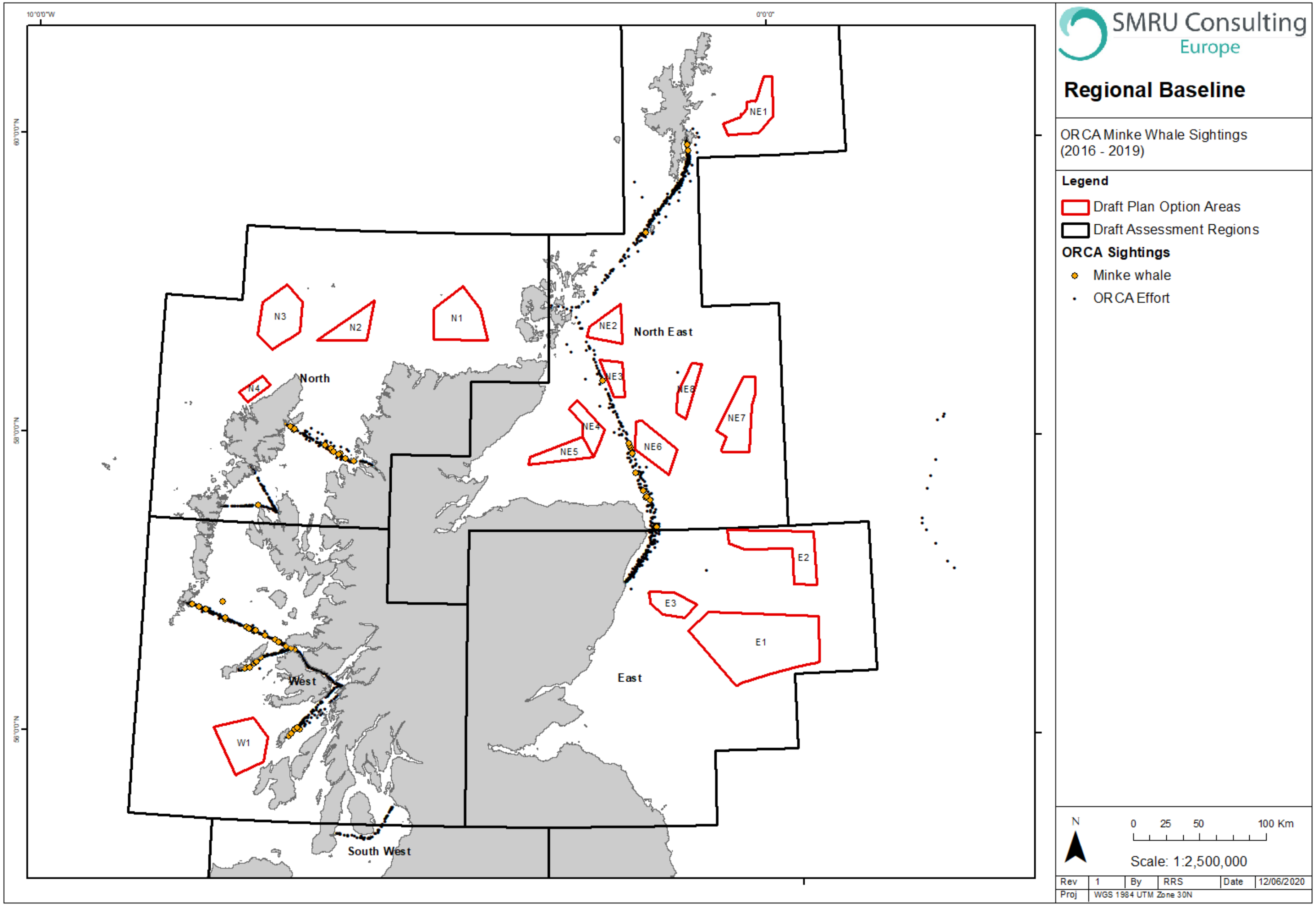


Figure 122: Minke whale sightings (orange dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

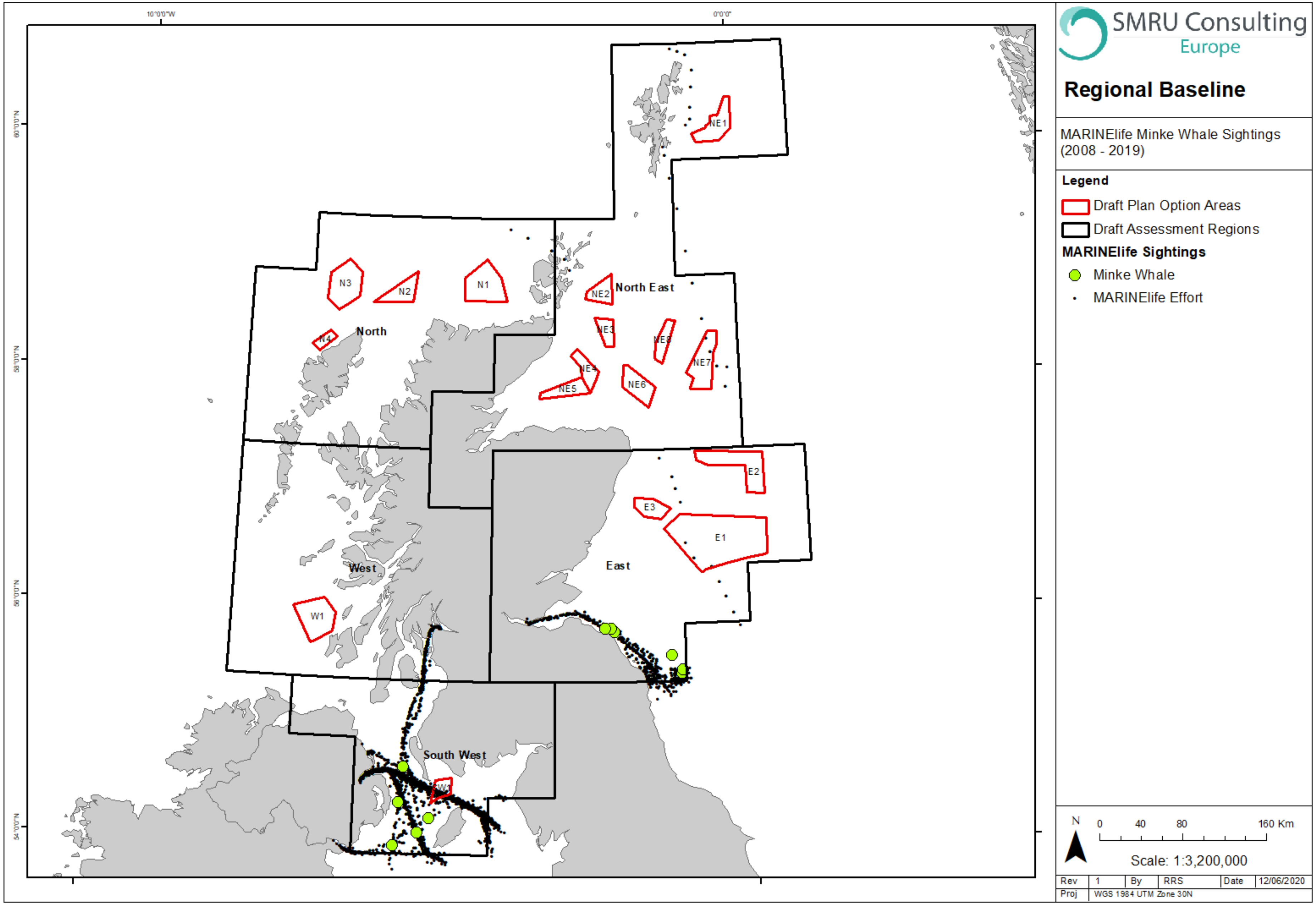


Figure 123: Minke whale sightings recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

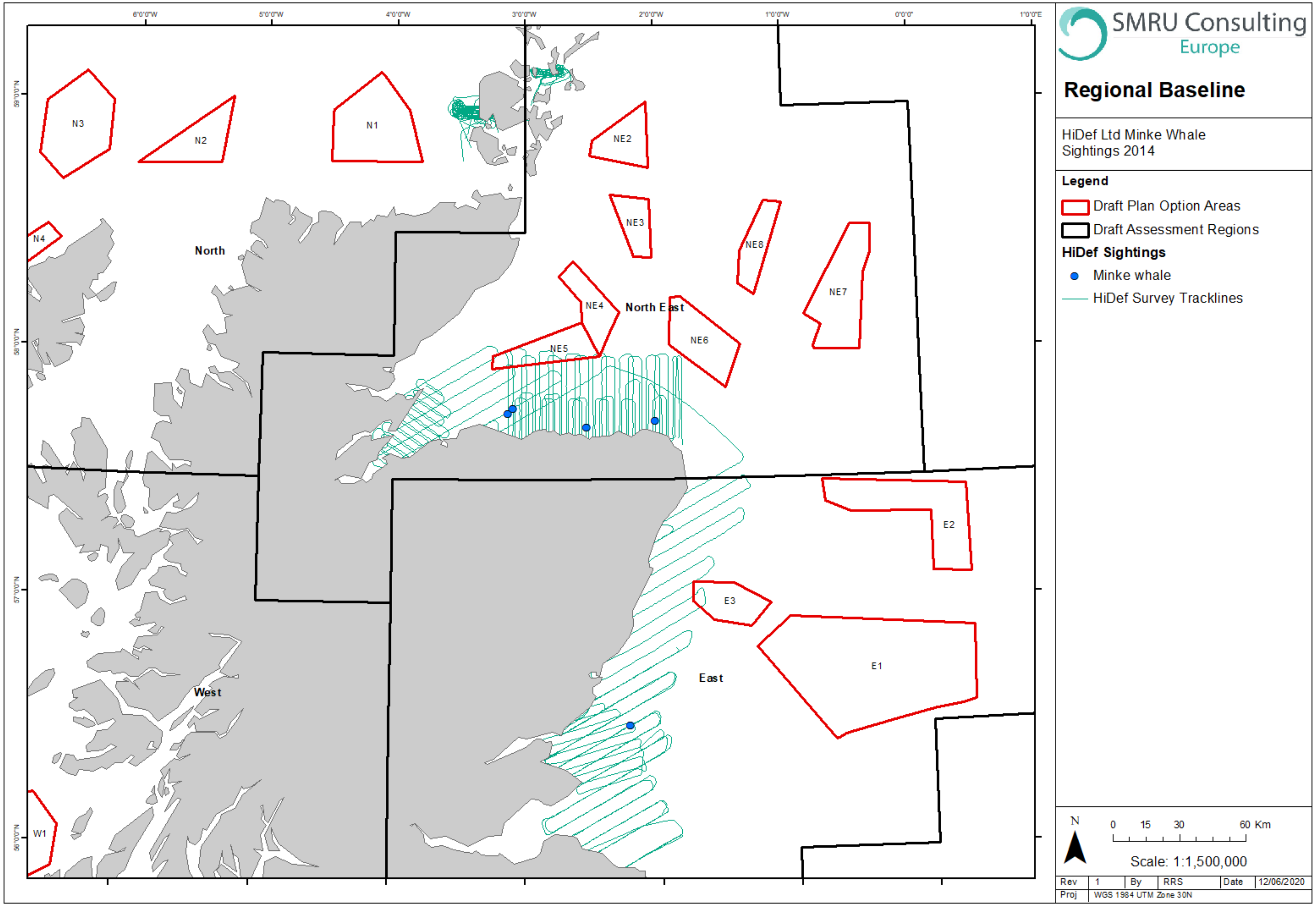


Figure 124: Minke whale sightings (blue dots) recorded during HiDef Ltd aerial surveys carried out in 2014.

Extensive survey effort conducted in east Scotland for the Forth and Tay offshore windfarms (Seagreen, Neart na Gaoithe and Inch Cape) have confirmed that minke whales are present in the Forth and Tay area (Sparling et al. 2011, Grellier and Lacey 2012, Inch Cape 2012, Neart na Gaoithe 2012, Sparling 2012, Inch Cape Offshore Limited 2018, Neart na Gaoithe 2018). Minke whales were primarily recoded in the summer months in the Forth and Tay area but were present throughout the survey areas (Figure 126 and Figure 127).

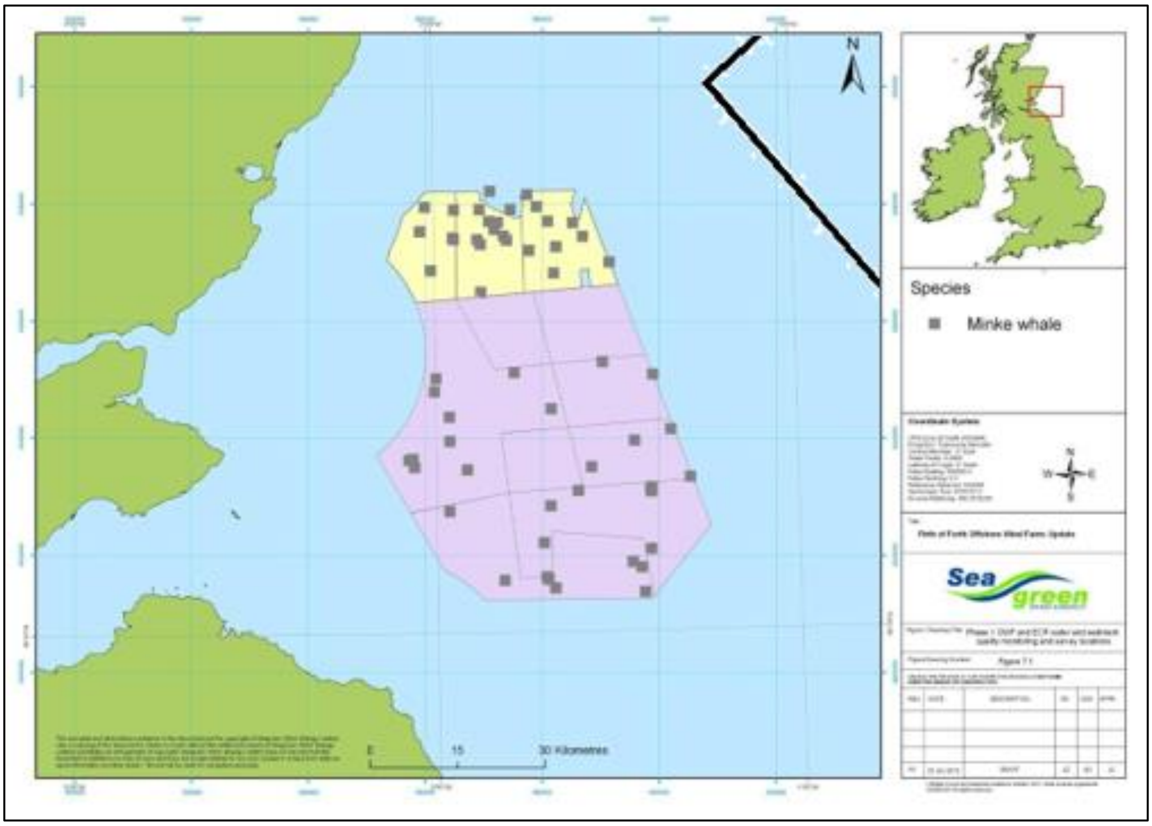


Figure 125: Minke whale sightings from the Firth of Forth Round 3 Zone vessel surveys May 2010 to November 2011 (Sparling 2012).DPOs are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

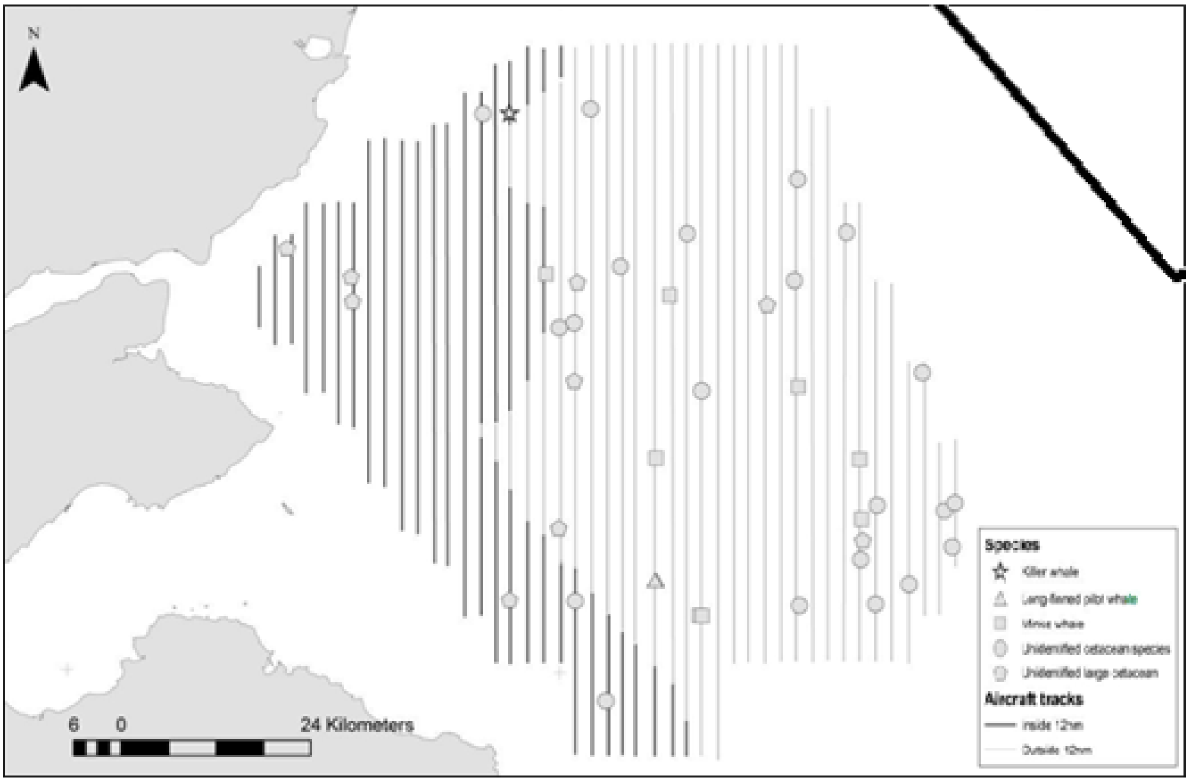


Figure 126: Large cetacean sightings during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPOs are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

Land-based Shorewatches record sightings of minke whales frequently, with sightings most concentrated along the North East, North and West Scotland coastlines (Figure 128). Whilst no sightings overlap the DPOs sites, these sightings may be useful when determining cable landfall locations.

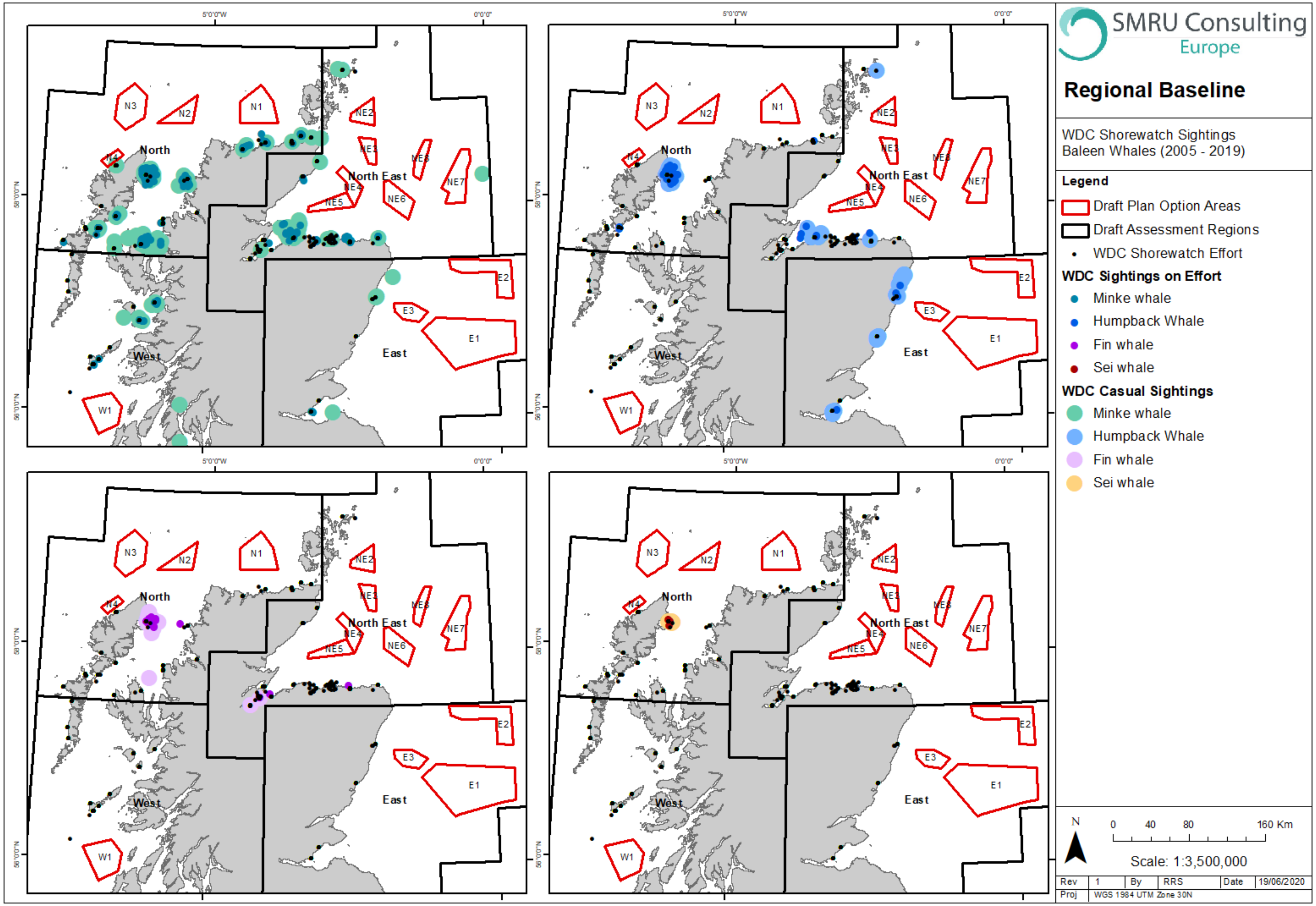


Figure 127: Sightings of minke whale, humpback whale, fin whale, and sei whale recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

Sightings records of minke whales in the Pentland Firth and Orkney Isles between 1980 and 2010 show a fairly coastal distribution of sightings, though there are also offshore sightings recorded. However this coastal distribution is likely indicative of effort rather than reflective of minke whale distribution in these waters (Figure 129) (Evans et al. 2011). Just south of the Pentland Firth, the University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth recorded 40 encounters with minke whales during a total of 241 trips between 2002 and 2016, though no sightings overlap with the DPO sites (Figure 130).

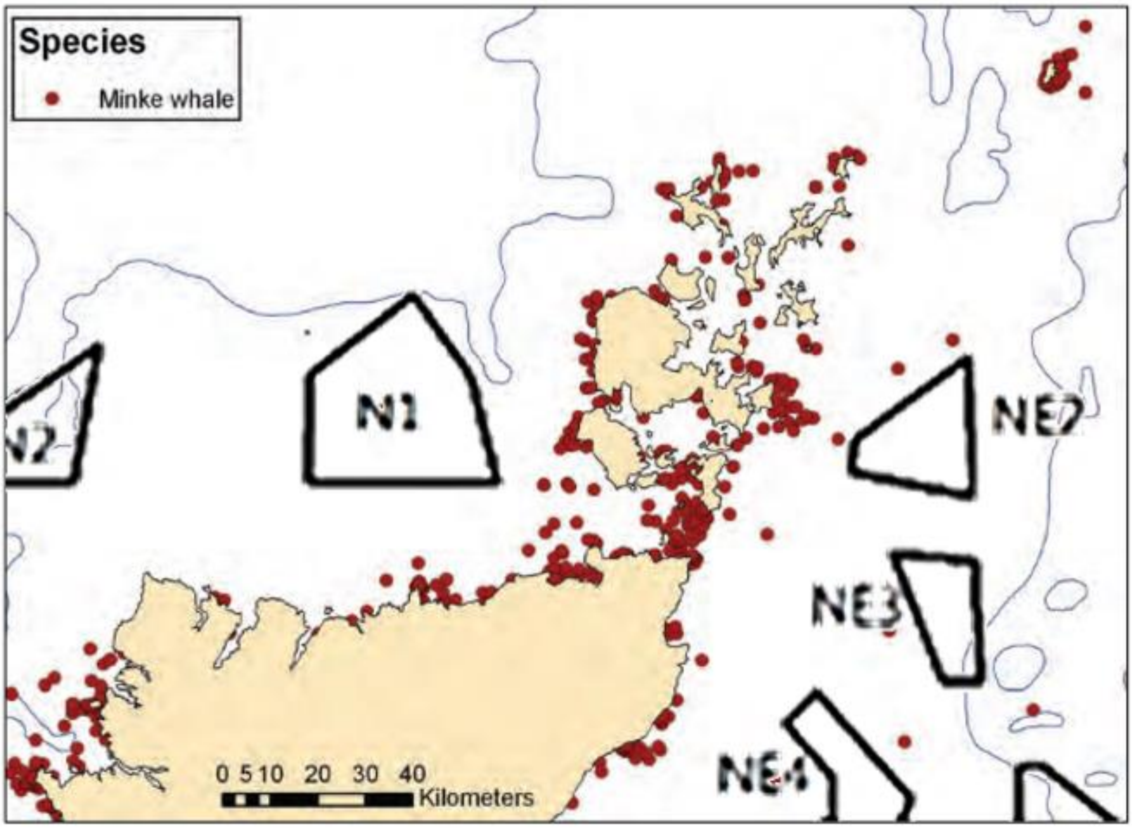


Figure 128: Distribution of sightings of minke whale around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

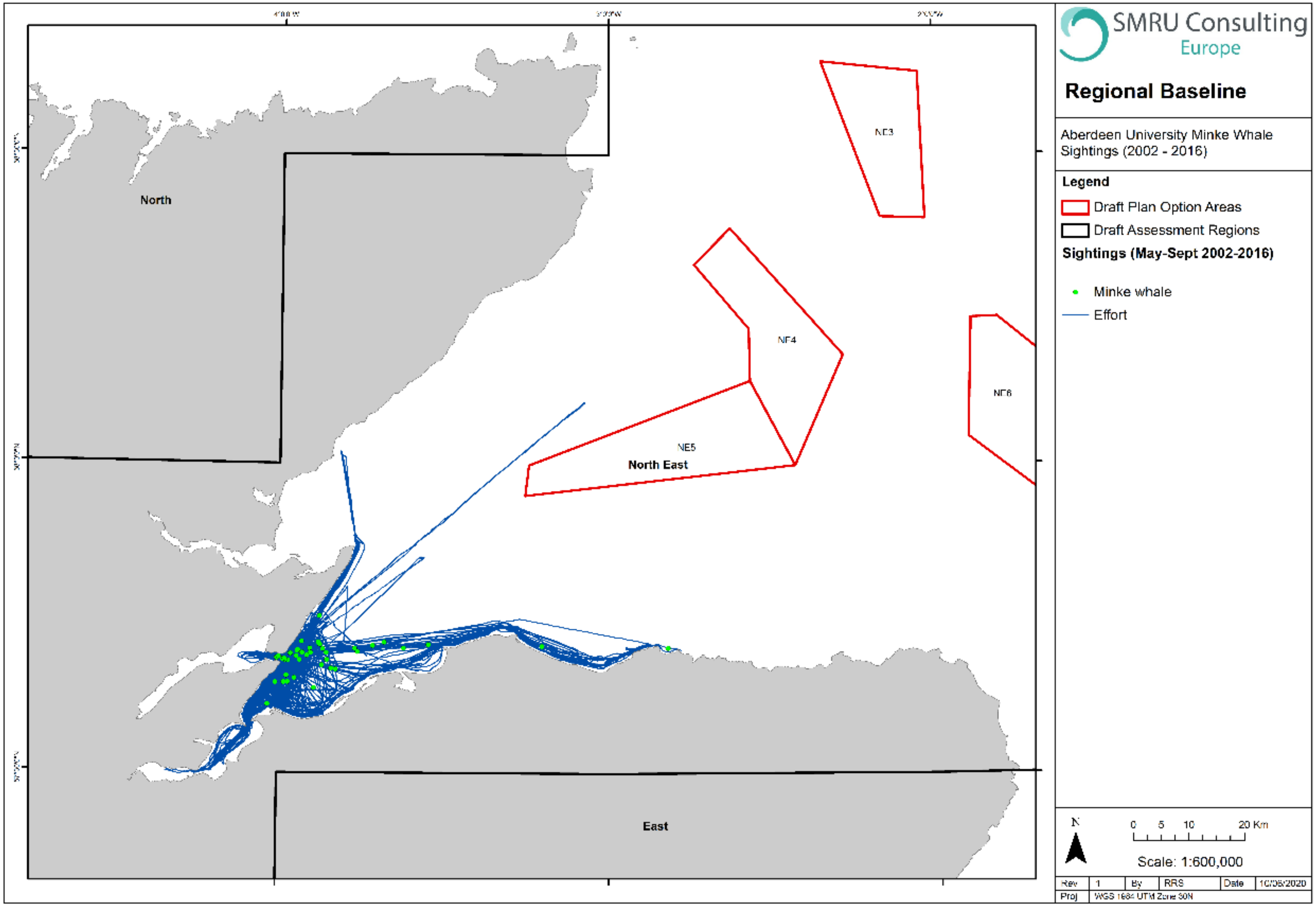


Figure 129: Sightings of minke whale recorded during bottlenose dolphin photo-ID surveys by the Aberdeen University Lighthouse Field Station. Data provided by Barbara Cheney.

Marine mammal sightings data covering the East Grampian coastline between 1973 and 2010 presented by Anderwald and Evans (2010) show a potential overlap of minke whale distribution with DPO site E3 (Figure 131), with a strong peak in sightings in July and August. Again, the coastal distribution in sightings data along the East Grampian coastline is more indicative of where effort was focused, rather than an accurate reflection of distribution in that area.

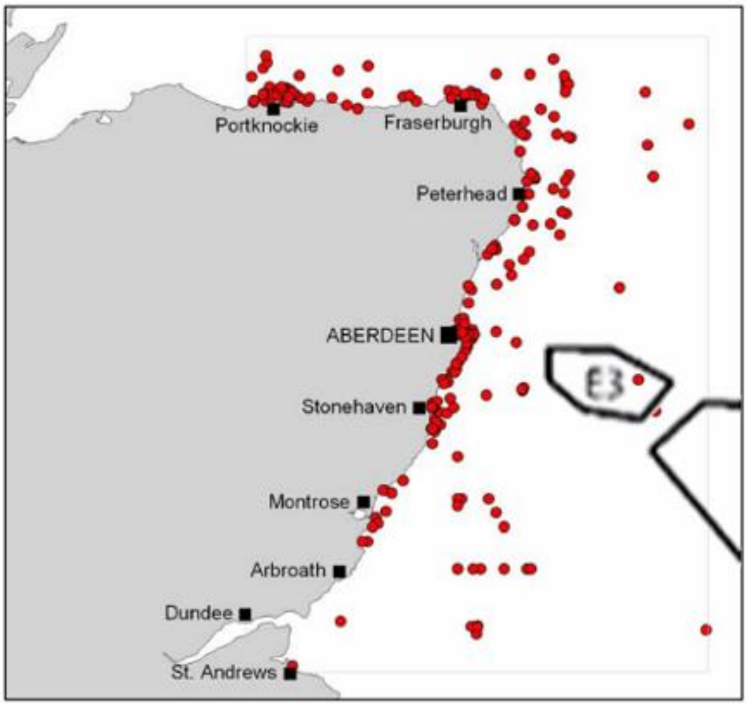


Figure 130: Distribution of Minke Whale sightings in East Grampian Region (Anderwald and Evans 2010). Overlaid for reference are the approximate regional and DPO areas.

3.3.8. Short-beaked common dolphin

Based on the information presented below, short-beaked common dolphins are seasonal visitors to Scottish waters, but their distribution is primarily focused in western and more offshore waters, with little expected overlap with DPO areas.

The most recent assessment of common dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019c).

The most recently collected broad-scale data on common dolphin abundance and distribution are available from the SCANS III survey. Common dolphins were sighted in all three SCANS surveys, with sightings concentrated in south west England in the Celtic Sea. In Scotland, the SCANS III survey blocks with the highest estimated densities were those in offshore waters to the west of Scotland with up to 0.133 common dolphins/km^2, with little overlap with any DPOs regions or sites (Figure 132, Figure 133).

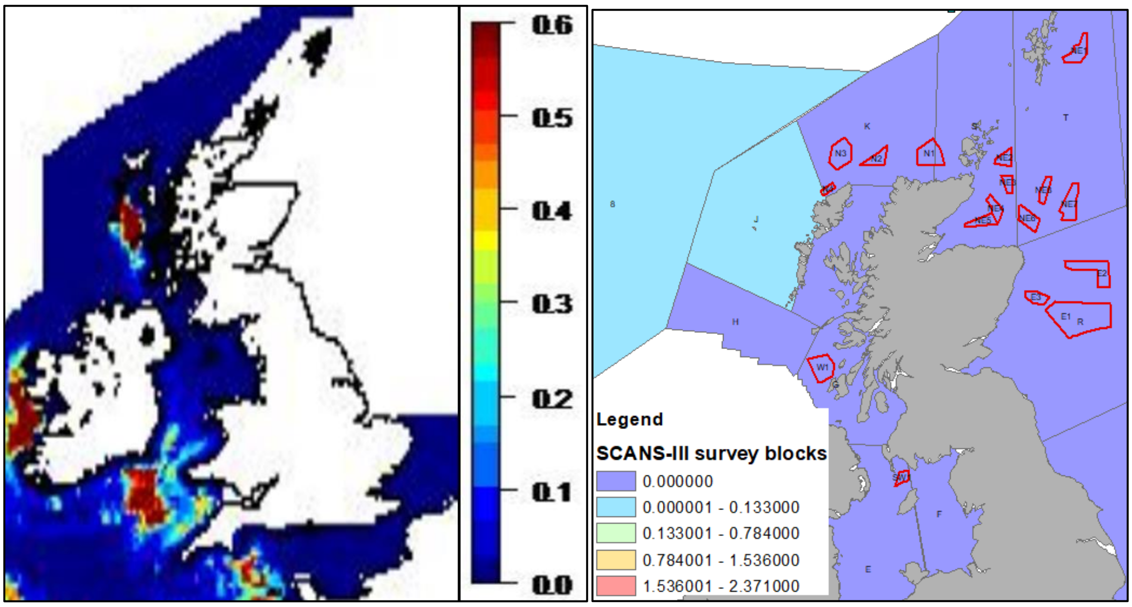


Figure 131: SCANS II common dolphin density surface (left), SCANS III block-wide uniform density estimates for minke whales in Scottish waters (right) (Hammond et al. 2017). Overlaid for reference are the DPO areas.

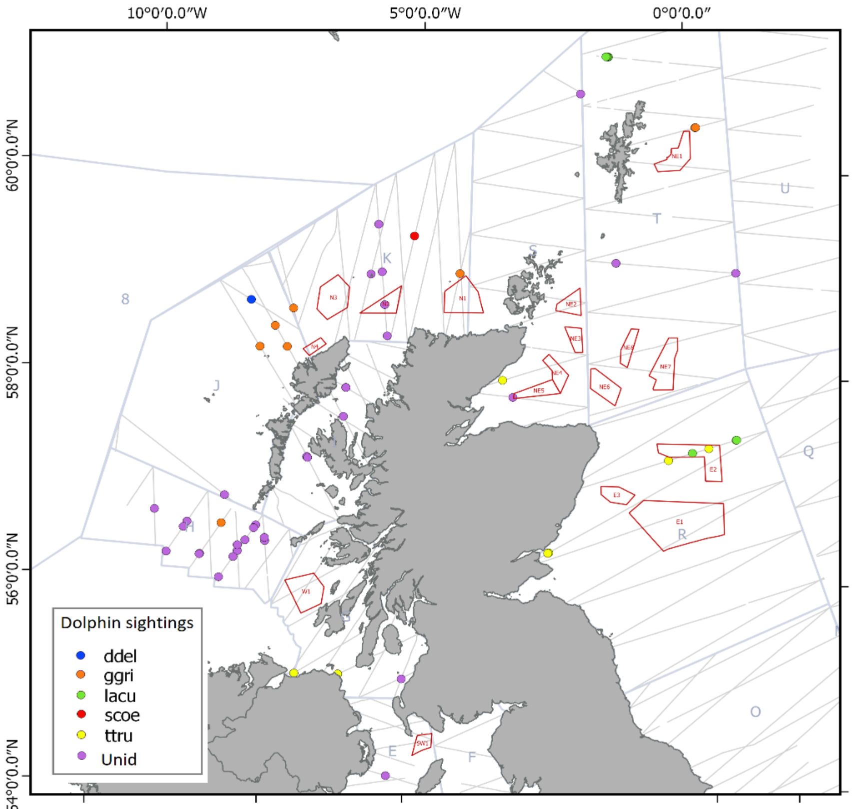


Figure 132: Sightings of dolphin species seen during the SCANS-III survey blocks containing DPO Areas (red). Ddel = Common dolphin (Delphinus delphis), ggri= Risso's dolphin (*Grampus griseus*), lacu= white-sided dolphin (*Lagenorhynchus acutus*), scoe = striped dolphin (*Stenella Stenella coeruleoalba*), ttru= bottlenose dolphin (*Tursiops truncatus*). Unid= dolphins not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The species distribution maps presented by Waggitt et al. (2020) predicted large seasonal variation in short-beaked common dolphin densities in Scottish waters, with low densities in winter months and much higher densities in the summer months in waters to the west of Scotland (Figure 134), especially relevant to DPO site N3. Although the maps suggest large seasonal variation in common dolphin density in Scottish waters, Waggitt et al. (2020) indicated that common dolphins are abundant year-round throughout the North-East Atlantic study area. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

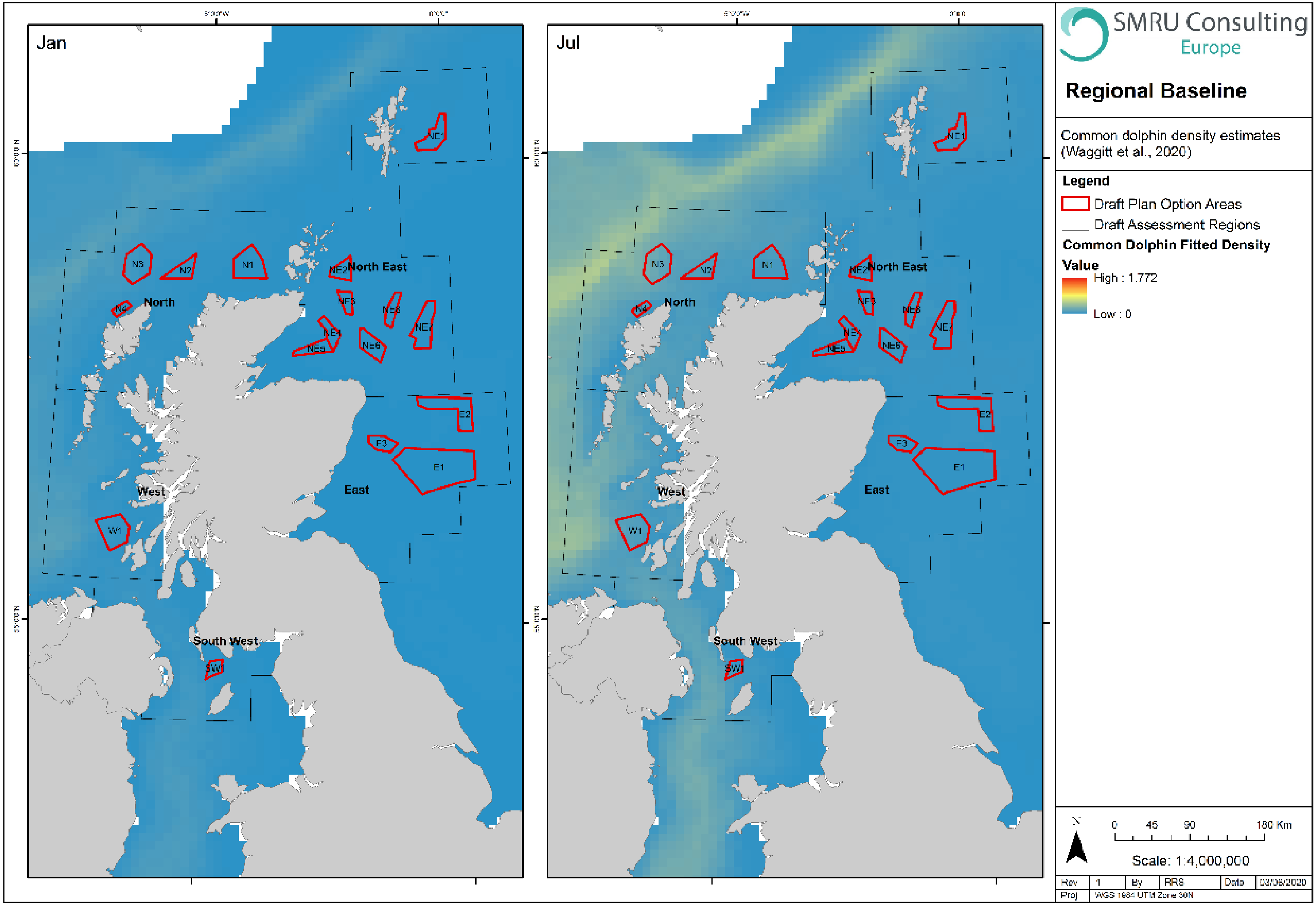


Figure 133: Spatial variation in predicted short-beaked common dolphin densities (animals per km²). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

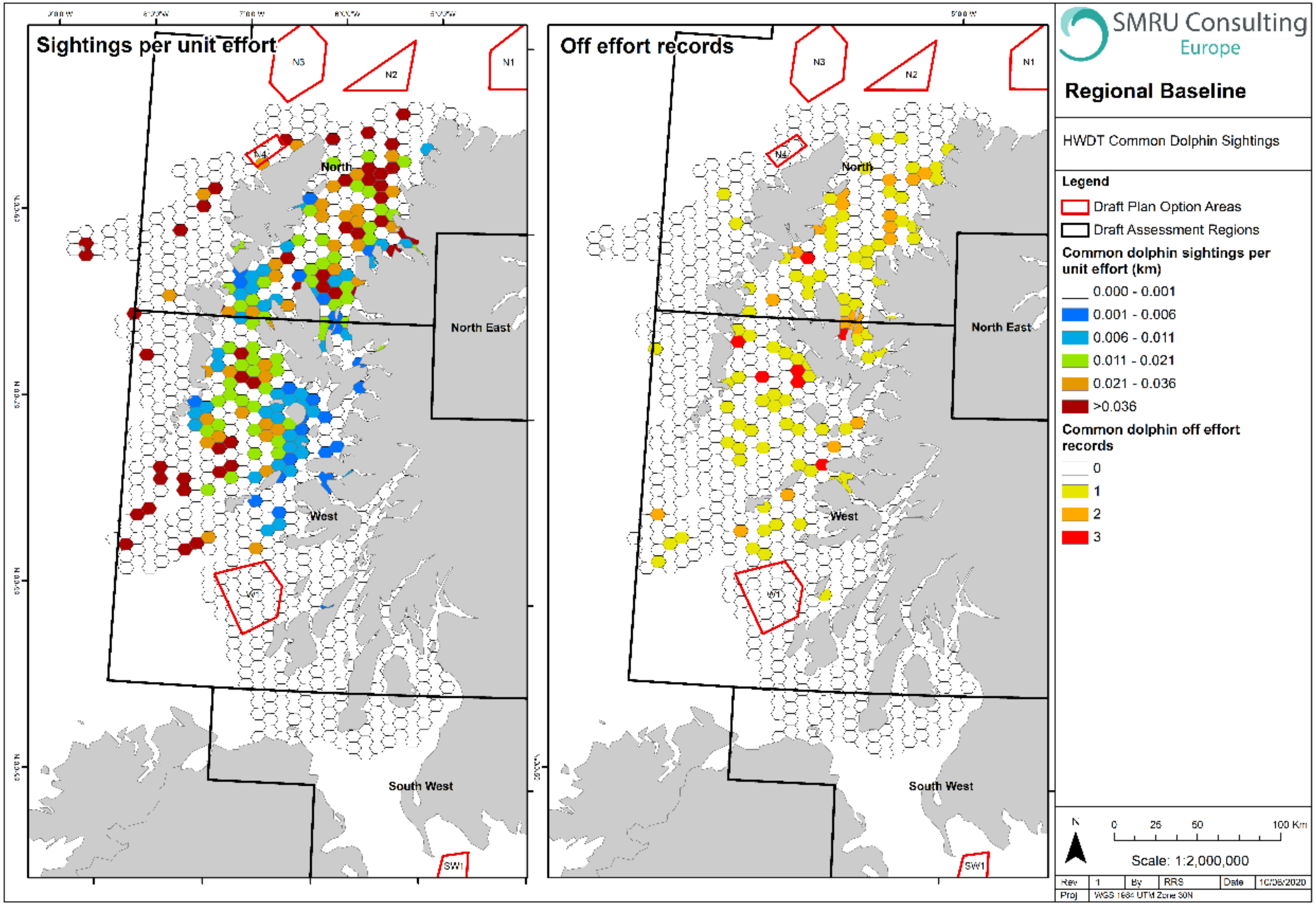


Figure 134: Sightings per unit effort, and off effort sightings, of common dolphins recorded by the HWDT during vessel based surveys 2003-2019 ((Hebridean Whale and Dolphin Trust 2020)). Note, white cell denotes >1 km effort but no sightings.

For the purpose of this report, the Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Short-beaked common dolphin sightings peak between April and October, though sightings do also occur more sporadically in the winter months. Most sightings are east of the Outer Hebrides, in the Minch, the Little Minch and the Sea of the Hebrides (Figure 134). Short-beaked common dolphins were only sighted in one of the two DPO sites covered by the HWDT data, in site N4. A proportion of the site N4 area had a minimum rate of >0.036 short-beaked common dolphins sightings per unit effort (km), though for other areas within the DPO site the sightings rate was extremely low (Figure 134).

The Scottish Marine Atlas describes short-beaked common dolphin habitat as open coast or offshore with a preference for areas of steep seabed, with distribution mainly around the Hebrides (Baxter et al. 2011). Mapped encounter rates show higher encounter rates offshore to west and north-west Scotland, with little overlap with any DPOs sites (Figure 135).

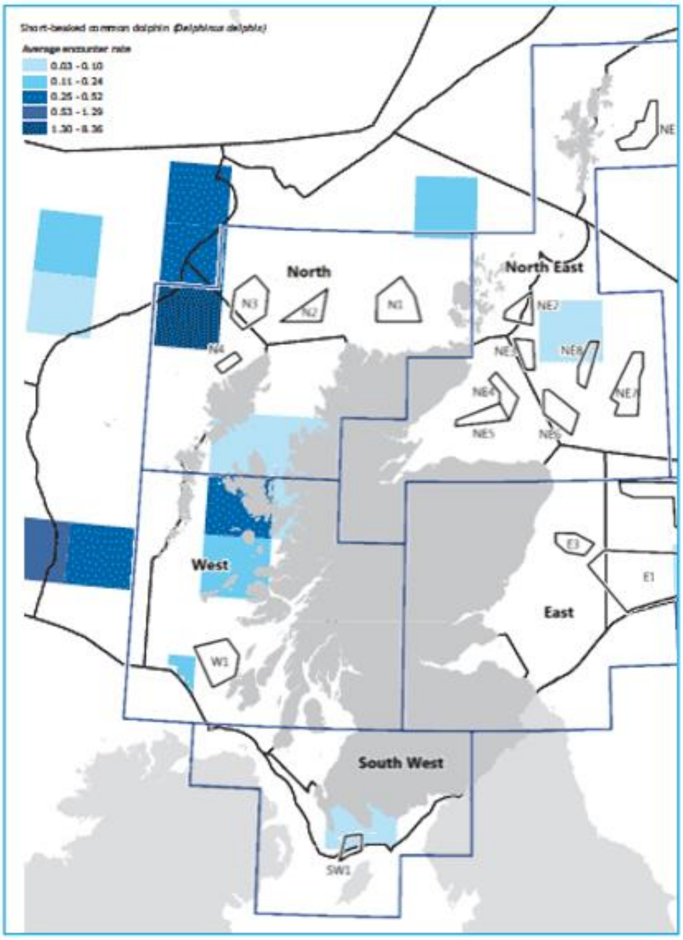


Figure 135: Common dolphin average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Scottish waters were previously thought to be towards the more northern extremity of short-beaked common dolphin distribution (Weir et al. 2001). Sightings data shows common dolphins to be common around the Inner Hebrides and the west coast of Scotland (Evans et al. 2011), in continental shelf waters, though there are less frequent sightings in the northern North Sea, as highlighted in Figure 138 (Reid et al. 2003). The distribution maps presented by Reid et al. (2003) show overlap with some DPOs sites, including E1, E2 and SW1.

Similarly, the majority of common dolphin sightings recorded by Weir et al. (2001) were around the 1,000 m isobath (Figure 136) with sightings year-round and a peak between September and November with notable concentrations on the West Hebrides Shelf during October and November. Out of 74 sightings, short-beaked common dolphins were only recorded once north of the 60°N latitude, with common dolphins generally ‘replaced’ by white-sided dolphins at latitudes greater than 60°N (Weir et al. 2001). However, since 2000 Evans et al. (2011) report common dolphin distribution has moved even further north and east, including Shetland, Orkney and the northern North Sea.

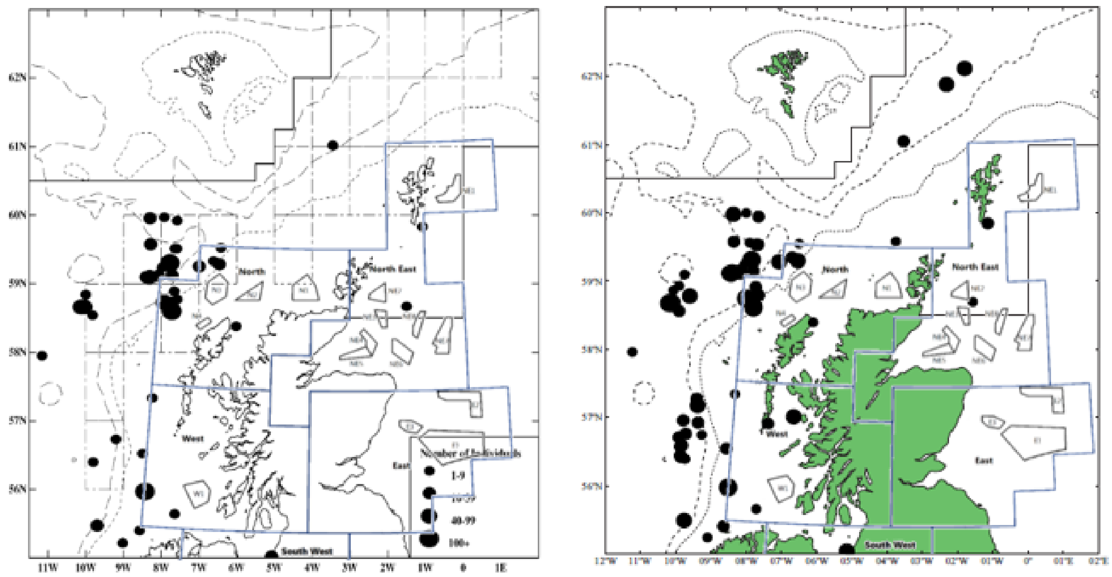


Figure 136: Left: Distribution of short-beaked common dolphin sightings (1979–1998) presented in the ‘Cetaceans of the Atlantic Frontier’. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants). (Weir et al. 2001). Right: Distribution of short-beaked common dolphin sightings (1979–1999) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

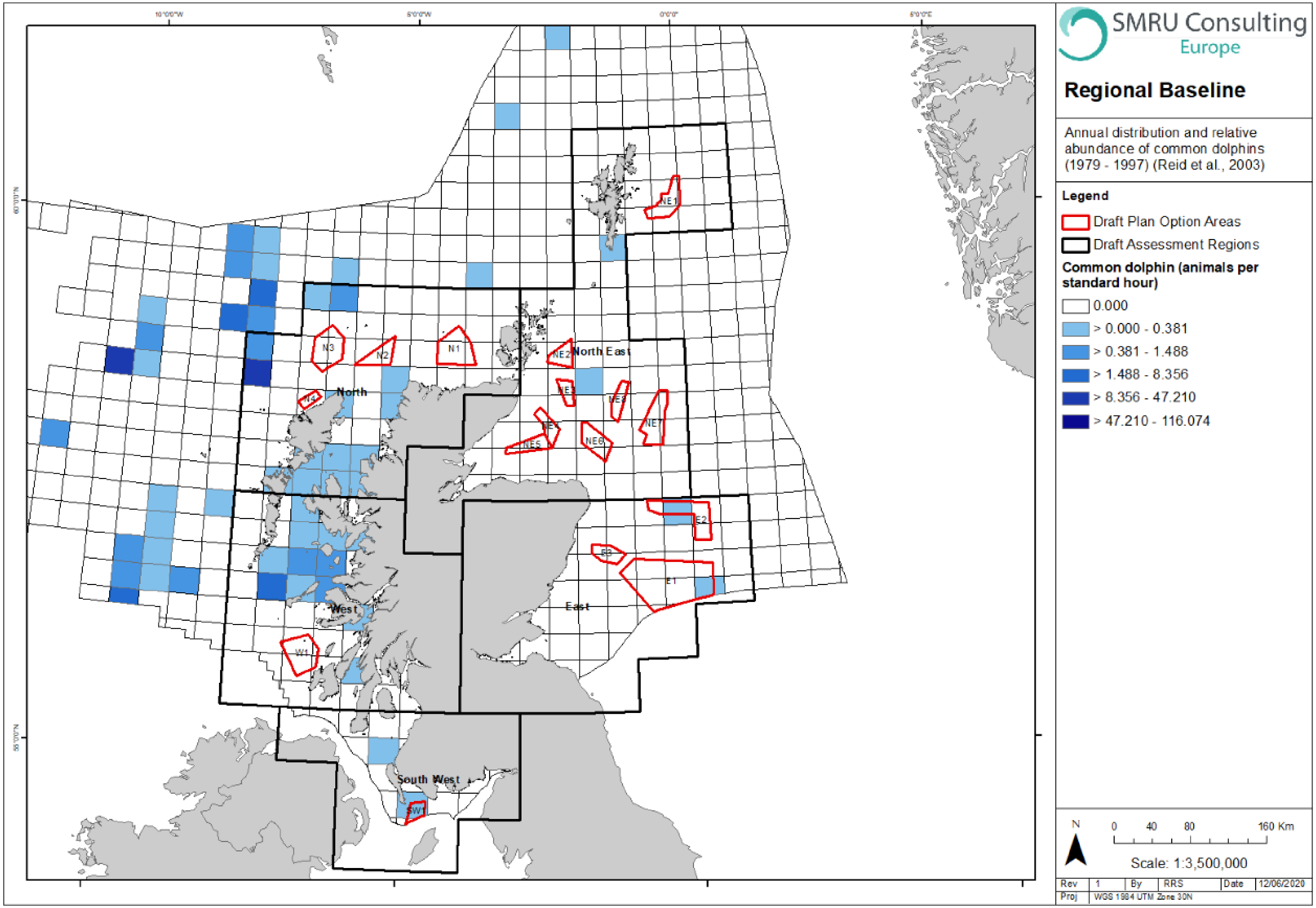


Figure 137: Aggregated annual distribution and relative abundance of short-beaked common dolphins (1979-1997) based on data presented in Reid et al. (2003).

Between 1983 and 1998, the Seabirds at Sea Team (SAST) surveys record few sightings of short-beaked common dolphins in Scottish waters during the summer months (May-Oct), with sightings in water temperatures ranging from 8.1 to 18.5°C (mean: 14.9°C; SD: 1.6°C) (MacLeod et al. 2008). Sightings of short-beaked common dolphins were higher, in comparison to white-beaked dolphins, in water temperatures above 14.8°C. No sightings overlapped any DPOs sites, though there were short-beaked common dolphins sightings in the North East and South West region (Figure 139).

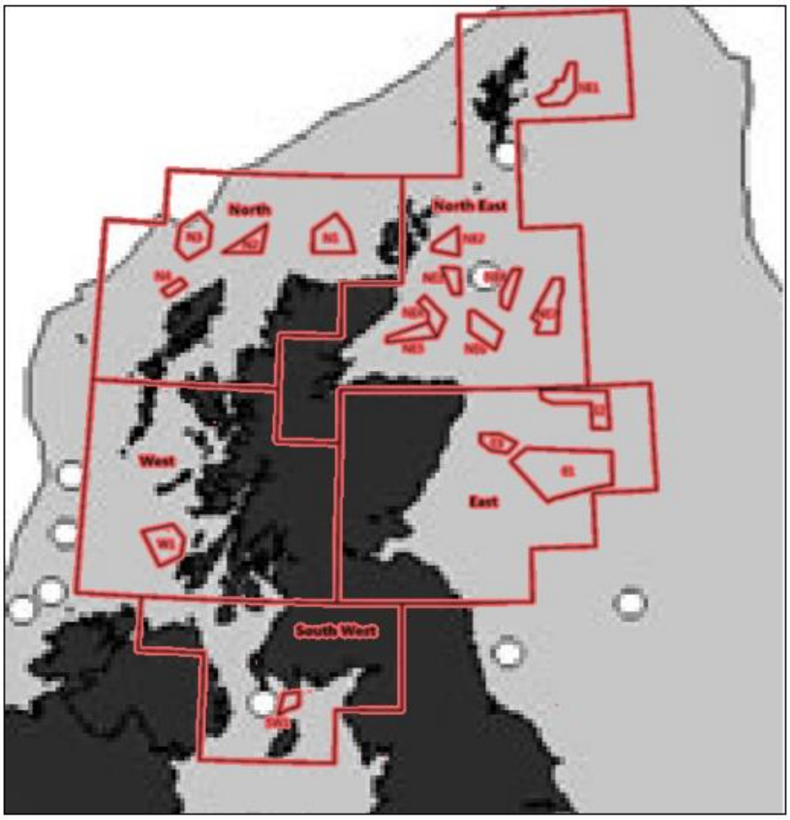


Figure 138: Distribution of short-beaked common dolphin sightings, from the Seabirds at Sea Team database, for shelf waters in summer months (May–October) 1983–1998. Grey shading: shelf waters of less than 200 m depth. NOTE: sightings recorded in non-shelf waters are not shown on this figure. Approximate DPO regions and sites are Overlaid for reference.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, short-beaked common dolphins sightings were evenly distributed between shelf waters and the deeper waters over the shelf edge and beyond (Stone 2015). In terms of the DPOs regions, short-beaked common dolphins were sighted in all regions apart from the South West and East regions, but by far were sighted most frequently in the North East Region (Figure 140). Sightings directly overlapped DPO sites N2, NE3 and NE6 (Figure 140).

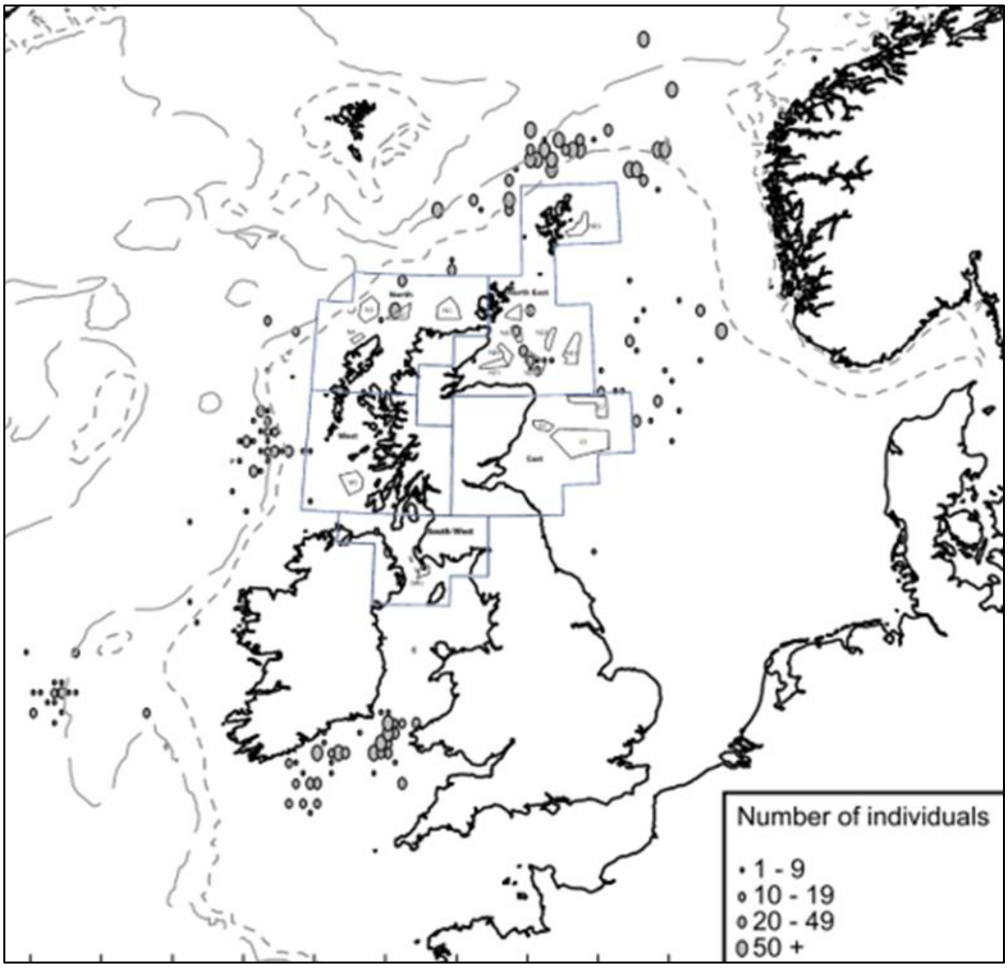
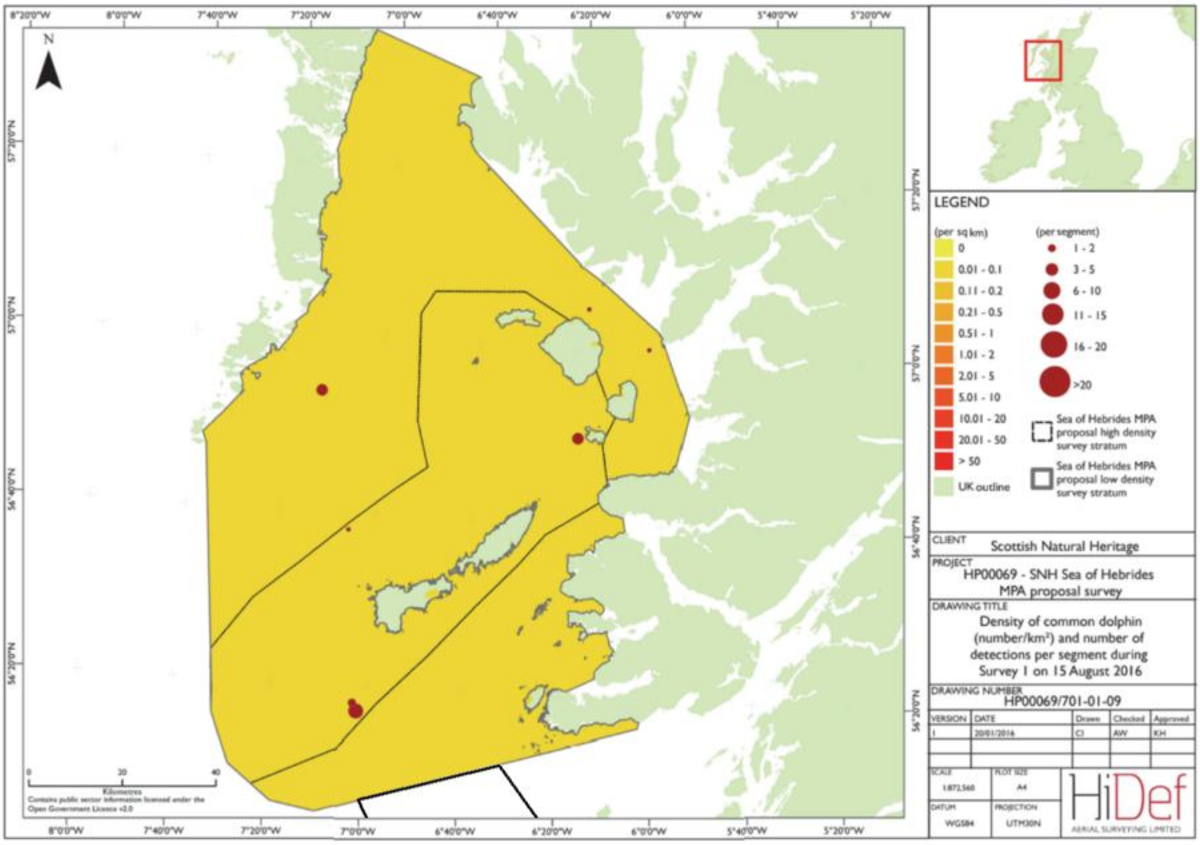
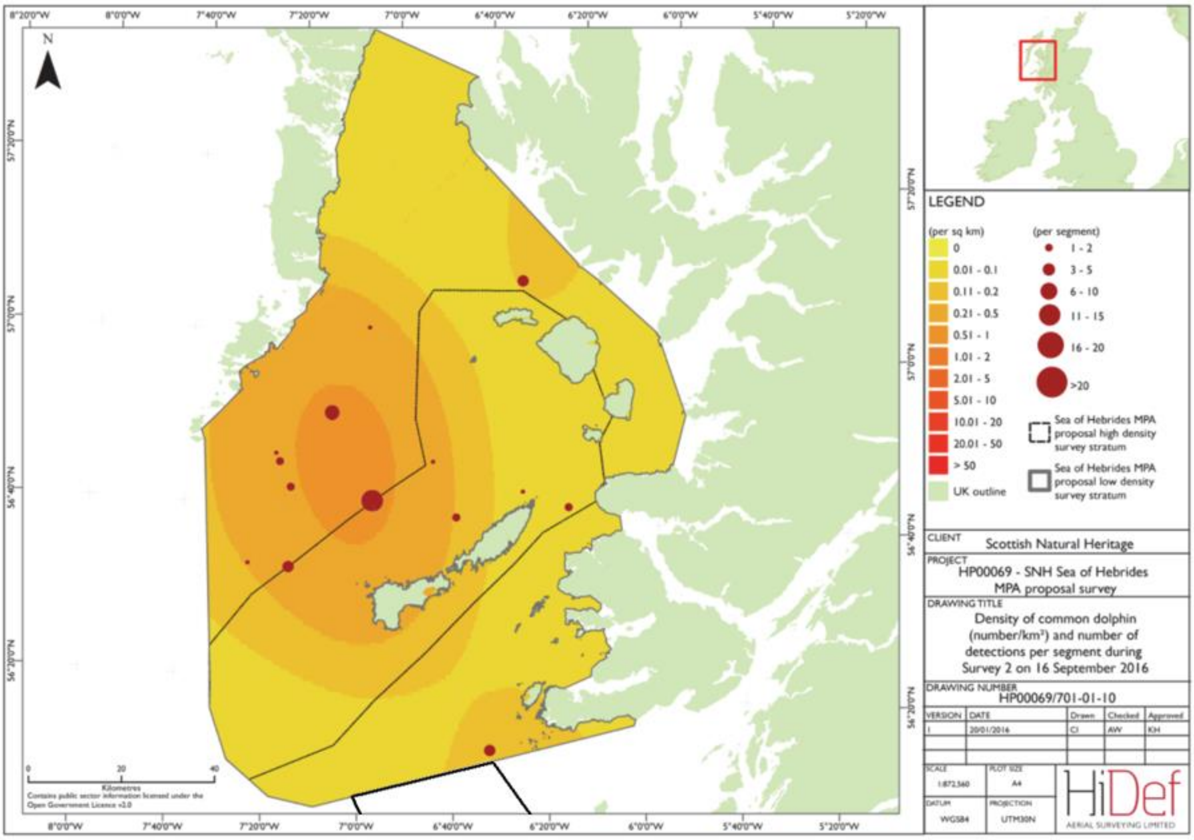


Figure 139: Short-beaked common dolphins encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Approximate DPO regions and sites are Overlaid for reference.

During HiDef aerial surveys around the Sea of Hebrides pMPA in 2016, short-beaked common dolphins were sighted on all three surveys (Webb et al. 2018). Between the first survey on 15 August and the last survey on 30 September 2016, the authors commented that the distribution of short-beaked common dolphins altered from being spread widely across the survey area to being more concentrated in deep water between the islands of Coll and Tiree, and Barra in the Outer Hebrides (Figure 141).



LEGEND
(per sq km)
0
0.01 - 0.1
0.11 - 0.2
0.21 - 0.5
0.51 - 1
1.01 - 2
2.01 - 5
5.01 - 10
10.01 - 20
20.01 - 50
> 50
UK outline
(per segment)
1 - 2
3 - 5
6 - 10
11 - 15
16 - 20
>20
Sea of Hebrides MPA proposal high density survey stratum
Sea of Hebrides MPA proposal low density survey stratum
CLIENT Scottish Natural Heritage
PROJECT HP00069 - SNH Sea of Hebrides MPA proposal survey
DRAWING TITLE Density of common dolphin (number/km²) and number of detections per segment during Survey 1 on 15 August 2016
DRAWING NUMBER HP00069/701-01-09
Kilometres
Contains public sector information licensed under the Open Government Licence v3.0
HiDef
AERIAL SURVEYING LIMITED



LEGEND
(per sq km)
0
0.01 - 0.1
0.11 - 0.2
0.21 - 0.5
0.51 - 1
1.01 - 2
2.01 - 5
5.01 - 10
10.01 - 20
20.01 - 50
> 50
UK outline
(per segment)
1 - 2
3 - 5
6 - 10
11 - 15
16 - 20
>20
Sea of Hebrides MPA proposal high density survey stratum
Sea of Hebrides MPA proposal low density survey stratum
CLIENT Scottish Natural Heritage
PROJECT HP00069 - SNH Sea of Hebrides MPA proposal survey
DRAWING TITLE Density of common dolphin (number/km²) and number of detections per segment during Survey 2 on 16 September 2016
DRAWING NUMBER HP00069/701-01-10
Kilometres
Contains public sector information licensed under the Open Government Licence v3.0
HiDef
AERIAL SURVEYING LIMITED

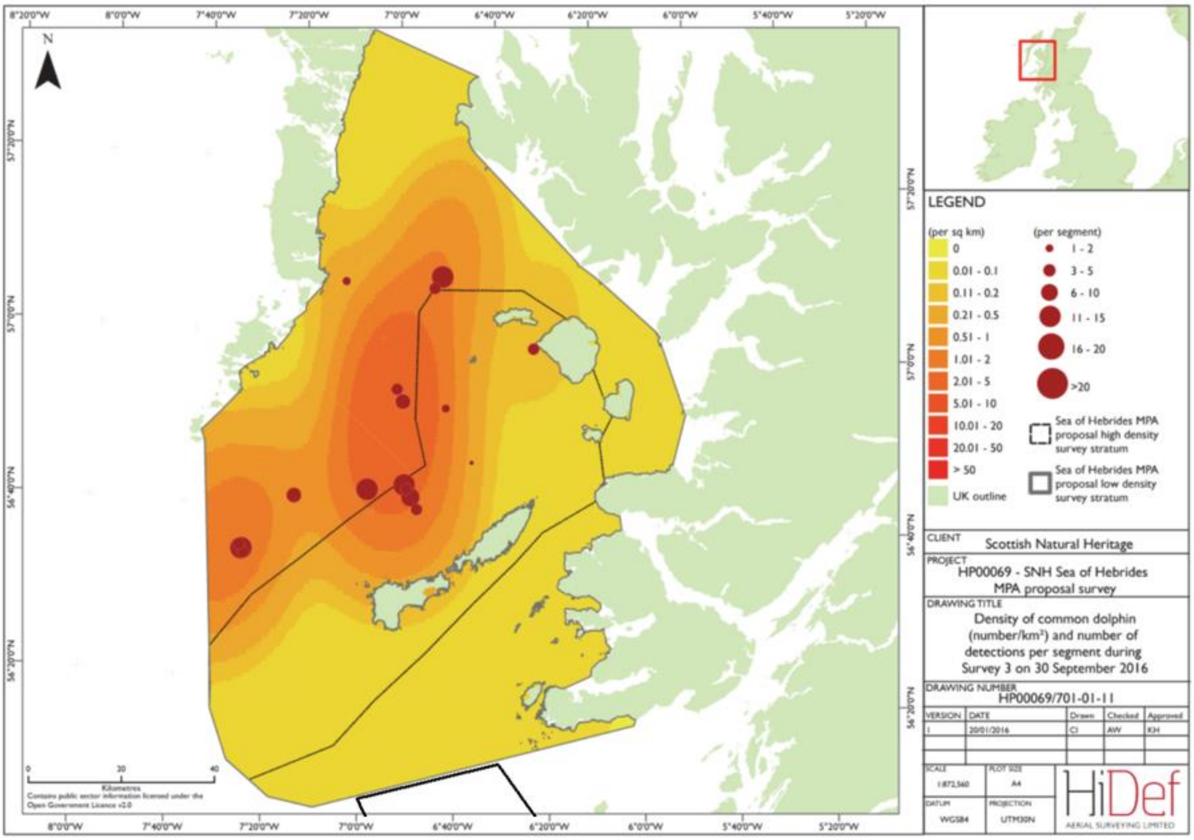


Figure 140: Top: Density of common dolphins (number/km^2) and number of detections per segment during Survey 1 of 3 (top), 2 of 3 (middle) and 3 of 3 (bottom) HiDef aerial surveys for the Sea of Hebrides pMPA (Webb et al. 2018). DPO sites are Overlaid for reference (thick black), with site W1 bordering the southern boundary of the pMPA.

Sightings recorded on dedicated ferry or large vessel surveys by ORCA recorded numerous short-beaked common dolphin sightings on the Hebridean ferry routes, but no sightings overlapping with any DPO sites (Figure 142). Similarly, MARINElife record a number of sightings of short-beaked common dolphins in the South West DPO region, but no sightings overlapping the SW1 site boundary (Figure 143).

Land-based dedicated Shorewatches between 2005 and 2019 sighted short-beaked common dolphins relatively frequently on the west coast of Scotland, with far less sightings on the east and north coast of Scotland (Figure 144). No sightings overlapped the DPOs site boundaries, though the sightings may be useful when considering cable landfall locations.

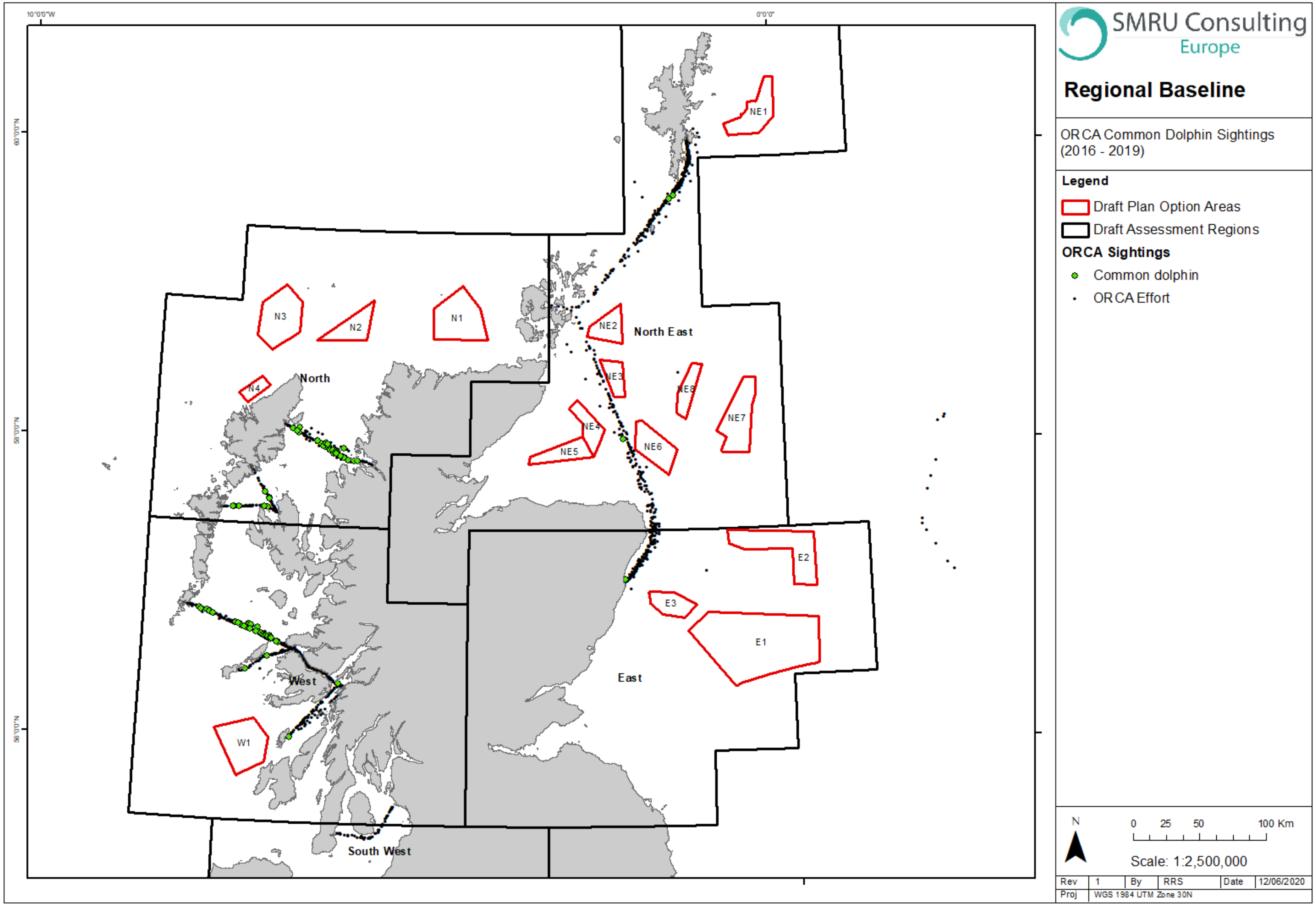


Figure 141: Short-beaked common dolphin sightings (green dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Data provided free of charge by ORCA.

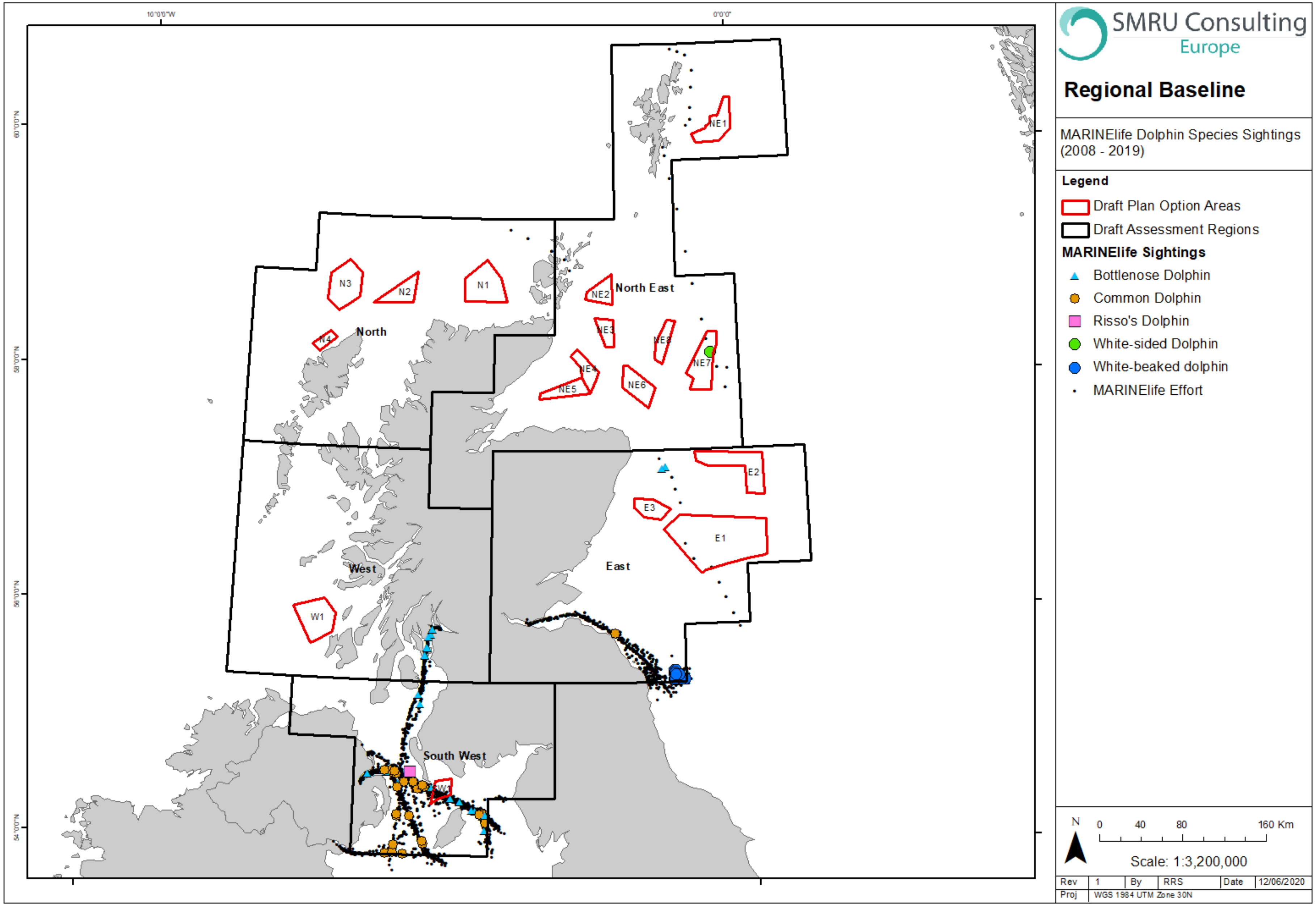


Figure 142: Dolphin sightings recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

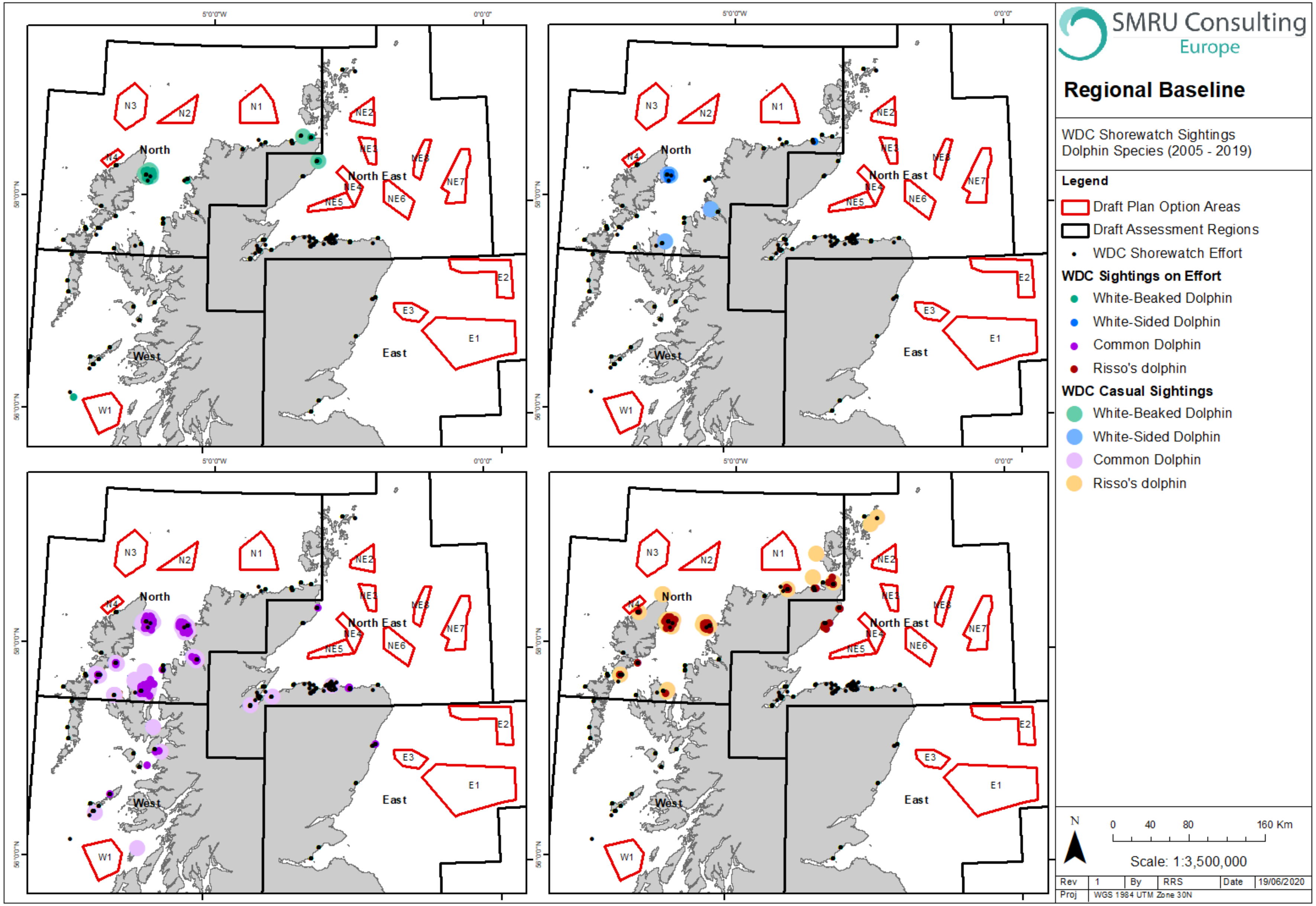


Figure 143: Sightings of white-beaked, white-sided, common and Risso's dolphin recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth recorded three encounters with common dolphins between 2002 and 2016 during a total of 241 trips. Coastal sightings of common dolphins along the northern Scottish coast and the Orkney Isles have been recorded between 1980 and 2010 (Figure 145), though sightings are relatively infrequent given the long time period of data collection (Evans et al. 2011).

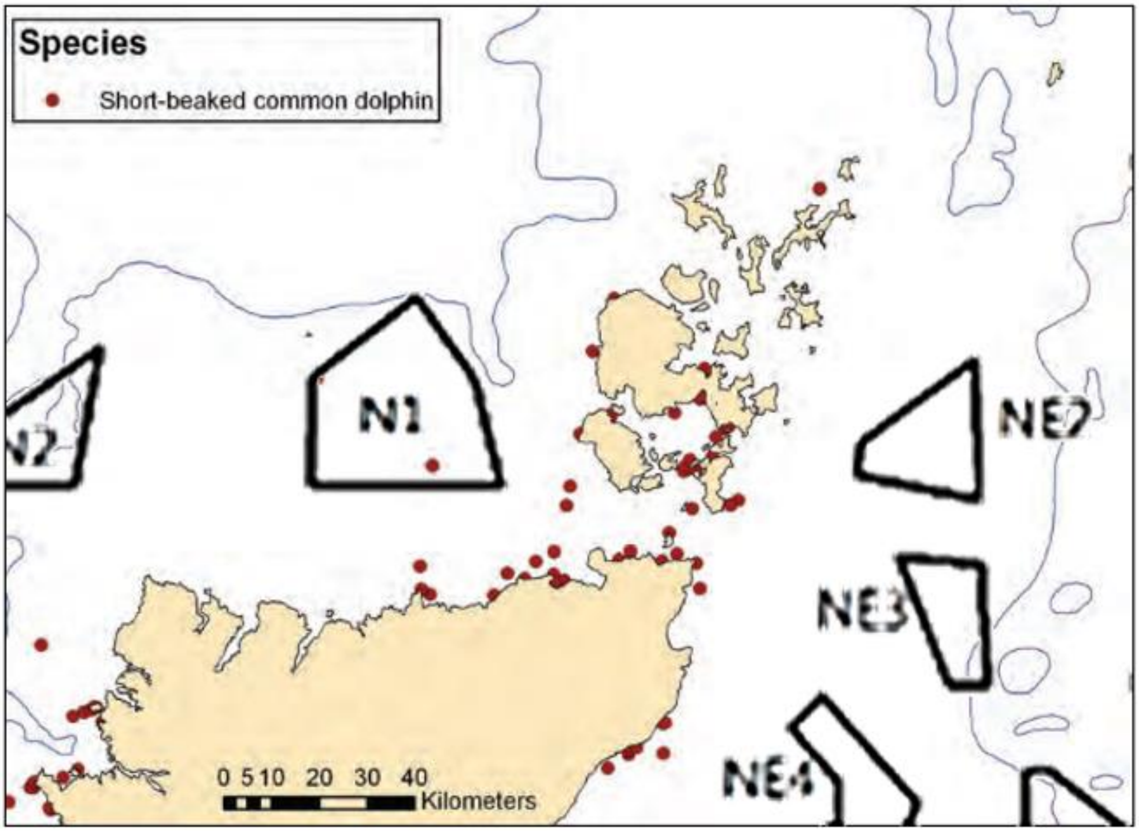


Figure 144: Distribution of sightings of short-beaked common dolphins around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.3.9. Atlantic white-sided dolphin

Based on the information presented below, Atlantic white-sided dolphins are present in low numbers in Scottish waters, with distribution mainly in deeper offshore waters during the summer months. There is there little expected overlap with DPO sites.

The most recent assessment of Atlantic white-sided dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019i). Preferring temperate and sub-polar seas, with a preference for deeper waters beyond the continental shelf, or slope areas, the Atlantic white-sided dolphin is not commonly recorded in Scottish waters, except in areas close to the shelf edge e.g. Shetland (Evans et al. 2011). Distribution is concentrated around the Hebrides, the Northern Isles, and offshore in the northern North Sea (Evans et al. 2011).

The most recently collected broad scale data on Atlantic white-sided dolphin abundance and distribution are available from the SCANS III survey. The SCANS III sightings data show a very clear offshore distribution of Atlantic white-sided dolphins, with almost all sightings located in Survey Block 8 (Atlantic - west of Scotland) where densities reached up to 0.083 white-sided dolphins/km^2 (Figure 146). Atlantic white-sided dolphins were sighted during the SCANS III survey within DPO site E2 (Figure 147), with medium to medium-high predicted densities in the North East and East DPOs regions.

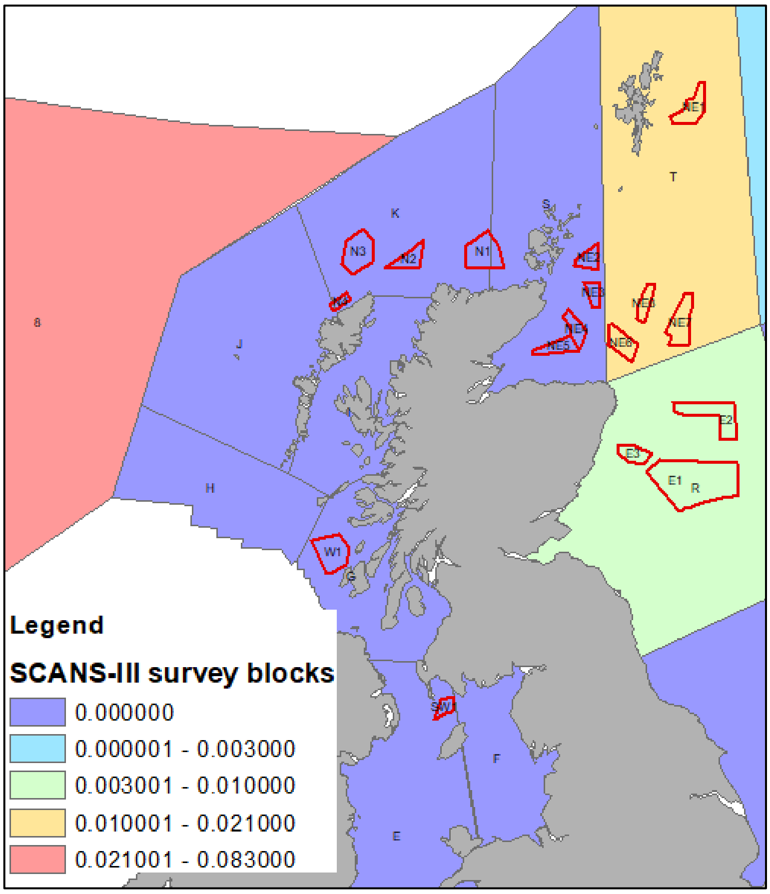


Figure 145: SCANS III block-wide uniform density estimates for white-sided dolphins in Scottish waters (Hammond et al. 2017). Overlaid for reference are the DPO areas.

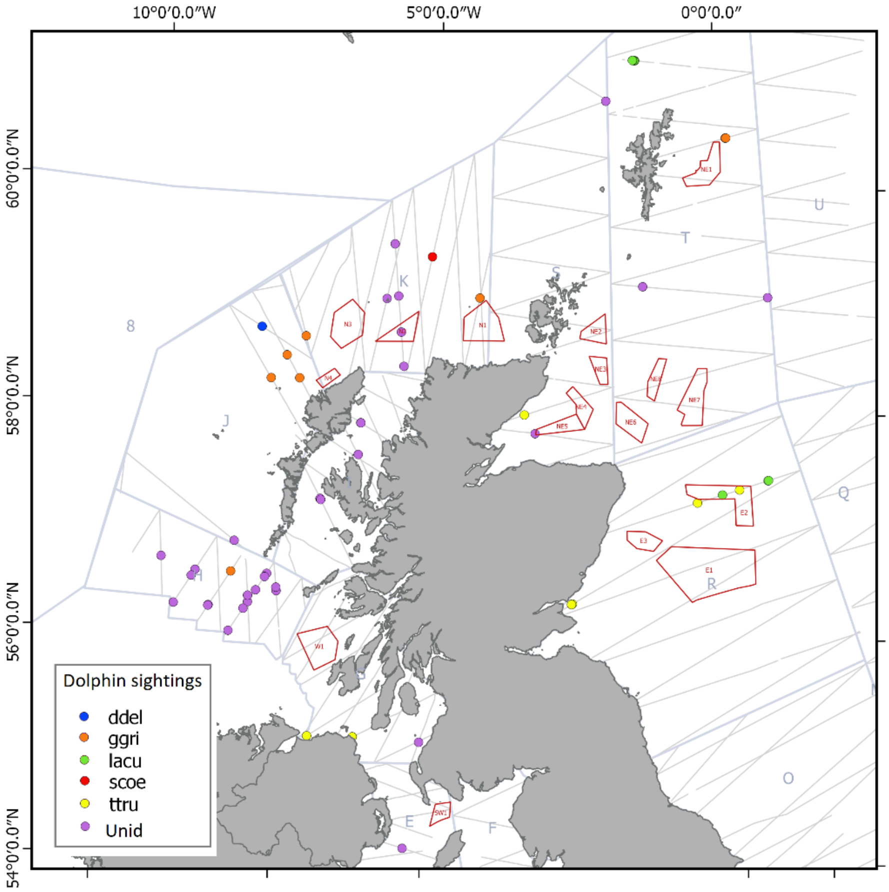


Figure 146: Sightings of dolphin species seen during the SCANS-III survey blocks containing DPO Areas (red). Ddel = Common dolphin (*Delphinus delphis*), ggri= Risso's dolphin (*Grampus griseus*), lacu= white-sided dolphin (*Lagenorhynchus acutus*), scoe = striped dolphin (*Stenella Stenella coeruleoalba*), ttru= bottlenose dolphin (*Tursiops truncatus*). Unid= dolphins not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The species distribution maps presented by Waggitt et al. (2020) predicted seasonal variation in Atlantic white-sided dolphin densities in Scottish waters, with relatively low densities throughout the year in coastal waters, but an increase in density in offshore deeper waters to the west of Scotland during the summer months (Figure 148). The high density areas of Atlantic white-sided dolphins predicted by Waggitt et al. (2020) are not close to any DPOs sites. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

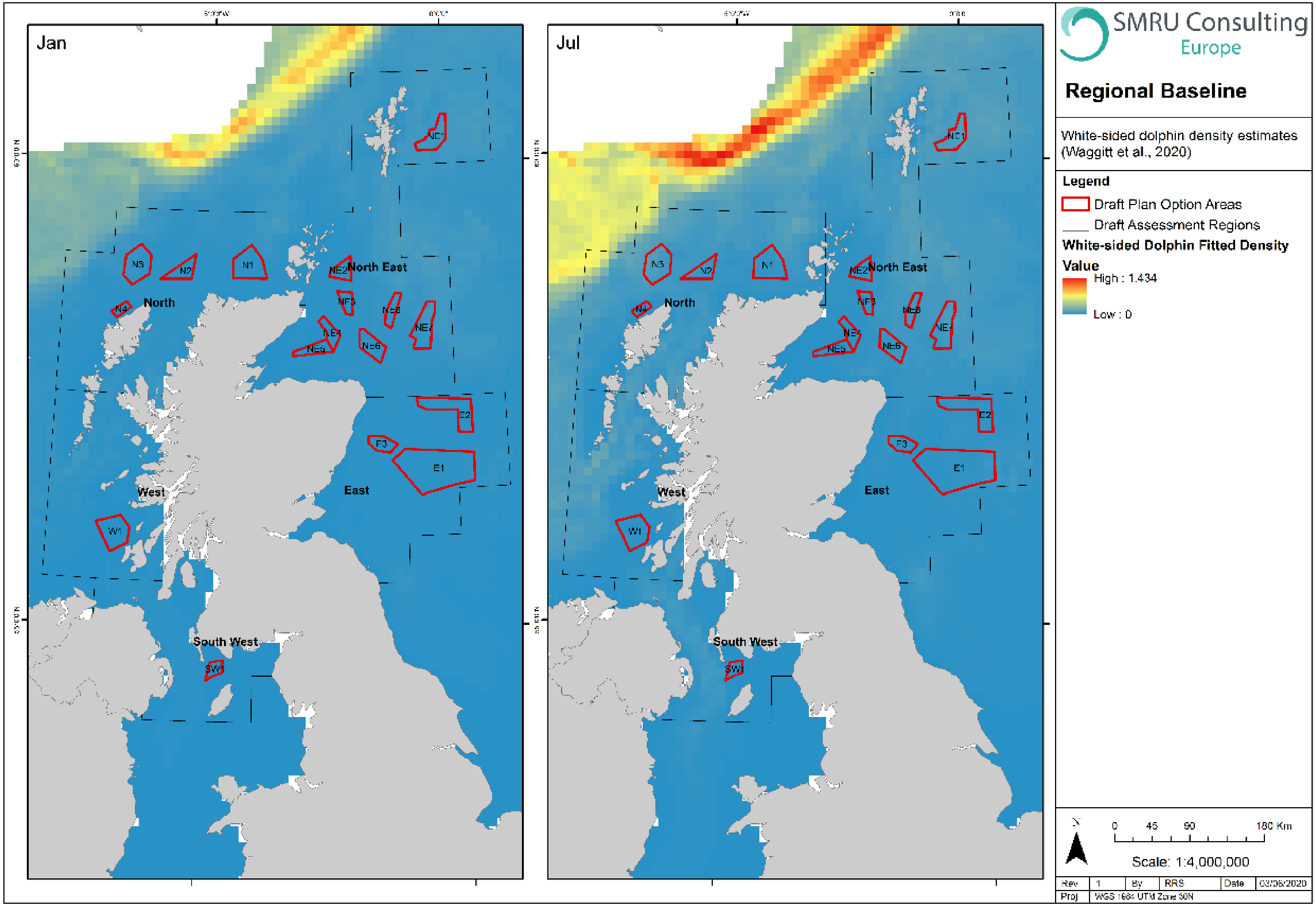


Figure 147: Spatial variation in predicted Atlantic white-sided dolphin densities (animals per km²). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

The Scottish Marine Atlas describes Atlantic white-sided dolphin habitat as offshore along the outer continental shelf and slope, with distribution mainly around the Hebrides, Northern Isles and North Sea (Baxter et al. 2011). Mapped encounter rates show some overlap of medium-low encounter rates in the North, North East and East DPOs regions, with the highest encounter rates overlapping into DPOs site N3 (Figure 149; Figure 135; Figure 117; Figure 82).

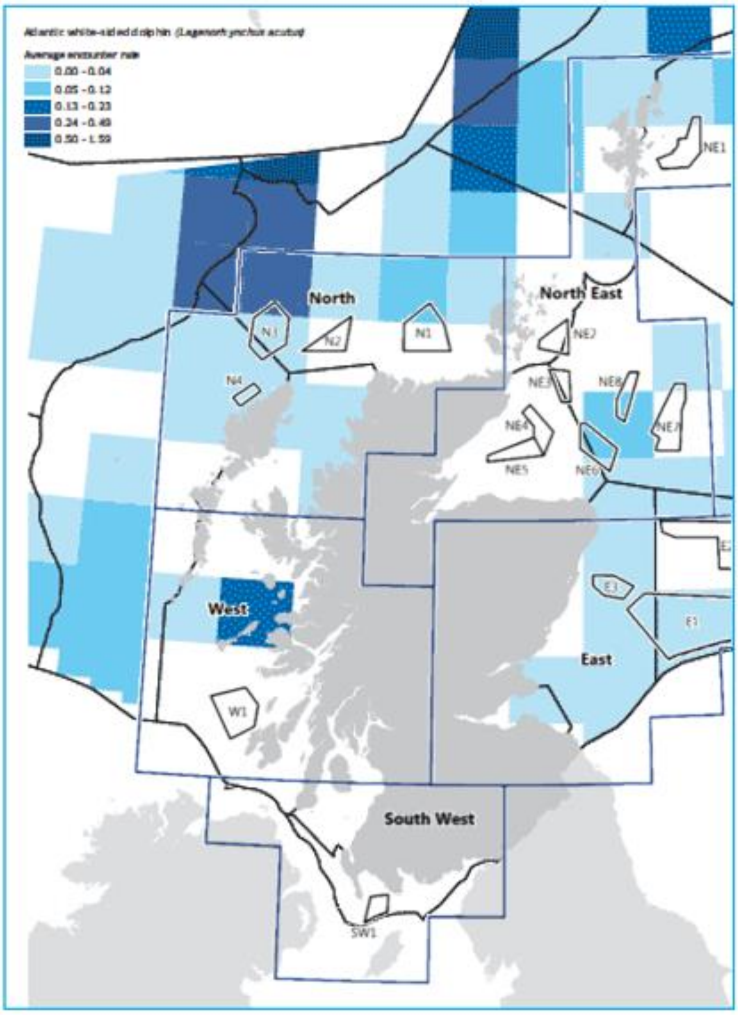


Figure 148: White-sided dolphin average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

In older survey data, Atlantic white-sided dolphins were found in deep waters around the north of Scotland throughout the year (Figure 151) and entered the North Sea mainly in summer (Reid et al. 2003). There is some overlap of the distributions predicted by Reid et al. (2003) with DPOs sites, particularly sites NE8, E1 and E3. Again, in survey data now over two decades old, the Atlantic white-sided dolphin was the most sighted species during the Cetaceans of the Atlantic Frontier surveys (Weir et al. 2001), and were recorded in all months of the year, with a higher number between June and August and October and November (Figure 150) (Pollock et al. 2000), though by far the highest sightings were in August. They were most abundant in deep water along shelf edges, especially along the Faroe-Shetland Channel and the Faroe Bank Channel (Figure 150), though sightings of groups in waters less than 1,000 m deep increased during July and August, suggesting an inshore movement during the summer months.

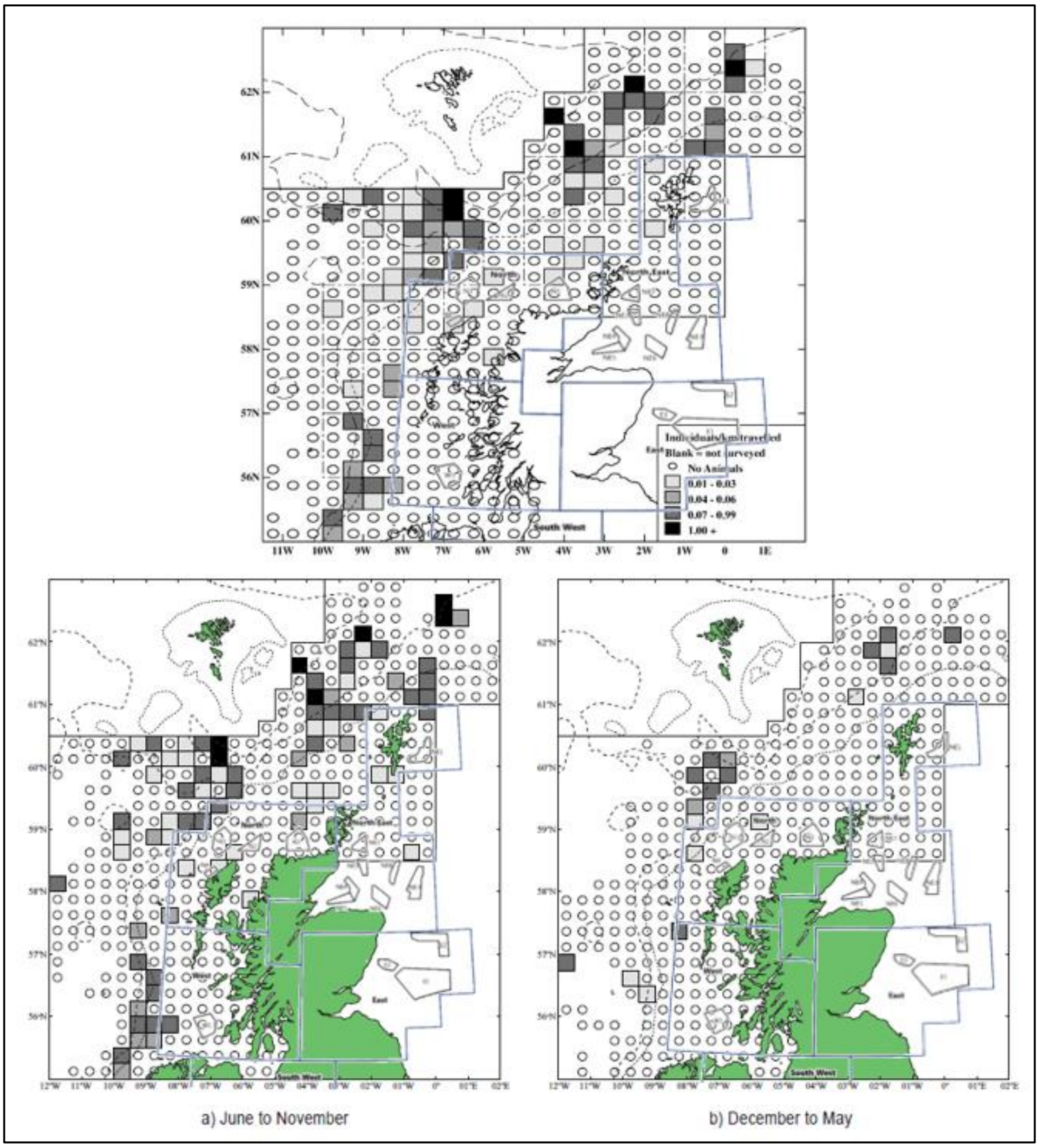


Figure 149: Above: Abundance of Atlantic white-sided dolphins (1979-1998) Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001).Below: Abundance of Atlantic white-sided dolphins (left) June to November and (right) December to May (1979-1999). (Pollock et al. 2000). Note, the legend is applicable to all figures. Overlaid for reference are the approximate regional and DPO areas.

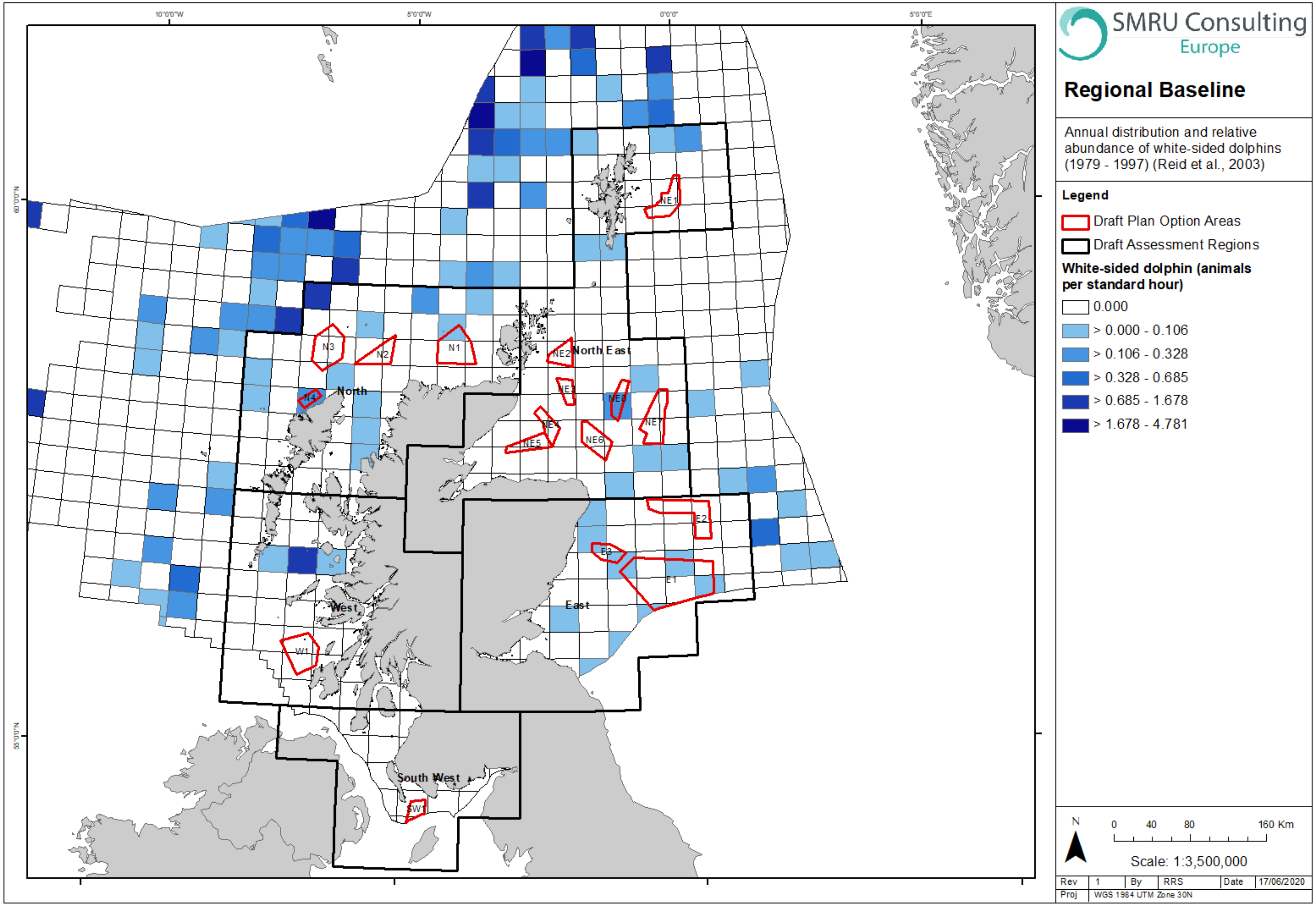


Figure 150: Aggregated annual distribution and relative abundance of Atlantic white-sided dolphins (1979-1997) based on data presented in Reid et al. (2003).

In 1998, Macleod et al. (2003) surveyed three areas of north western Scottish waters (the Outer Hebrides, west of the Shetland Islands and the central Faroe-Shetland Channel), and Atlantic white-sided dolphin was the most frequently sighted species throughout the area. They were sighted predominantly in the deeper waters beyond the continental shelf edge. Relative abundance was higher in the Faroe-Shetland Channel (11 sightings/100 km) compared to the Outer Hebrides (1.85 sightings/100 km). All survey strata had higher relative abundance estimates than had been shown from previous surveys in the northern North Sea (0.046 sightings/100 km, Borchers et al. (1995)). All sightings recorded were out with the boundaries of any of the DPO areas, with this data now also dated.

During the NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009, Atlantic white-sided dolphins were sighted to the north and west of Shetland, but not seen within any DPOs regions or sites (Figure 153).

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, Atlantic white-sided dolphins seemed to prefer shelf edge and deep waters, and were again sighted in waters to the west of Shetland, in the Faroe-Shetland channel (Stone 2015). Sightings also occurred in the central and northern North Sea and Outer Moray Firth, with distribution also extended along the shelf edge, and deeper waters to the west of Scotland. In terms of the DPOs regions, Atlantic white-sided dolphins were sighted in all regions apart from the South West region (Figure 152). Sightings directly overlapped DPO sites NE4, NE7, E1 and E2 (Figure 152).

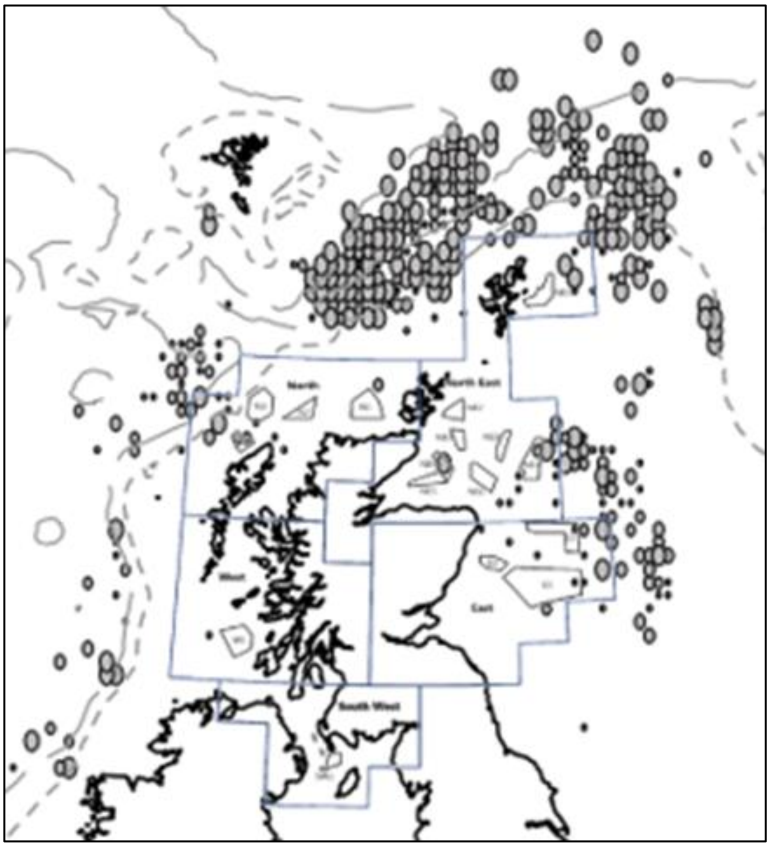


Figure 151: Atlantic white-sided dolphins encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

During vessel-based surveys aboard ferries or large shipping vessels, MARINElife recorded sightings of Atlantic white-sided dolphins only once, though this sighting was within DPO site NE7 (Figure 154).

During land-based Shorewatches, Atlantic white-sided dolphins were spotted rarely, off Tiumpan Head, the Isle of Skye and the north coast of mainland Scotland, with no overlap with any DPOs sites (Figure 155).

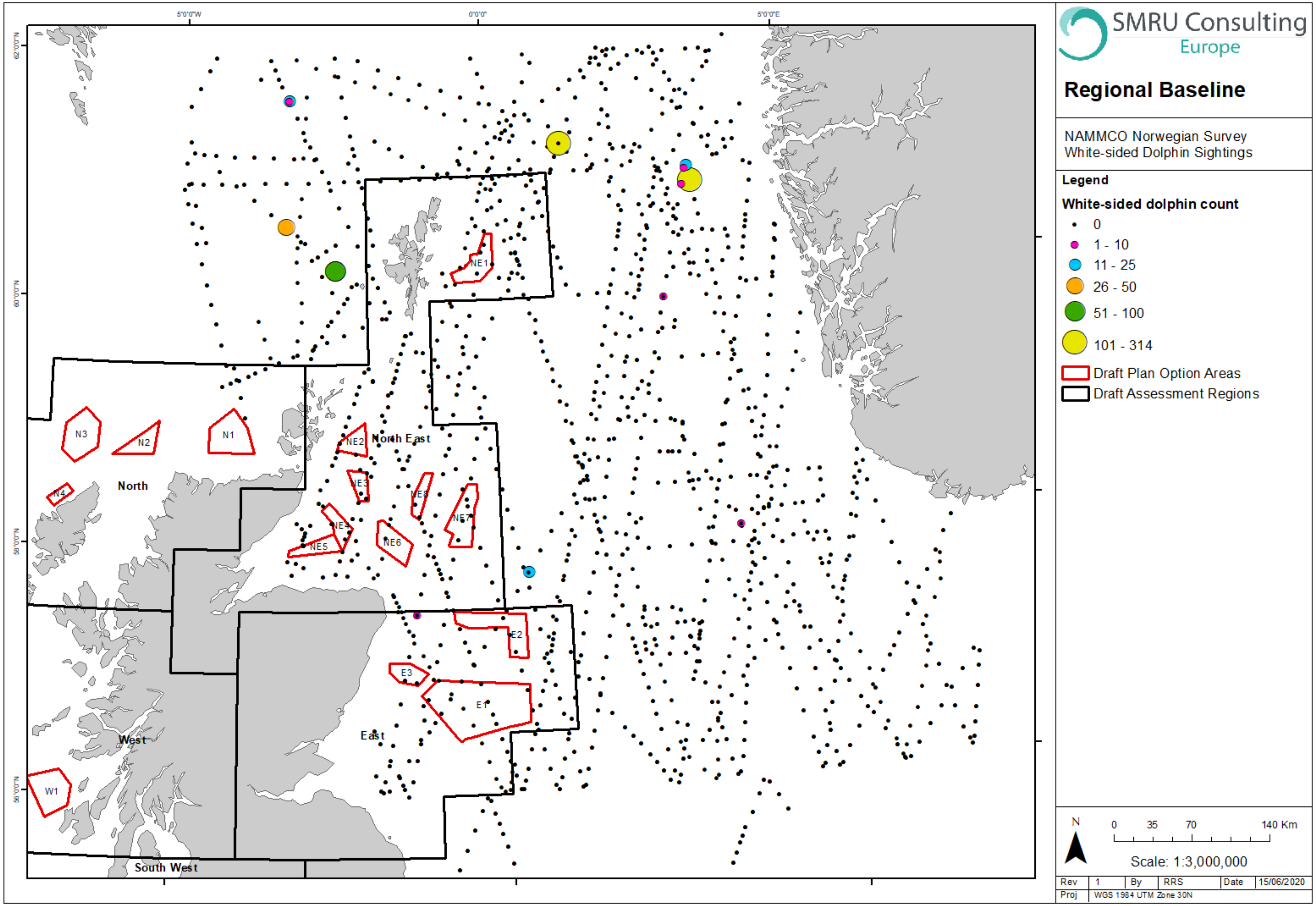


Figure 152: Atlantic white-sided dolphin sightings (coloured dots) during NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009. Data provided free of charge.

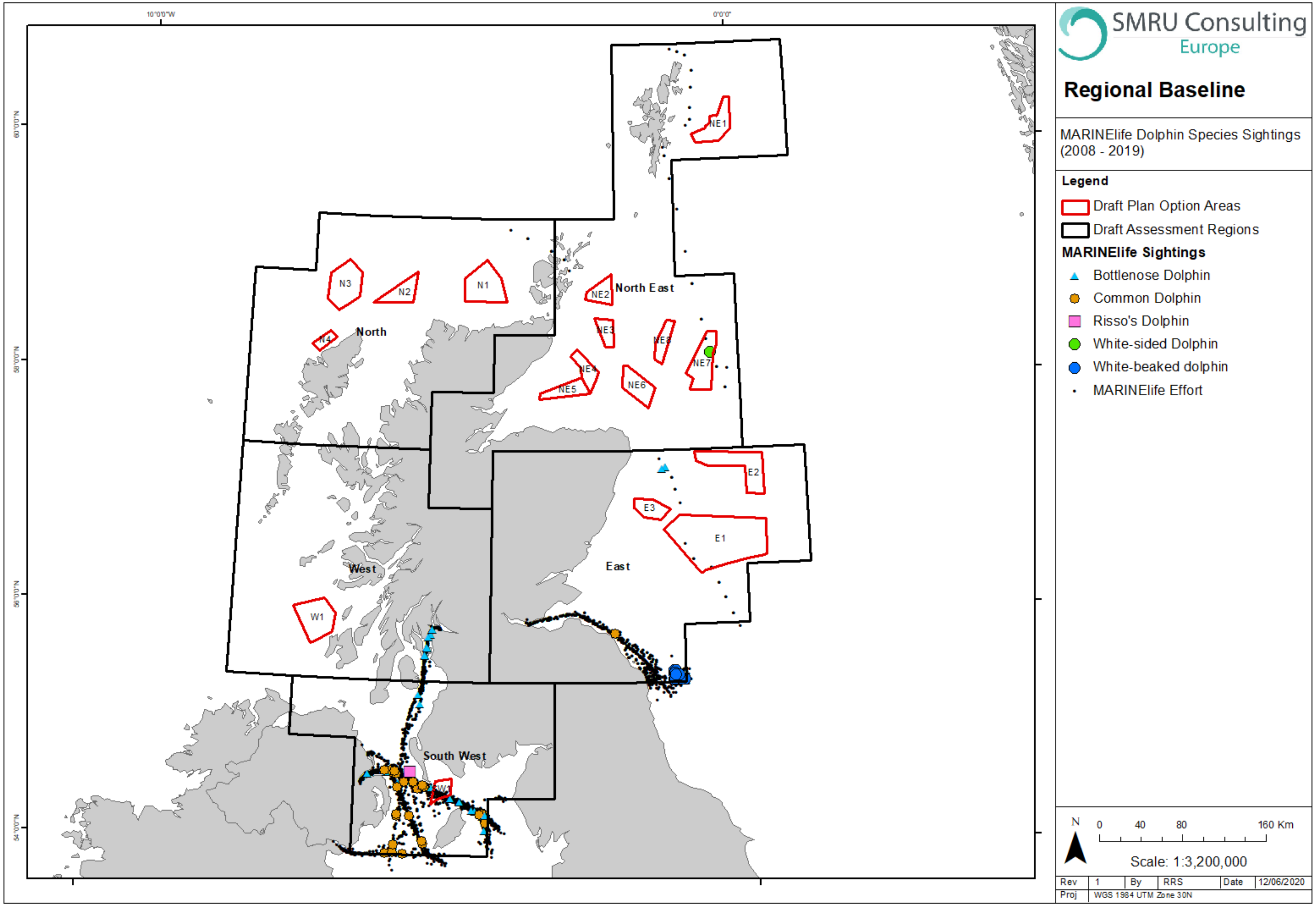


Figure 153: Dolphin sightings recorded by MARINElife between 2008 and 2019 during vessel-based watches. Data provided at cost by MARINElife.

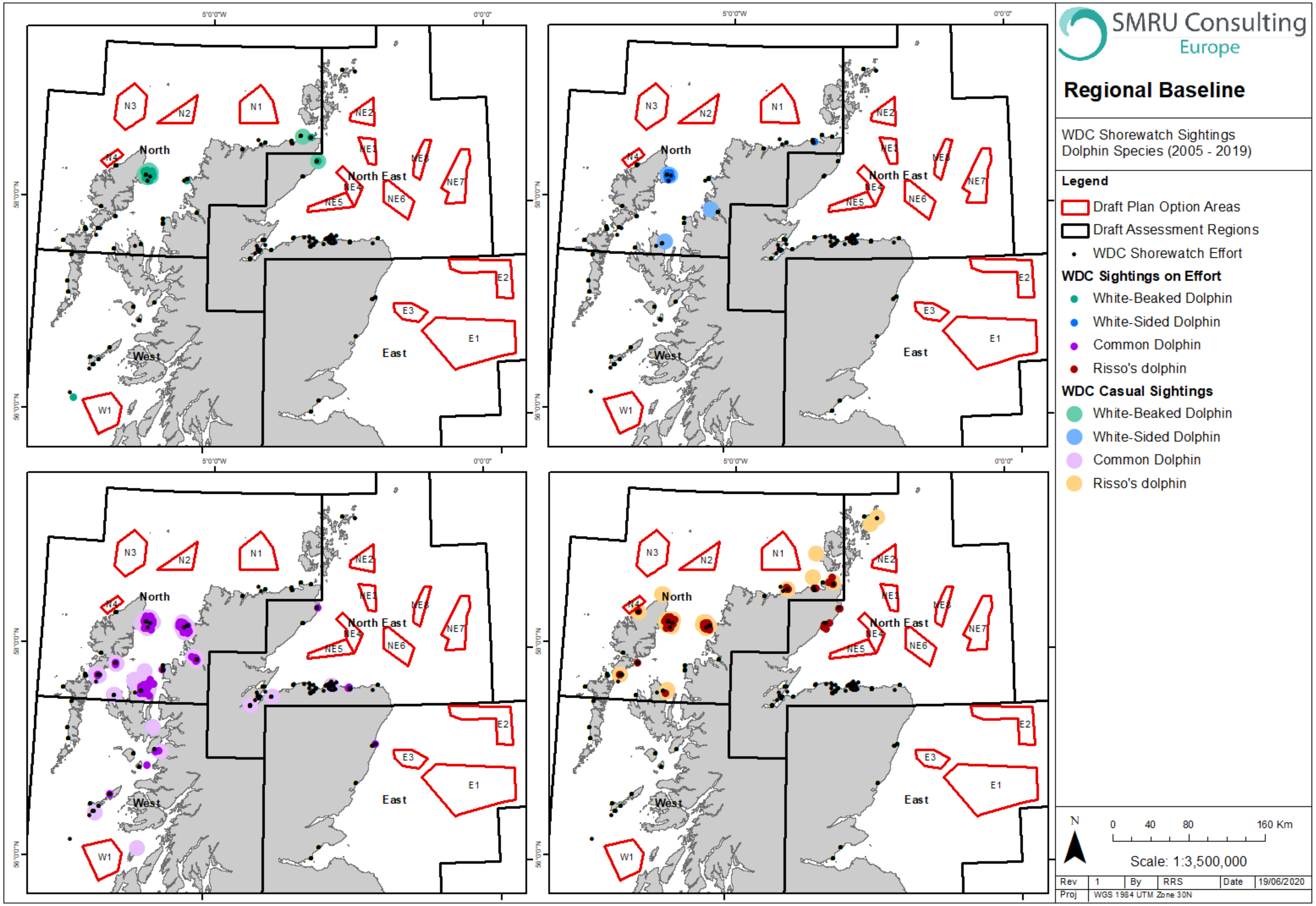


Figure 154: Sightings of white-beaked, white-sided dolphin, common and Risso's dolphins recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth recorded no encounters with Atlantic white-sided dolphins between 2002 and 2016 during a total of 241 trips. Further north, around the Pentland Firth and Orkney Isles, Evans et al. (2011) show a mainly offshore distribution of Atlantic white-sided dolphins (Figure 156), with most sightings occurring in July and September, though sightings have occurred in all months between March and October.

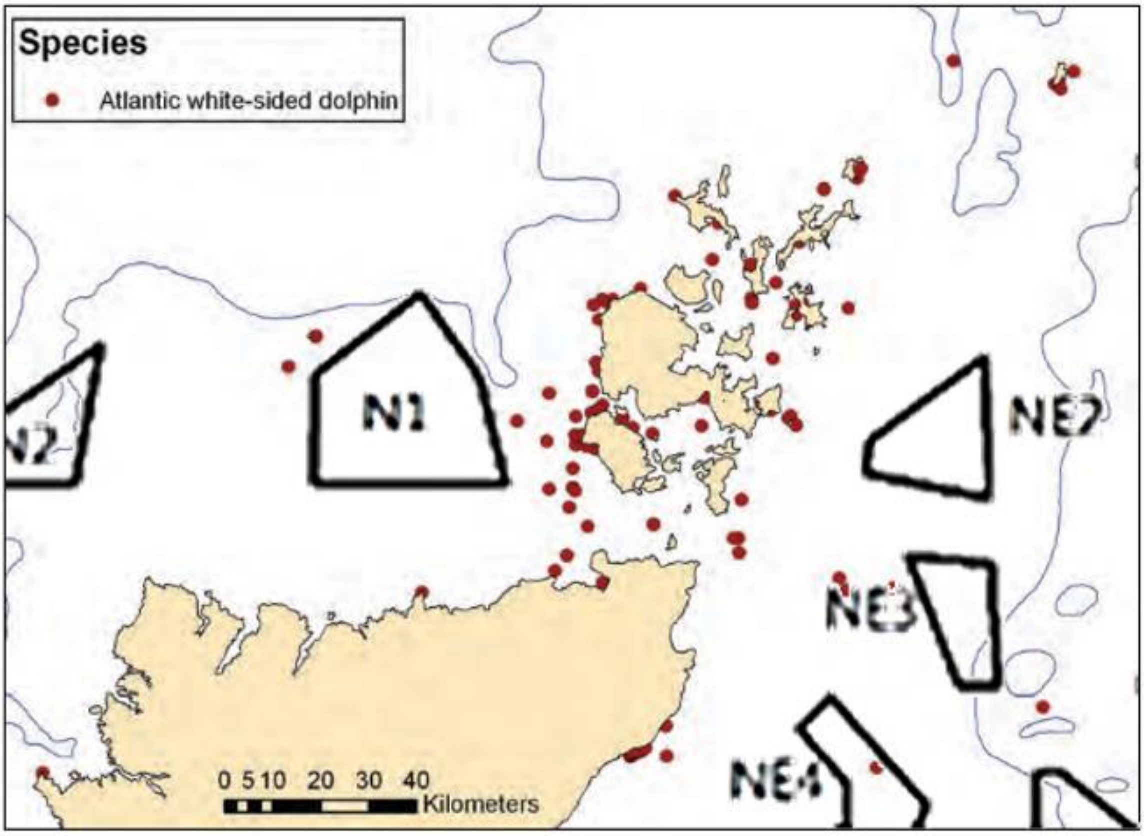


Figure 155: Distribution of sightings of Atlantic white-sided dolphins around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Marine mammal sightings data covering the East Grampian coastline between 1973 and 2010 presented by Anderwald and Evans (2010) show a potential overlap of Atlantic white-sided dolphin distribution with DPO site E3, with 75% of sightings in this area in the months of July and August (Figure 157). However, since 2003 there have been no live sightings in the region (Anderwald and Evans 2010).

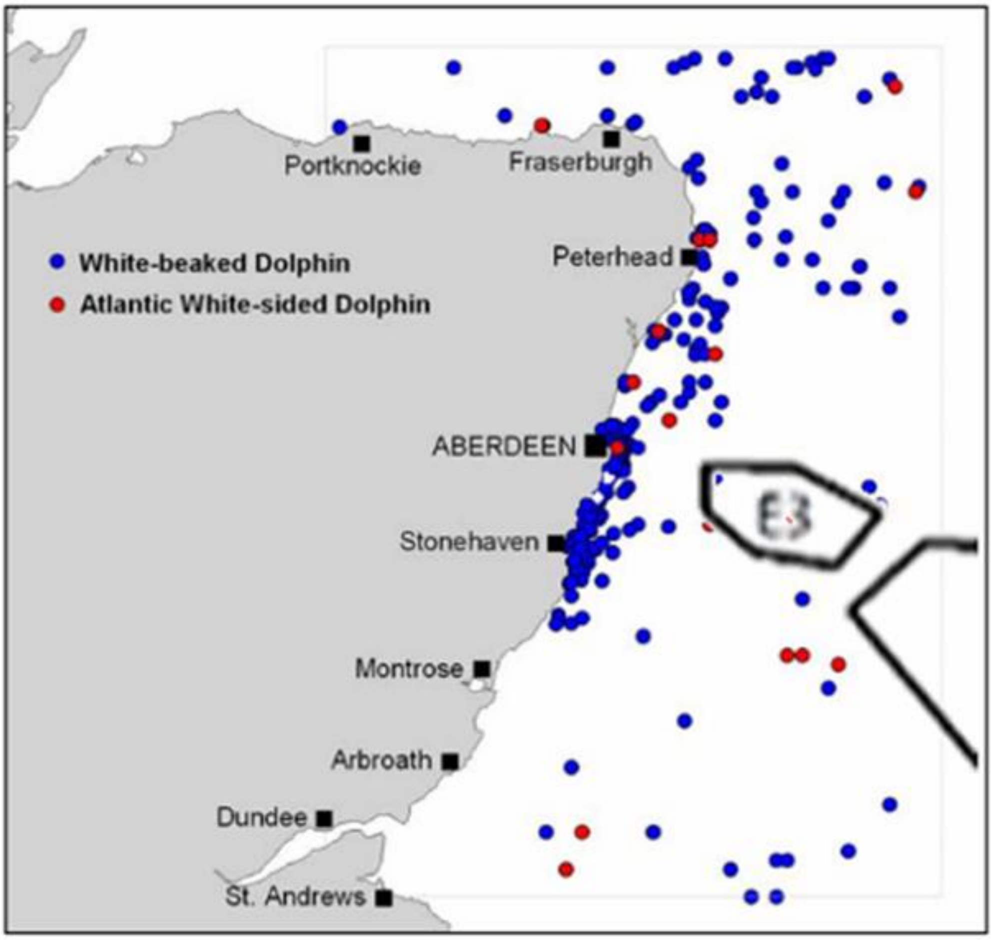


Figure 156: Distribution of White-beaked (blue dots) and Atlantic White-sided Dolphin (red dots) sightings in East Grampian Region (Anderwald and Evans 2010). Overlaid for reference are the approximate regional and DPO areas.

3.3.10. Long-finned pilot whale

Based on the information presented below, long-finned pilot whales primarily occur in deeper waters further offshore. Sightings within the DPO regions were rare, however there have been rare sightings within DPO sites.

The most recent assessment of pilot whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019g).

The most recently collected broad scale data on pilot whale abundance and distribution are available from the SCANS III survey. The SCANS III sightings data show a very clear offshore distribution of long-finned pilot whales, with almost all sightings located in Survey Block 8 (Atlantic - west of Scotland) where densities reached up to 0.079 pilot whales/km^2 (Figure 158). Density predictions were also reasonably high in Survey Block K, which corresponds with the North DPO region and covers those sites within it. For the remainder of Scottish waters and DPO regions, density estimates remain low. No SCANS III survey sightings of long-finned pilot whales overlap with any of the DPOs sites (Figure 159).

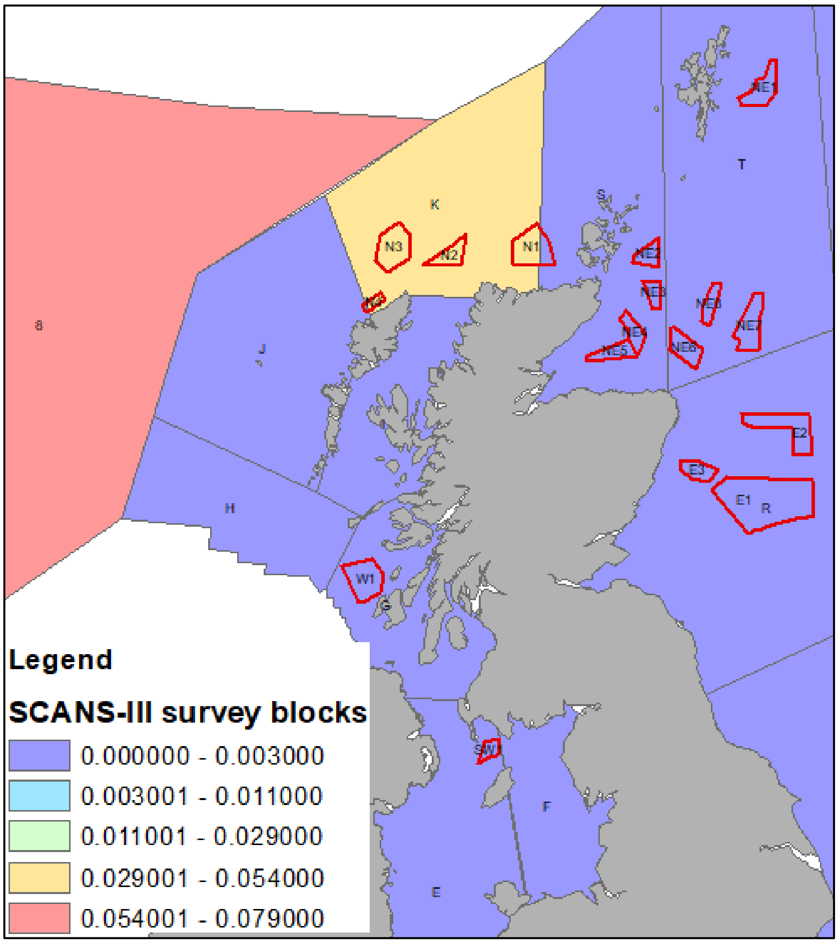


Figure 157: SCANS III block-wide uniform density estimates for long-finned pilot whales in Scottish waters (left) (Hammond et al. 2017). Overlaid for reference are the DPO areas.

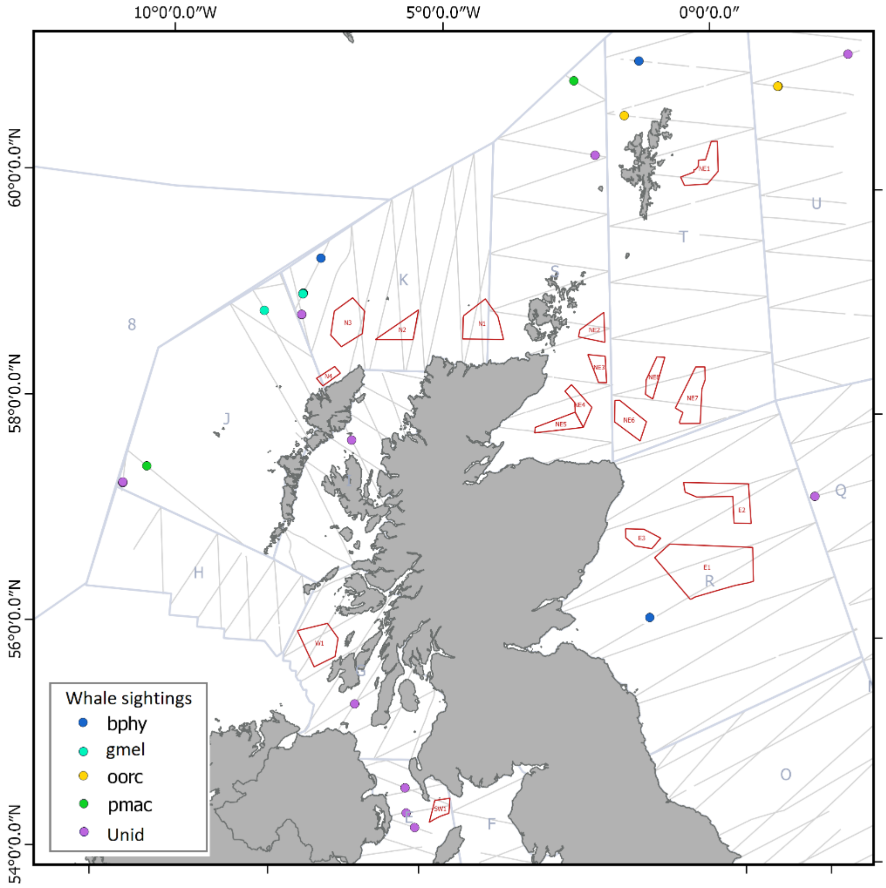


Figure 158: Sightings of whale species seen during the SCANS-III survey blocks containing DPO Areas (red). Bphy = fin whale (*Balaenoptera physalis*), gmel= long-finned pilot whale (Globicephala *melas*), oorc= killer whale (*Orcinus orca*), pmac= sperm whale (*Physeter macrocephalus*) and Unid=whales not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The most recent collation of data seeking to provide estimates of distribution of long-finned pilot whales within the North-East Atlantic, including Scottish waters is presented in Waggitt et al. (2020). Over the entire North-East Atlantic study area, Waggitt et al. (2020) suggested long-finned pilot whales move into deeper waters during the summer months, but also persist in the region year-round. However, more specifically for Scottish waters the species distribution maps presented suggest a similar offshore distribution year-round (Figure 160), with little overlap with DPOs sites.

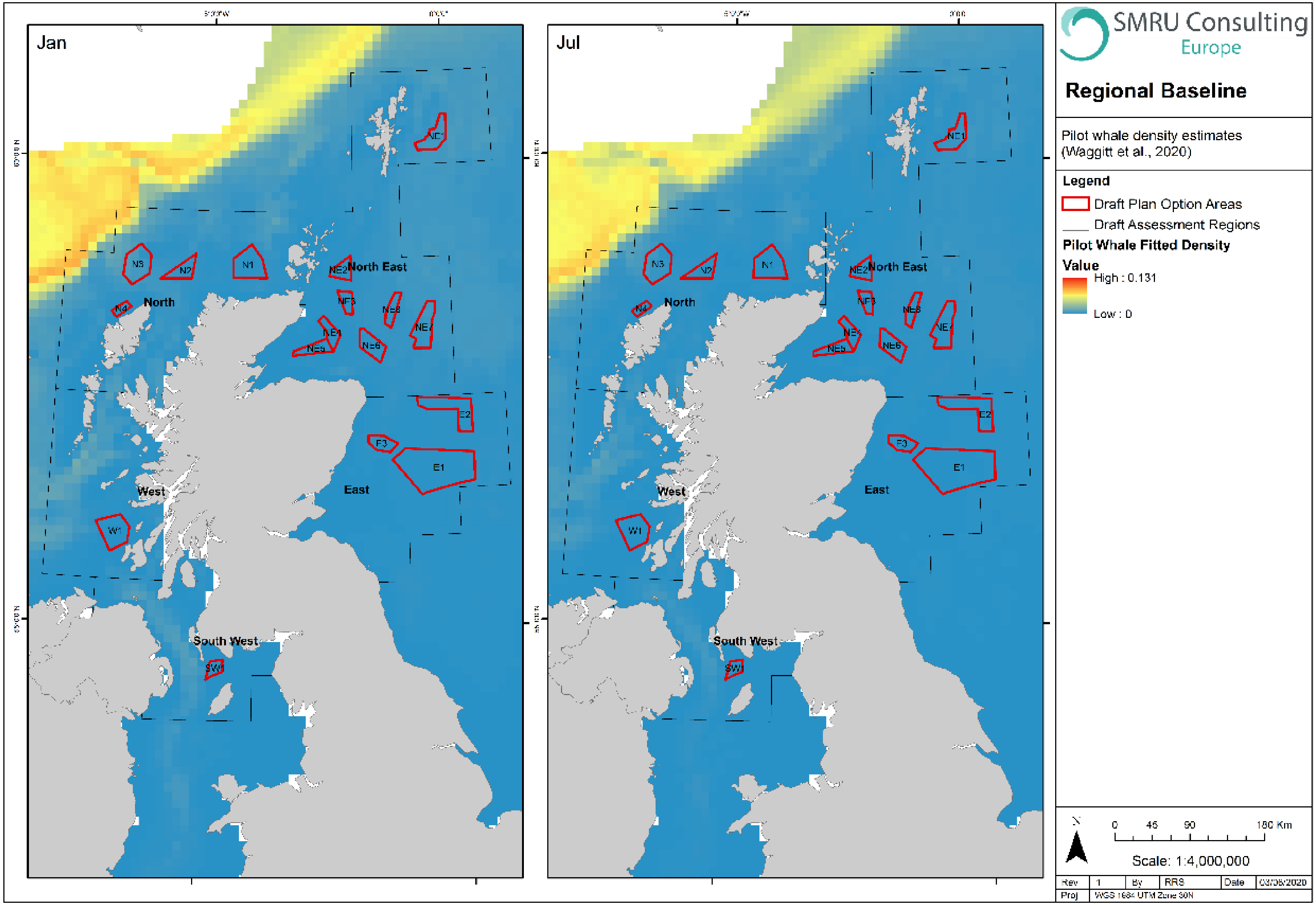


Figure 159: Spatial variation in predicted long-finned pilot whale densities (animals per km²). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Rogan et al. (2017) modelled a combination of SCANS-II, CODA and T-NASS survey data covering 2005 and 2007 to predict abundance of pilot whales in the North-East Atlantic. Pilot whale sightings were distributed widely along the continental shelf edge and in ocean waters, with no sightings in the North Sea. Sightings were also strongly associated with the 2000 m depth contour, and steep slopes on both sides of the Rockall Trough were predicted to be important areas for pilot whales in the North-East Atlantic (Figure 161). There were no sightings of pilot whales in any of the DPO regions, and therefore the results presented by Rogan et al. (2017) do not predict any sightings within the DPOs areas themselves.

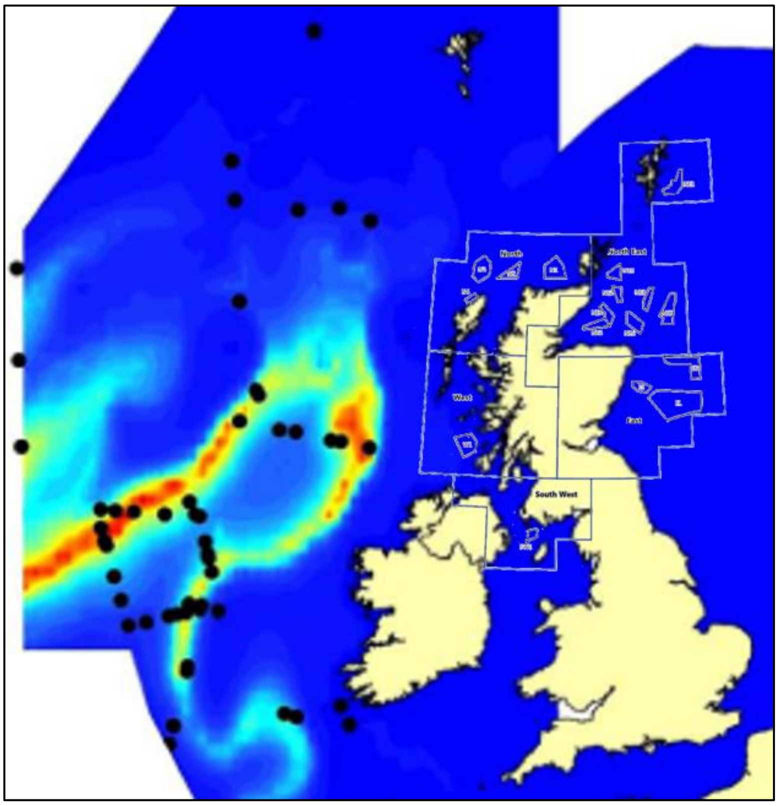


Figure 160: Surface map of smoothed predicted abundance (numbers/km^2) for pilot whales (Rogan et al. 2017). Overlaid for reference are the approximate regional and DPO areas

The Scottish Marine Atlas describes Atlantic long-finned pilot whale habitat as the deep waters along and seaward of the continental shelf edge, with sightings limited to the Moray Firth and offshore west of the Hebrides and Shetland (Baxter et al. 2011). Mapped encounter rates show some overlap of low encounter rates with some Moray Firth based DPOs sites, but the highest encounter rates are offshore of north-west Scotland and do not overlap with any DPOs sites (Figure 162).

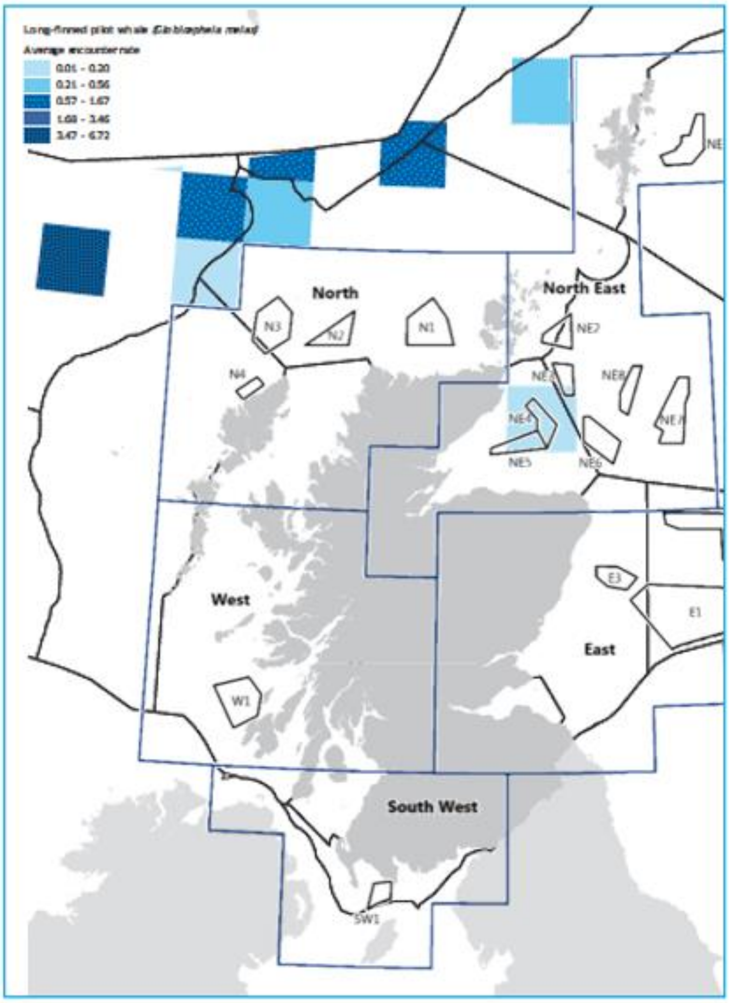


Figure 161: Pilot whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Older survey data indicate similar patterns of distribution. For example the ‘Atlas of Cetacean Distribution in north-west Europe’ described long-finned pilot whales as common with a wide distributed in the deeper waters of the North Atlantic, especially waters to the north and south of the Wyville Thompson Ridge (Figure 164) (i.e. 200-3,000 m depth), with relatively few occurrences in shallower water around northern Scotland, although they will seasonally enter more coastal areas, such as the Faroes and northern Scotland (Reid et al. 2003, Evans et al. 2011). In Scottish waters, long-finned pilot whales are seen in the greatest numbers to the north of Scotland and south-east of the Faroes. The distribution predictions presented by Reid et al. (2003) suggest an overlap with DPOs sites N3, NE4 and NE5.

Older sightings data presented in the Cetaceans of the Atlantic Frontier show a strong association with the shelf edge, with animals concentrated along the Faroe-Shetland Channel and the Faroe-Bank channel (Figure 163), likely related to the habitat preference of their deep-water squid prey (Weir et al. 2001). They were also sighted in the Outer Hebrides and the Faroe-Shetland Channel during the Macleod et al. (2003) surveys, with a preference for deeper waters and a relative abundance estimate of up to 1.6 sightings per 100 km surveyed.

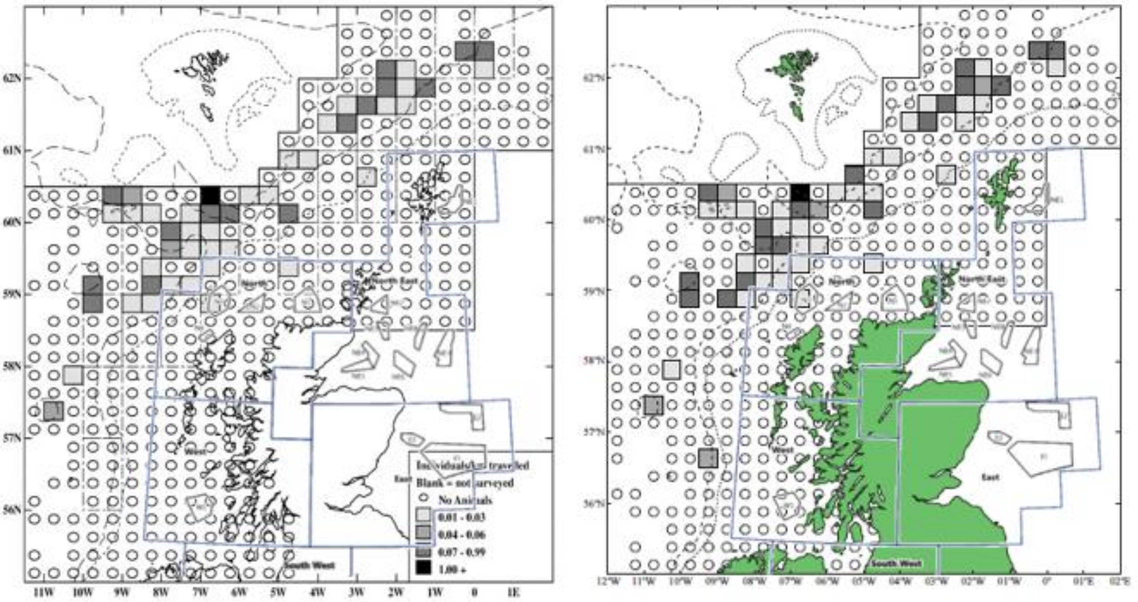


Figure 162: Left: Abundance of long-finned pilot whales (1979-1998) presented in the Cetaceans of the Atlantic Frontier. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants). (Weir et al. 2001). Right: Abundance of long-finned pilot whales (1979-1999). (Pollock et al. 2000). The legend is applicable to both figures. Overlaid for reference are the approximate regional and DPO areas.

During NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009, long-finned pilot whales were sighted to the north and west of Shetland, and no sightings were within any of the DPO regions or sites (Figure 165).

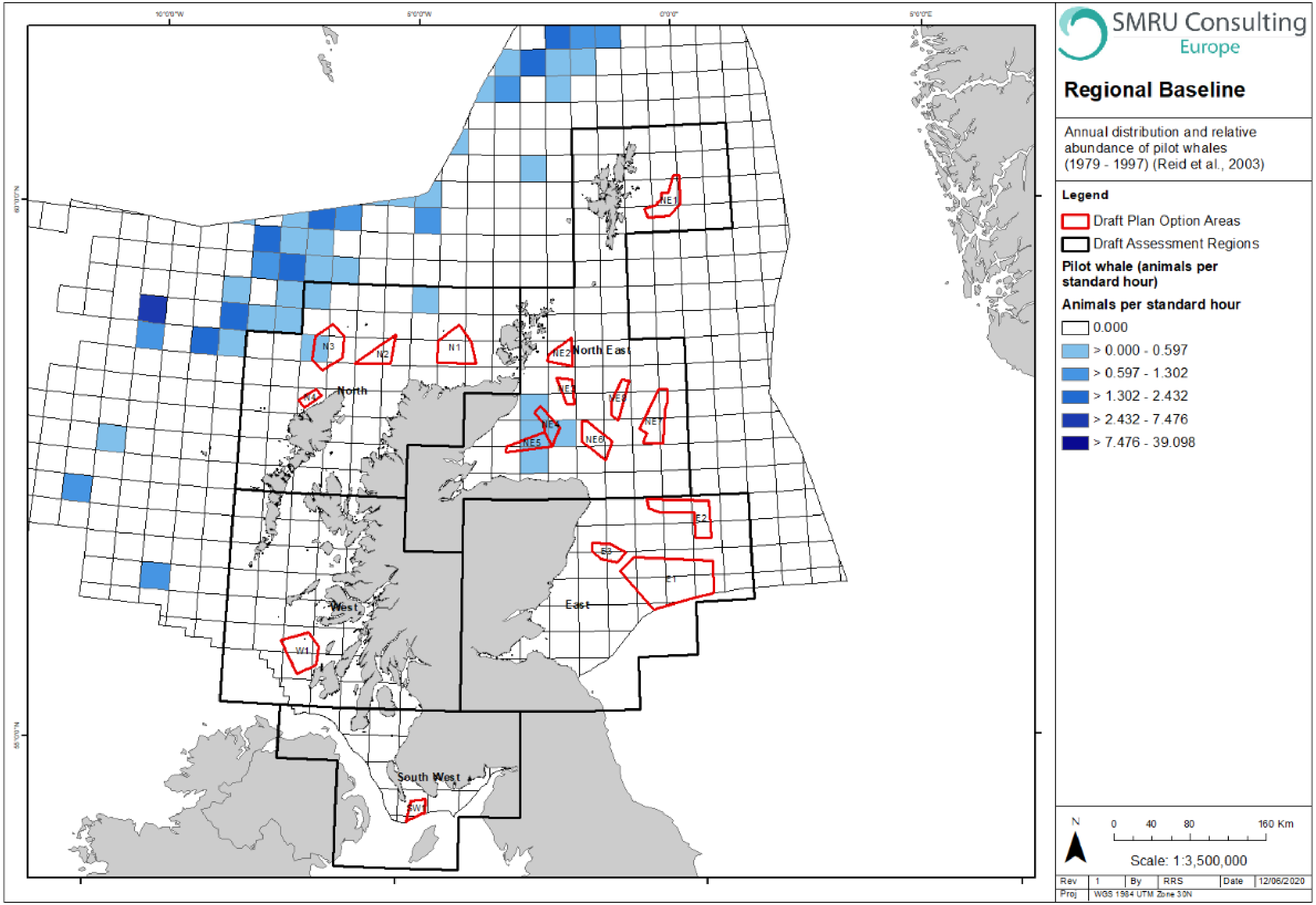


Figure 163: Aggregated annual distribution and relative abundance of long-finned pilot whales (1979-1997) based on data presented in Reid et al. (2003).

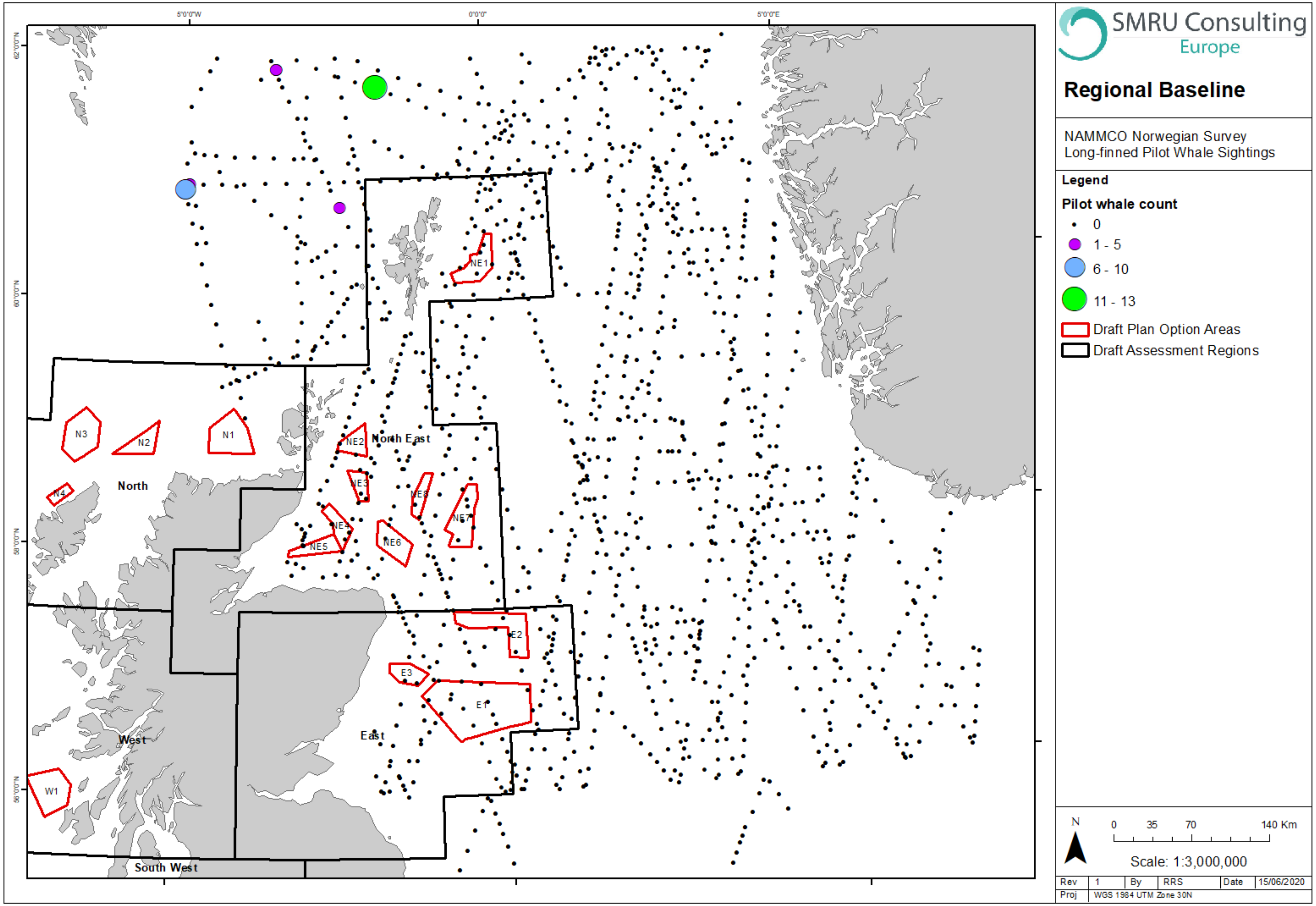


Figure 164: Long-finned pilot whale sightings (coloured dots) during NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009. Data provided free of charge.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, long-finned pilot whale sightings were distributed in deep waters and along the shelf edge (Stone 2015). In terms of the DPOs regions, long-finned pilot whales were sighted in all regions apart from the South West region, but sightings were infrequent in comparison to other species recorded during the surveys (Figure 166). Sightings did not directly overlap any DPO sites (Figure 166).

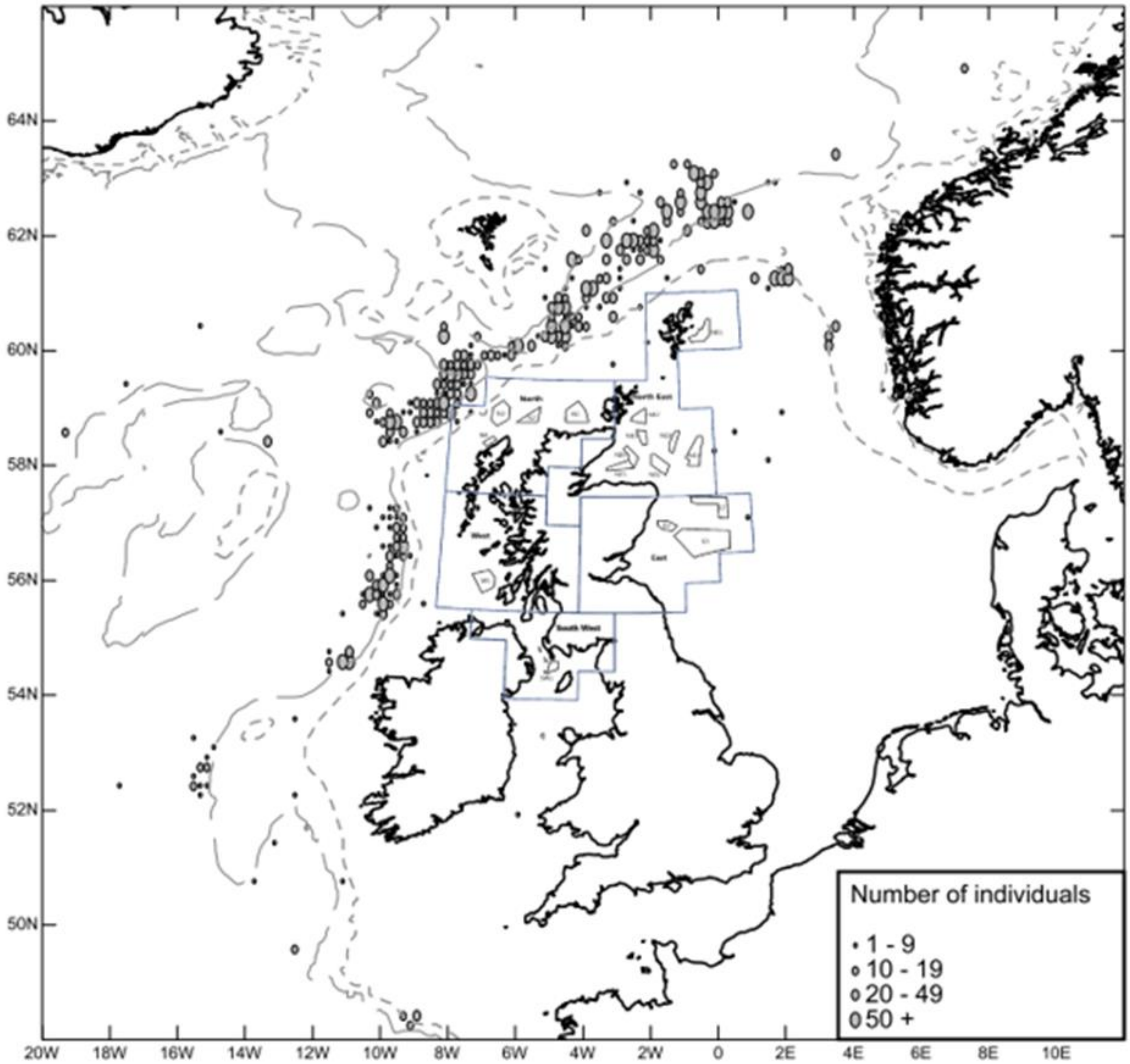


Figure 165: Long-finned pilot whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

During land-based Shorewatches, long-finned pilot whales were sighted infrequently around the Scottish coastlines, with sightings on the Isle of Lewis, Skye and along the coast of the Moray Firth (Figure 167). No sightings overlap the DPO site boundaries, but sightings from shore data may be useful when considering cable landfall locations.

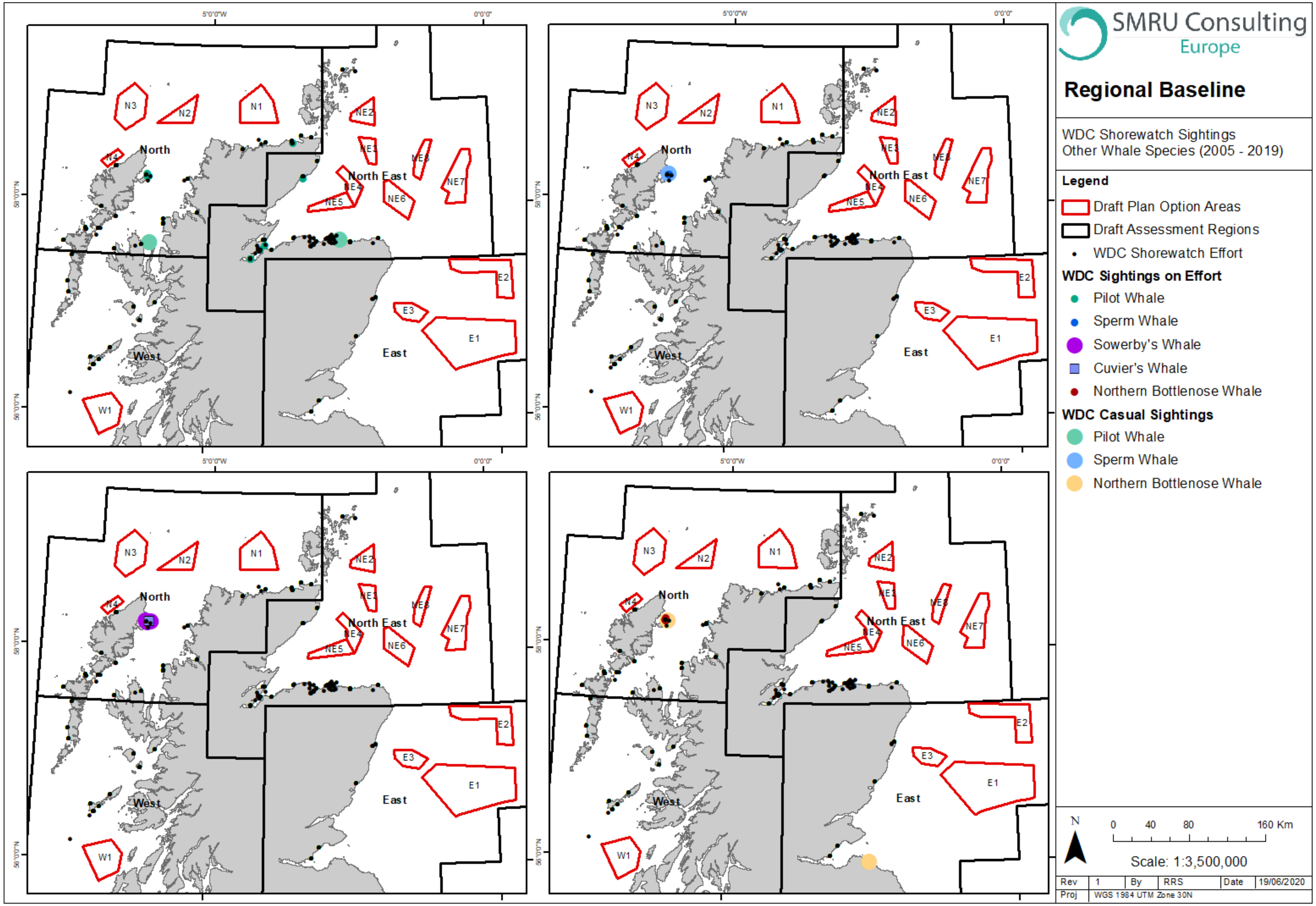


Figure 166: Sightings of long-finned pilot whale, sperm whale, Sowerby's beaked whale, Cuvier's beaked whale and northern bottlenose whale recorded by WDC Shorewatch 2005 and 2019.

Long-finned pilot whales were recoded once during aerial surveys in the Forth and Tay offshore windfarm area (Figure 168) (Grellier and Lacey 2012).

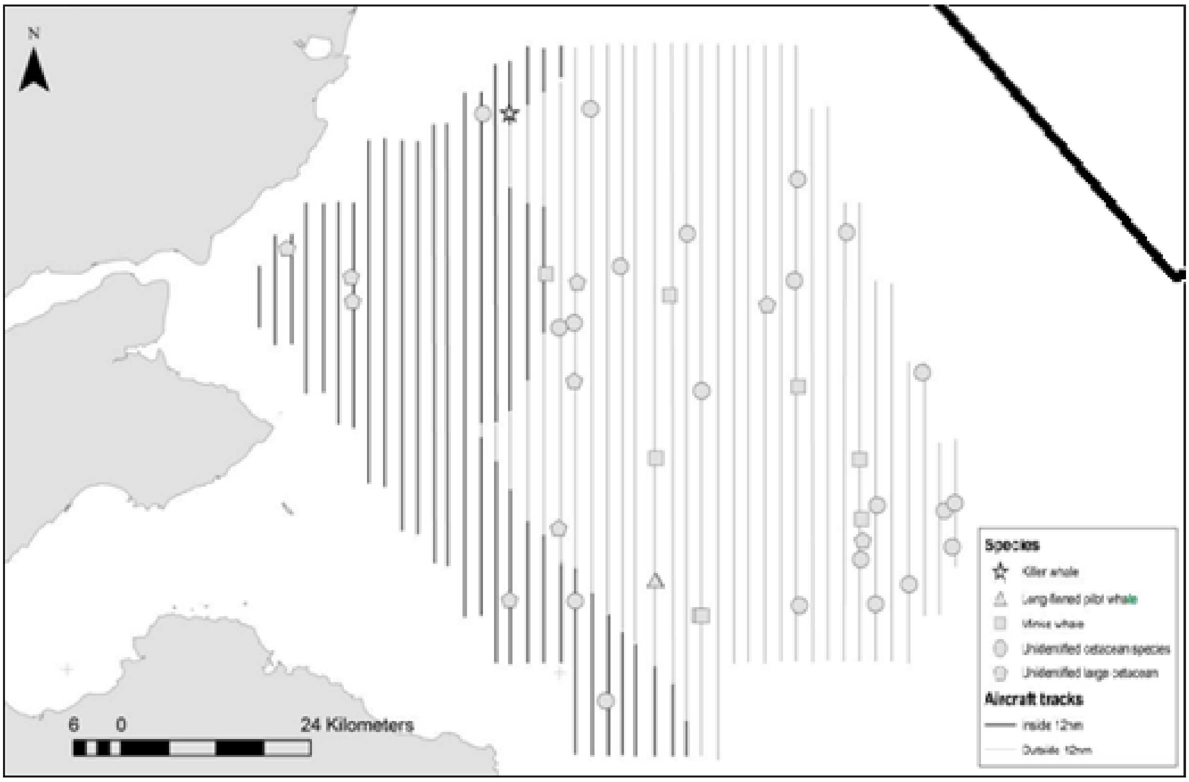


Figure 167: Large cetacean sightings during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPOs are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the inner Moray Firth recorded no encounters with long-finned pilot whales between 2002 and 2016 during a total of 241 trips. Further north of this, sightings around the Pentland Firth and Orkney Isles between 1980 and 2010 showed long-finned pilot whales are distributed both off-shore and near-shore (Figure 169) and occur mainly between May and August, though sightings do occur year-round with particularly large group sizes have been recorded in January (Evans et al. 2011). There was one sighting of long-finned pilot whale within the DPO site NE4 (Figure 169).

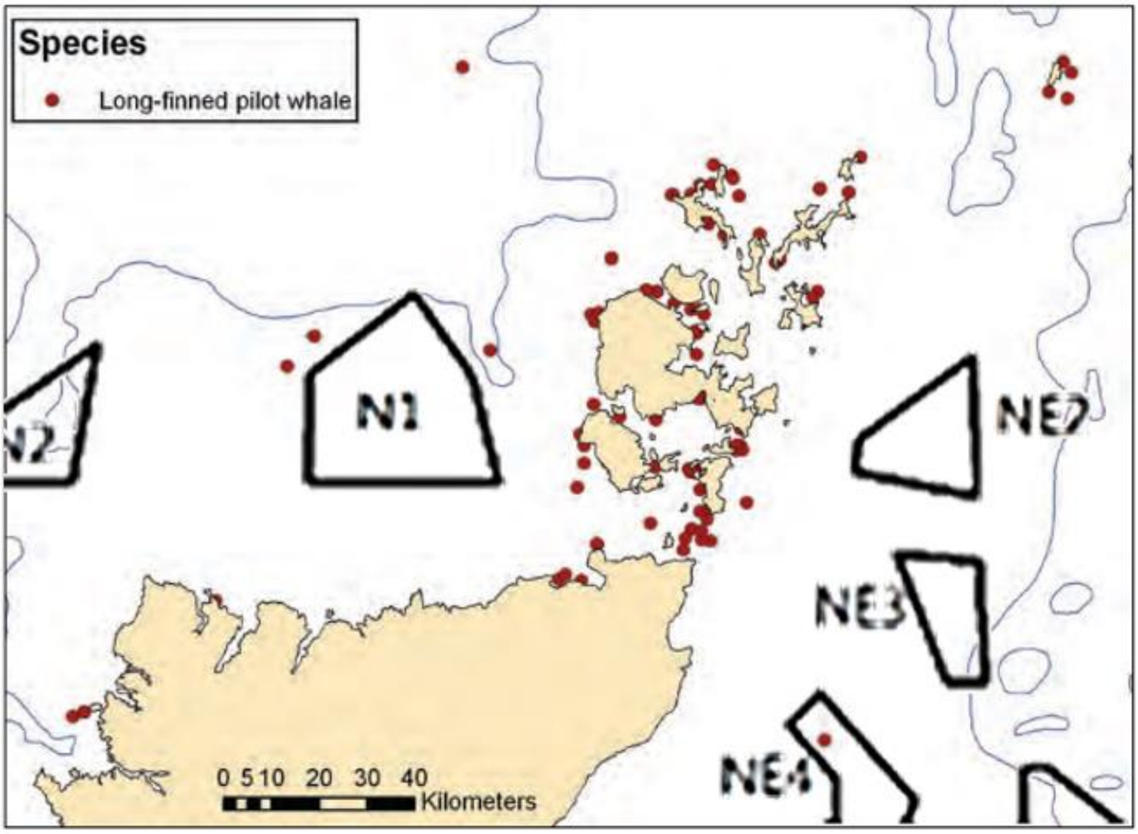


Figure 168: Distribution of sightings of long-finned pilot whales around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.3.11. Killer whale

Based on the information presented below, killer whales are resident year-round in Scottish waters but in low densities, and so there is little expected overlap with DPO sites.

The most recent assessment of killer whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019n).

Killer whales sightings numbers and associated abundance and distribution estimates derived from SCANS III data were not reported by Hammond et al. (2017), and similarly SCANS II and SCANS I associated publication(s) do not report on any killer whale sightings, although not all sightings were reported in all documentation. Killer whales were sighted in Scottish waters during SCANS III (Appendix 3: SCANS surveys) to the north-west of Shetland (Figure 170), though no sightings overlap with DPOs sites. Density surface maps could not be produced for killer whales using SCANS III data due to the low number of sightings.

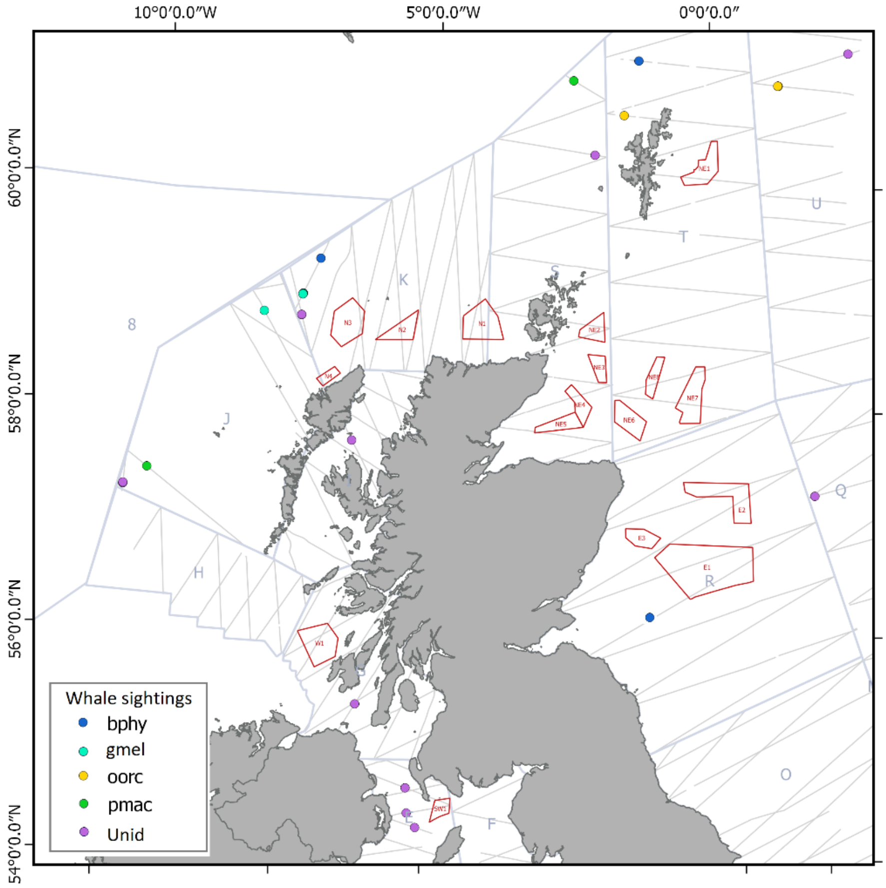


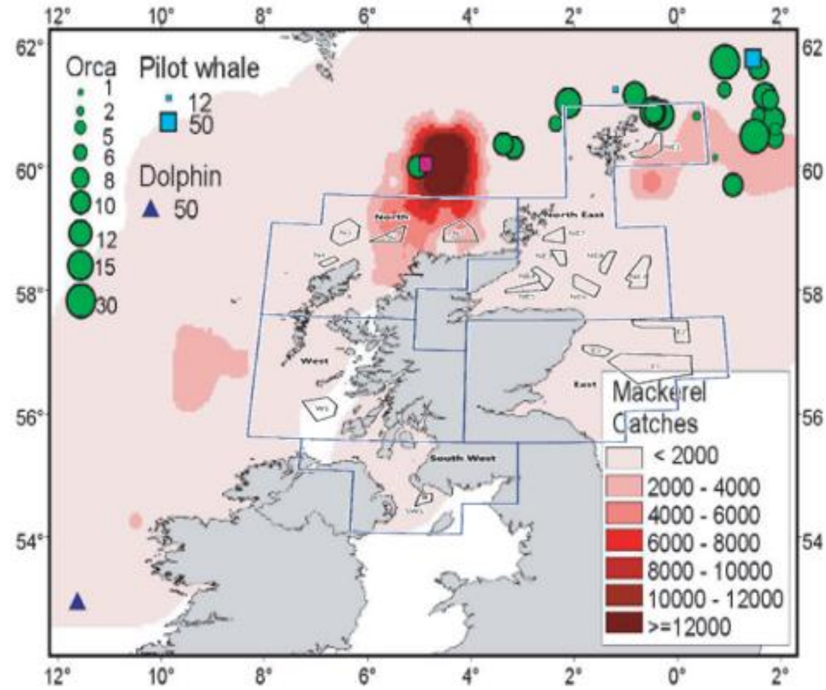
Figure 169: Sightings of whale species seen during the SCANS-III survey blocks containing DPO Areas (red). Bphy = fin whale (*Balaenoptera physalis*), gmel= long-finned pilot whale (*Globicephala melas*), oorc= killer whale (*Orcinus orca*), pmac= sperm whale (*Physeter macrocephalus*) and Unid= whales not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

Killer whale sightings around Scotland are most likely be individuals from two separate assemblages. Sightings on the west coast of Scotland are most likely to be individuals from a small assemblage that range around Britain and Ireland known as the West Coast Community. Sightings from this community are collated by HWDT. This population now has only eight individuals, four males and four females, uniquely identified by their dorsal fins and saddle patch colouration. As there have been no new births in the previous two decades it is likely that this population will decline further (Beck et al. 2014).

The killer whales sighted around the Northern Isles and further offshore likely make up a more numerous North Atlantic community of killer whales, with evidence of movement from the Northern Isles to Iceland to summer-spawning herring grounds (Foote et al. 2010). During the winter months, killer whales are often recorded offshore in Scottish waters, particularly in the northern North Sea, associated with mackerel and herring fisheries (Luque et al. 2006). During the summer months, killer whales are sighted reasonably frequently around the coasts of the Northern Isles, though are present in lower densities around the isles year-round. Sightings of killer whales in the Northern Isles are well documented on various social media pages, including Shetland Orca Sightings[23], Orca Survey Scotland[24] and the Hebrides and NW Scotland Cetacean Sightings[25] group. For some of these social media pages, sightings are collated and submitted to Sea Watch Foundation. There is an increase in coastal sightings around Shetland between May and September, and an increase in offshore sightings associated with mackerel fisheries during the winter months, especially around vessels to the north and east of Shetland (Figure 171) (Luque et al. 2006).

The species distribution maps presented by Waggitt et al. (2020) suggest that killer whales tended to move into the North-East Atlantic study area during the summer, although for Scottish waters only distribution appears to remain reasonably similar throughout the year, although densities of killer whales offshore of western Scotland do appear to increase (Figure 172). Higher densities are seen especially in DPO area NE1. Note: the Waggitt et al. (2020) distribution maps are available for all months, however, only January and July are presented here for illustrative purposes.

[23] https://www.facebook.com/groups/shetlandorcasightings/
[24] https://www.facebook.com/orcasurveyscotland/
[25] https://www.facebook.com/groups/HebridesandNWScotlandCetaceanSightings/



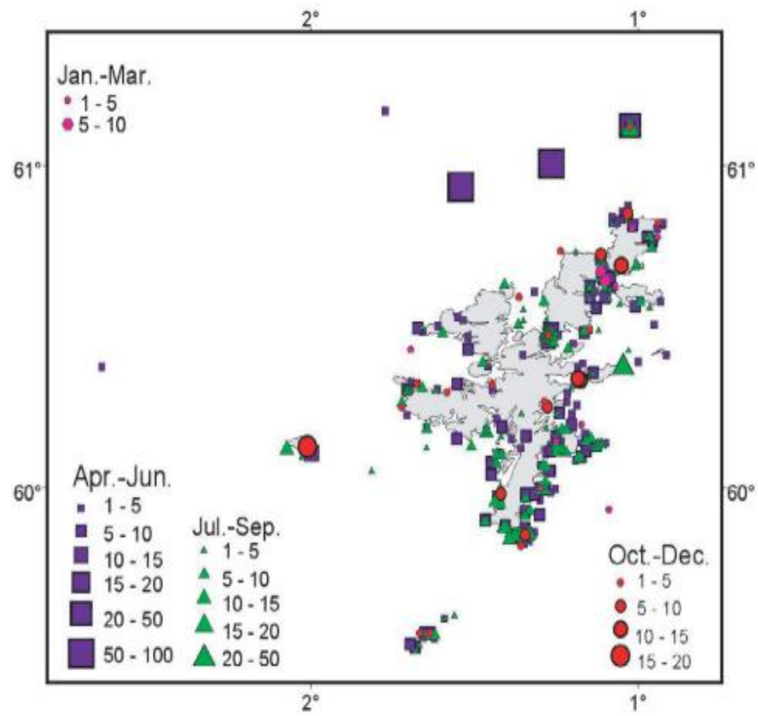


Figure 170: a) Geographical distributions of mackerel catches by the Scottish pelagic fleet in 2005 (tonnes) and killer whale sightings from pelagic boats (sightings refer to number of times a pod of orcas was sighted). during mackerel season (October to March), 1997-2005. b) Locations of killer whales sightings around Shetland from 1989–2006 (n = 539, data from the Shetland Sea Mammal Group) (Luque et al. 2006). Overlaid for reference are the approximate regional and DPO areas.

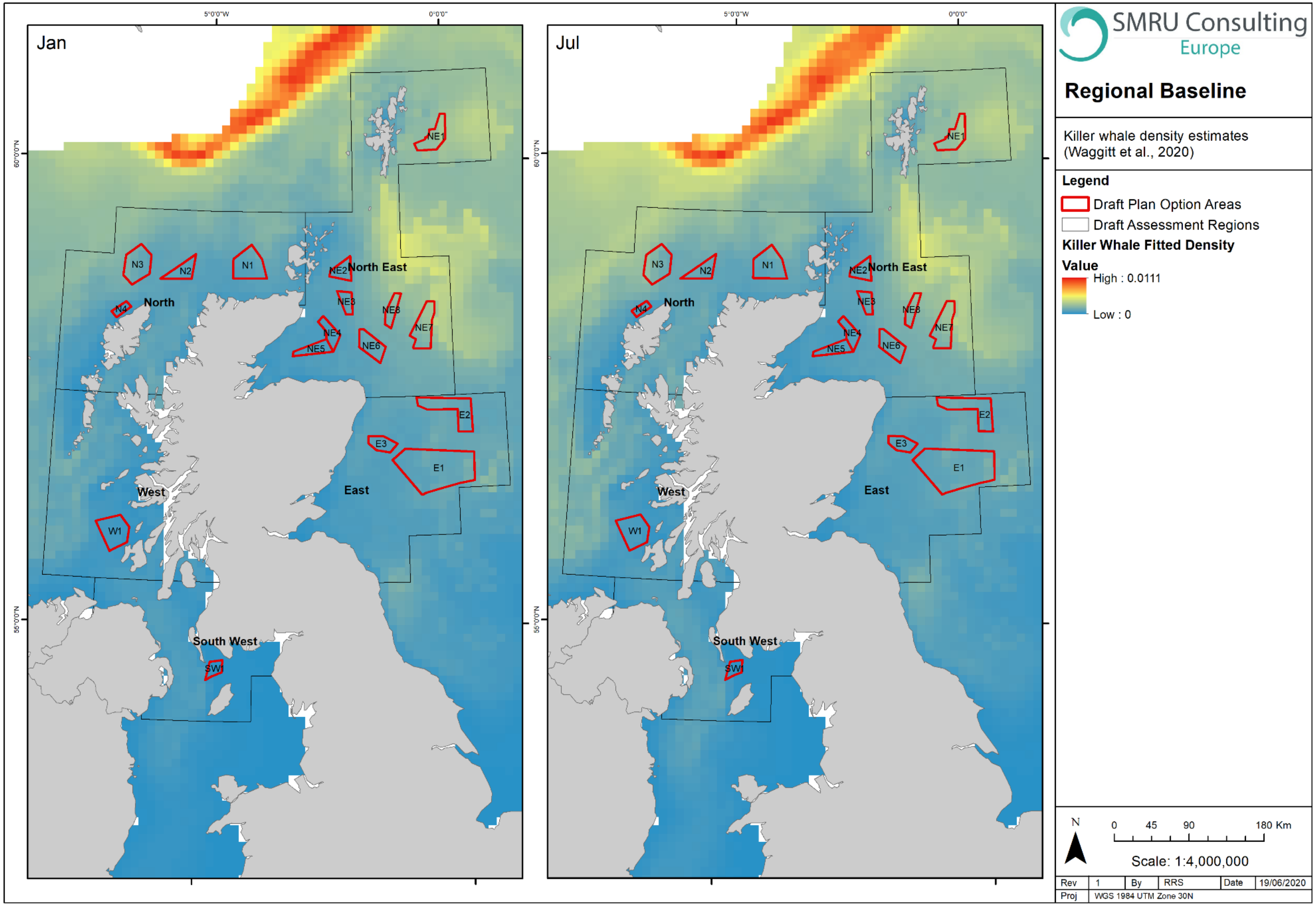


Figure 171: Spatial variation in predicted killer whale densities (animals per km^2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Analysis of older survey and sightings data show killer whales to be widely distributed in Scottish waters throughout the year, with coastal sightings concentrated around northern Scotland and the Northern Isles between May and July (Reid et al. 2003, Evans et al. 2011). Killer whales are also sighted around the west coast (Figure 174) (Reid et al. 2003), with these sightings likely to be individuals from the West Coast Community.

Weir et al. (2001) recorded a wide distribution of killer whales in most months of the year, with the main concentration of sightings around the north and north-west of Shetland, with groups tending to be smaller within the 200 m isobath. Sightings were primarily in offshore waters of 200-1,000 m depth to the north of the Shetland Isles in May and June (Figure 173) (Pollock et al. 2000).

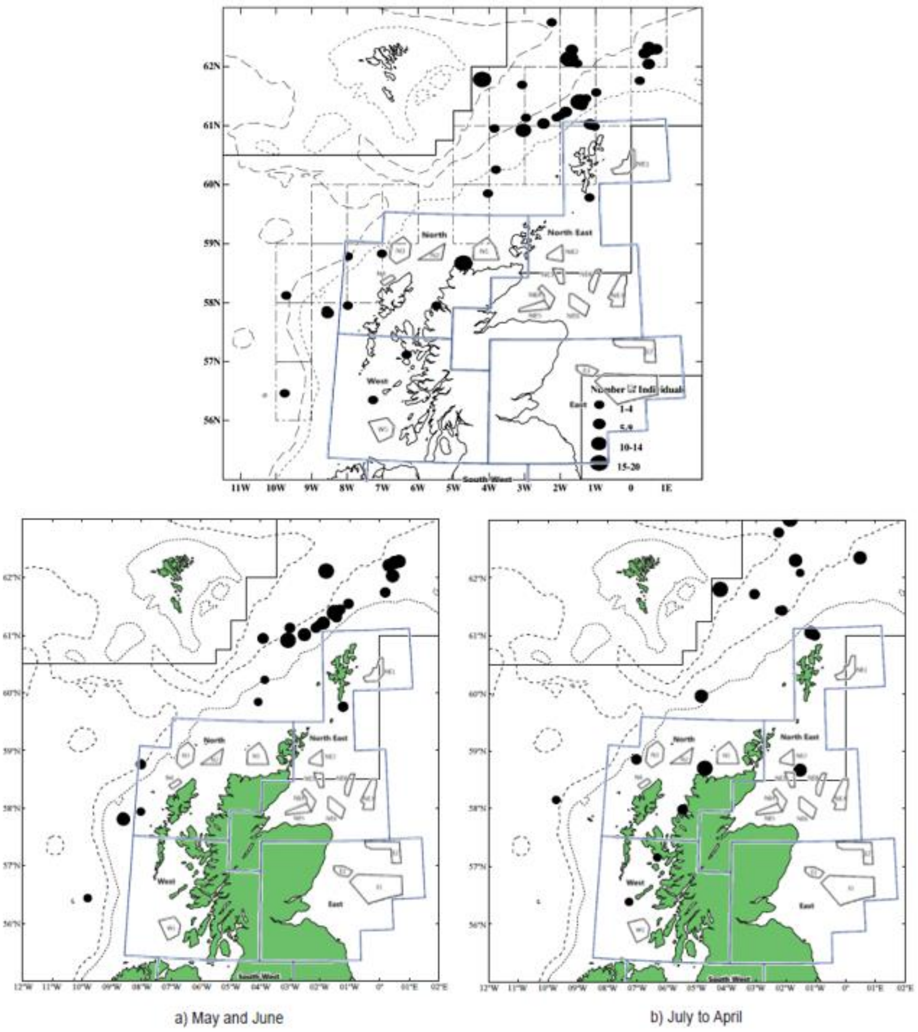


Figure 172: Above: Distribution of killer whale sightings (1979-1998) recorded during the Cetaceans of the Atlantic Frontier surveys. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants). (Weir et al. 2001). Below: Distribution of killer whale sightings between (left) May and June and (right) July and April (1979-1999). Circle size is indicative of group size. (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

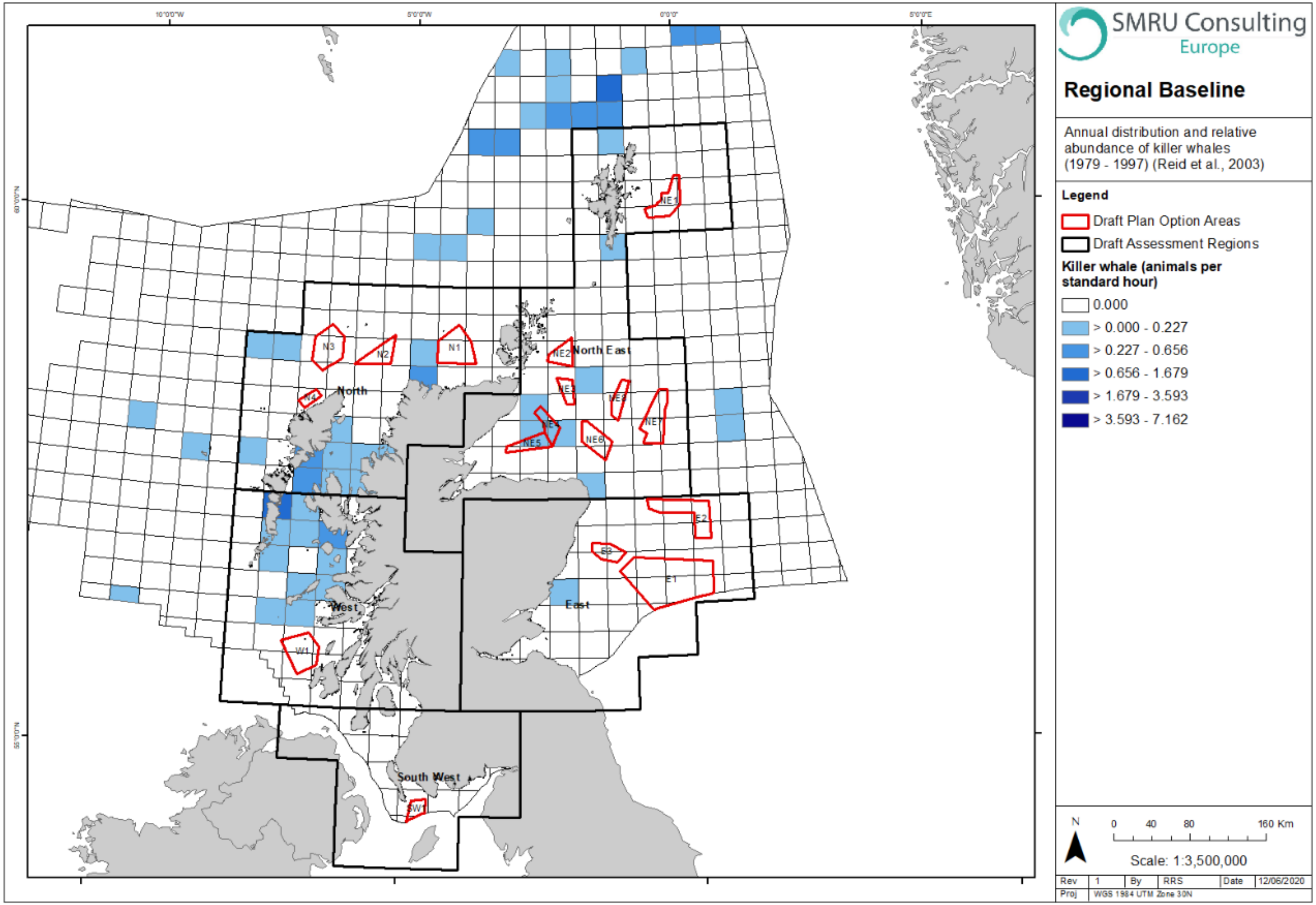


Figure 173: Aggregated annual distribution and relative abundance of killer whales (1979-1997) based on data presented in Reid et al. (2003).

The Scottish Marine Atlas describes killer whale habitat as open coast, straits and sounds, sea lochs and offshore, with sightings all around the coast but mainly concentrated around Mull, the north-east coast and the Northern Isles (Baxter et al. 2011). Mapped encounter rates show relatively low use across the DPOs regions, with the overlap in higher encounter rates in DPOs site N1 (Figure 175).

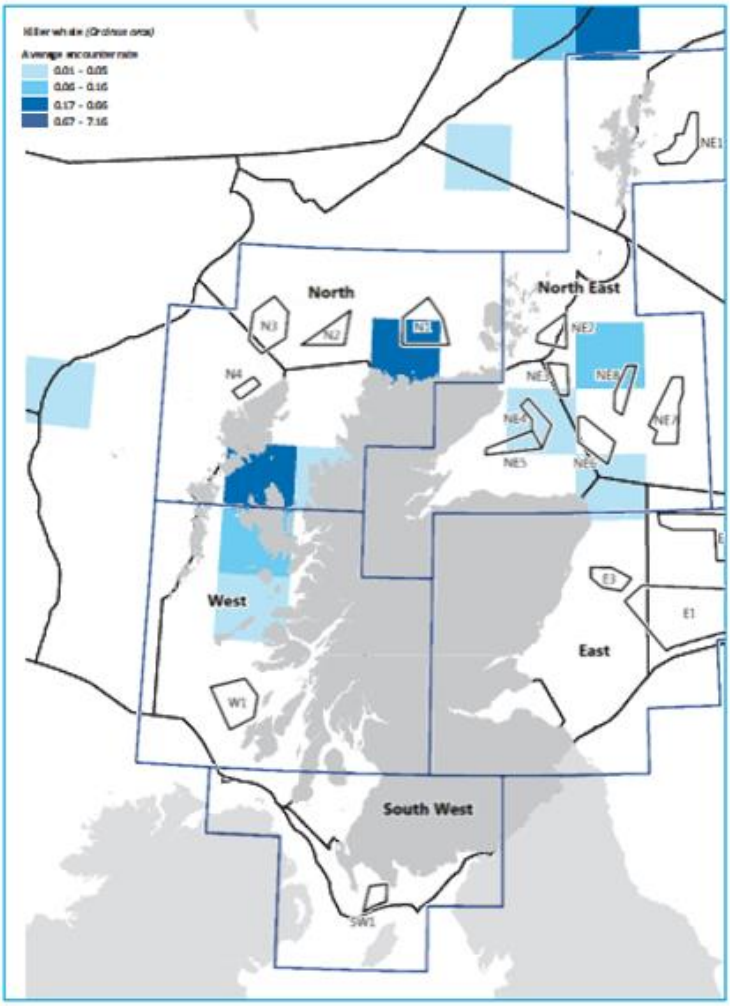


Figure 174: Killer whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

The Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Killer whale sightings from their vessel-based surveys were sparse, with only 16 sightings in 15 years (Figure 176), most of which were photo-identified as being from the West Coast Community pod. Sightings tended to be more coastal. Whilst sightings are infrequent, killer whales are thought to be present in Hebridean waters all year round. There were no sightings of killer whales within the DPO sites covered by the HWDT surveys (Figure 176).

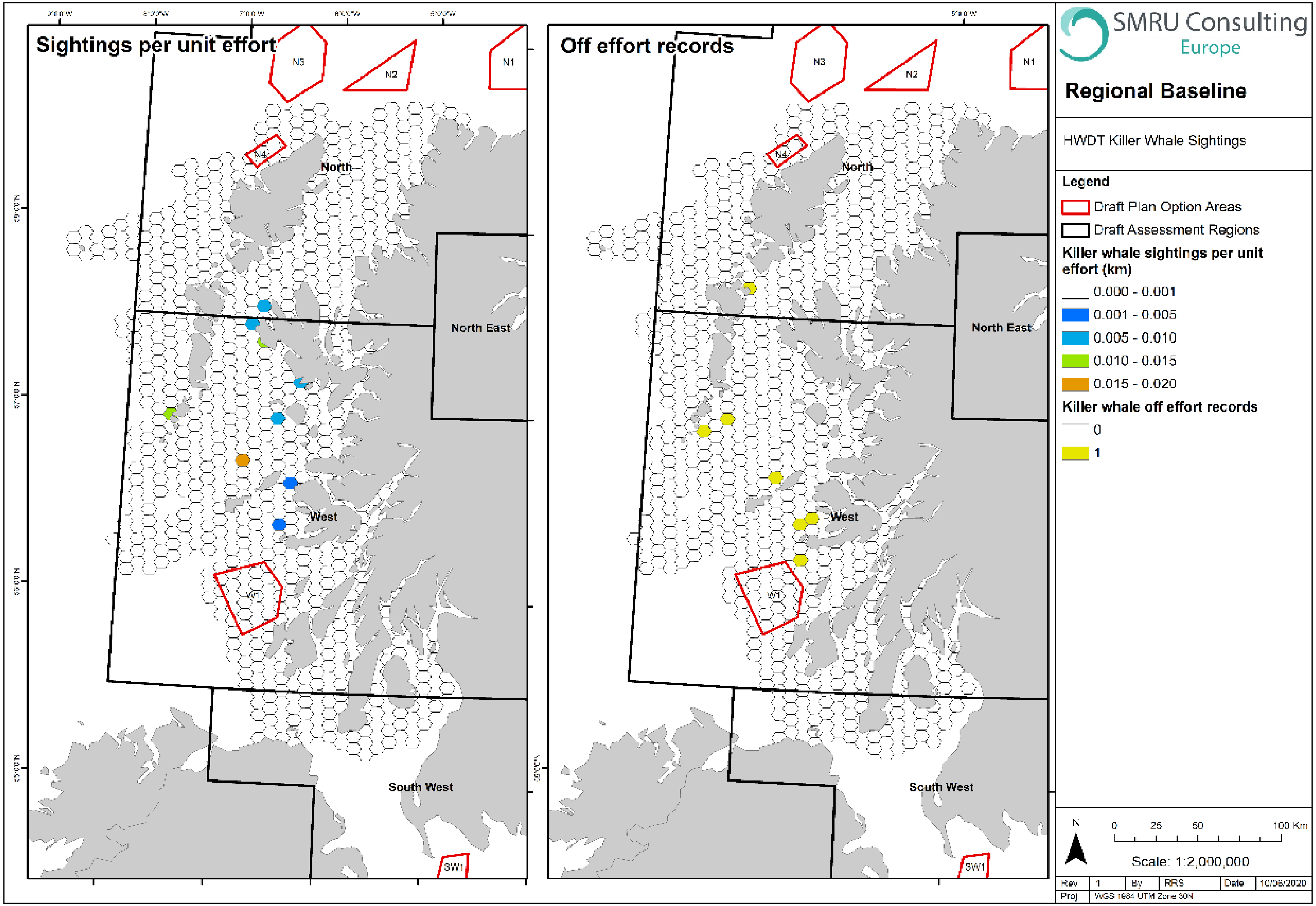


Figure 175: Sightings per unit effort, and off effort sightings, of killer whales recorded by the HWDT during vessel based surveys between 2003-2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009 recorded sightings of killer whales in the North East and East DPO regions, though these were rare and did not overlap with any DPO sites (Figure 178).

Similarly, ORCA recorded killer whale sightings during their ferry-based watches, with sightings on routes off the west coast, on the south coast of mainland Shetland, and on the eastern tip of the southern Moray Firth coastline, with no sightings overlapping DPO sites (Figure 179).

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, killer whales were sighted over the outer shelf and shelf edge to the north-east of Shetland and also a number of sightings over the shelf edge and deep waters to the west and north of Shetland (Stone 2015). Sightings were also recorded in lower numbers throughout the northern North Sea and Outer Moray Firth. In terms of the DPOs regions, killer whales were sighted only in the North East and East regions (Figure 177). There was one sighting that overlapped DPO site NE4 (Figure 177).

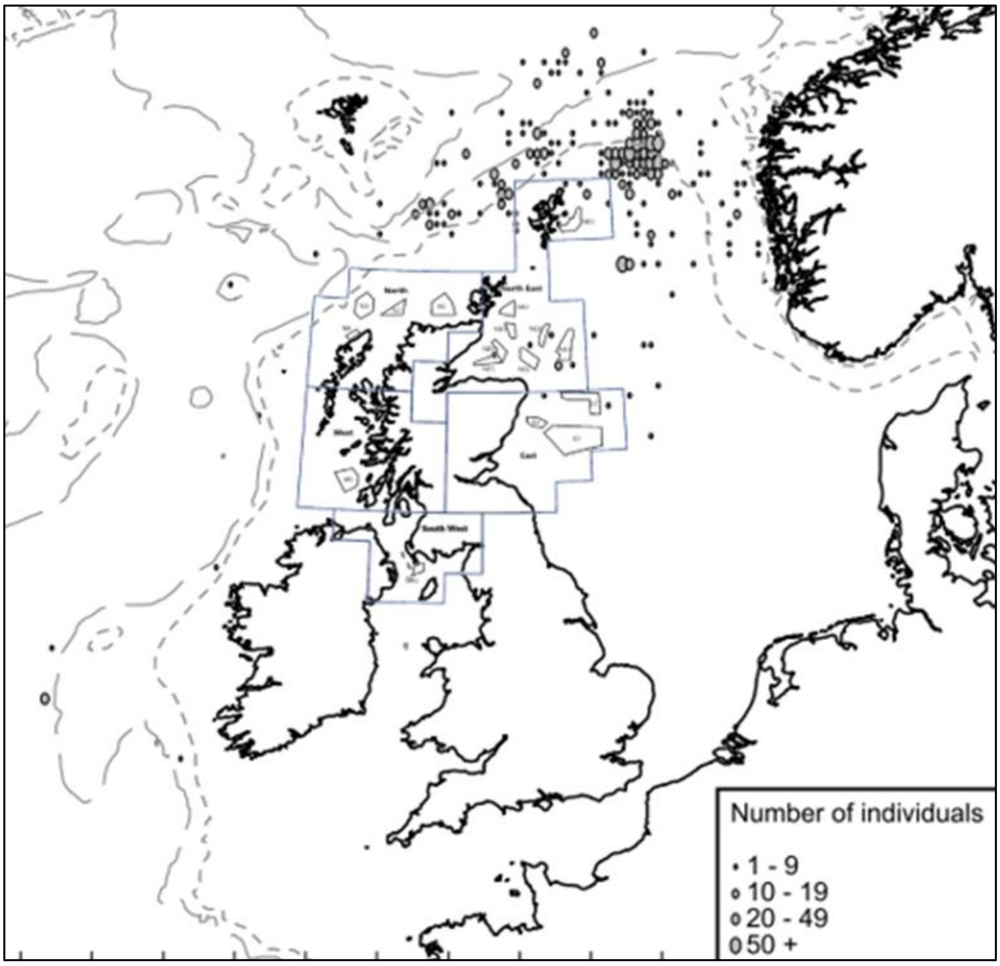


Figure 176: Killer whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

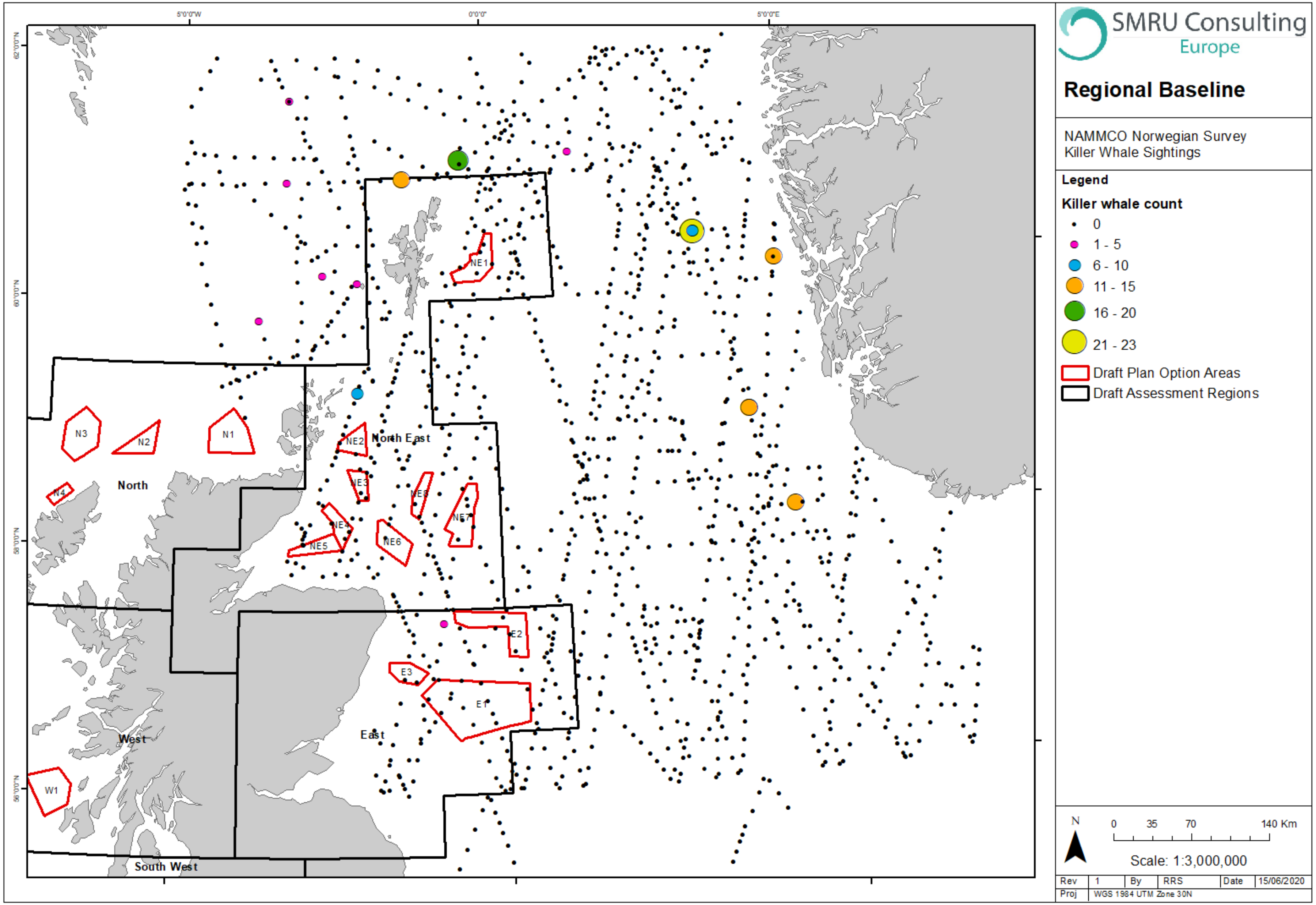


Figure 177: Killer whale sightings (coloured dots) during NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009.

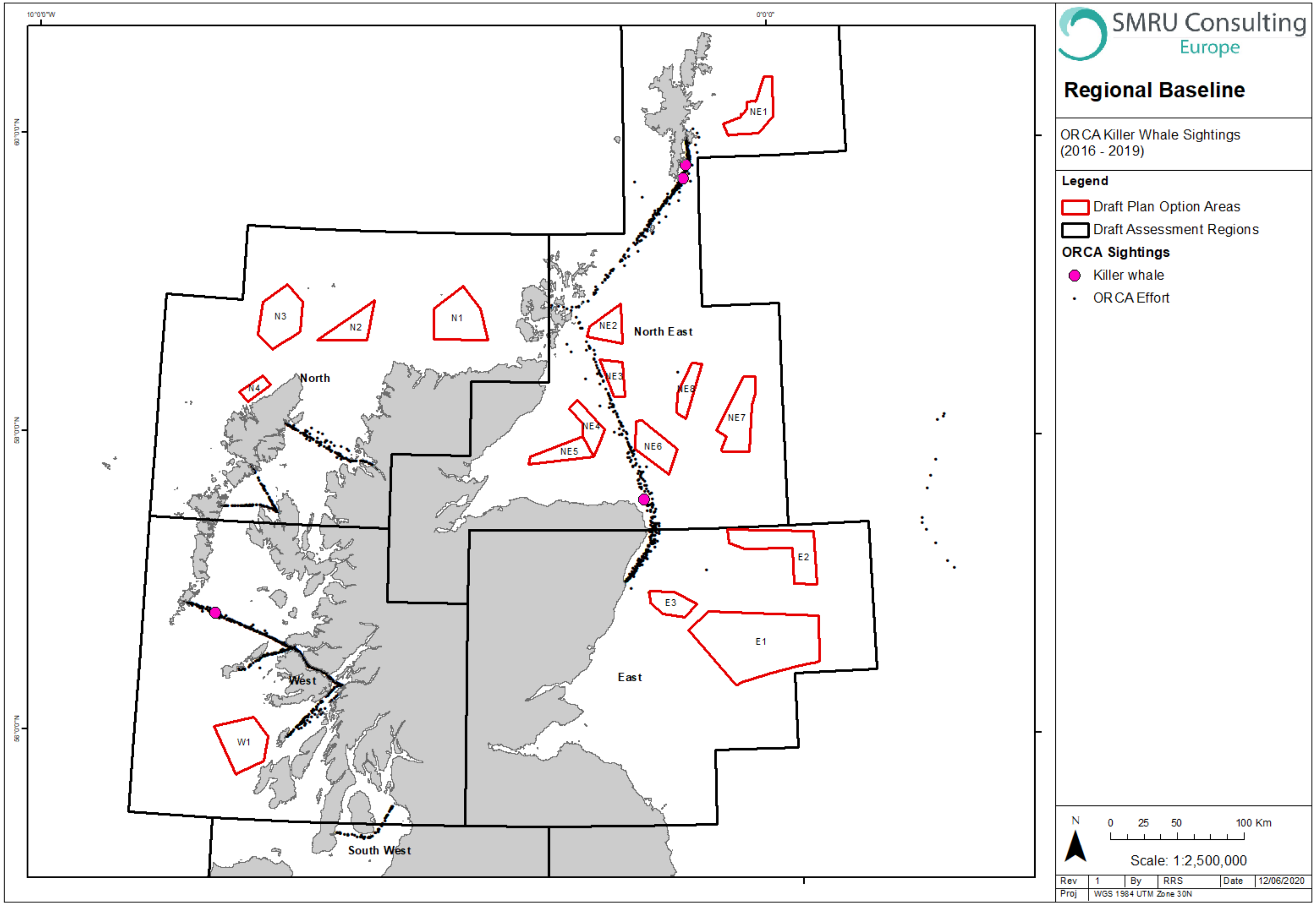


Figure 178: Killer whale sightings (pink dots) recorded by ORCA between 2016 and 2019 during ferry-based watches. Black dots show effort. Data provided free of charge by ORCA.

Killer whales were recoded once during aerial surveys in the Forth and Tay offshore windfarm area, just east of Montrose (Figure 180) (Grellier and Lacey 2012).

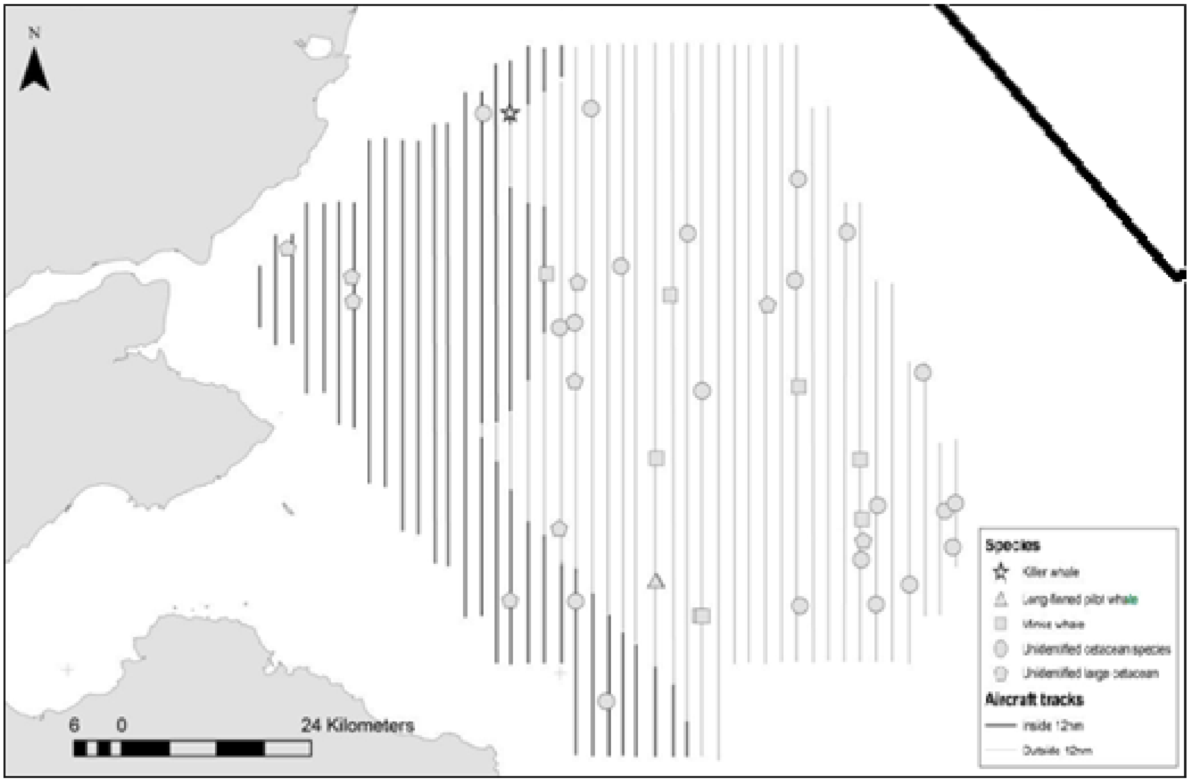


Figure 179: Large cetacean sightings during The Crown Estate aerial surveys for the FTOWDG region 2009-2010 (Grellier and Lacey 2012). DPOs are Overlaid for reference, with the boundary of site E1 to the north east of the survey site.

The Irish Whale and Dolphin Group – Northern Ireland[26] collated known sightings of members of the West Coast Community killer whale pod between 2004 and 2020, with some sightings reasonably close to west coast Scotland DPOs sites W1 and SW1, and falling within the South West DPO Region (Figure 181). The Irish Whale and Dolphin Group submit any sightings of interest to HWDT (S. Berrow, personal communication).

[26] https://www.facebook.com/IWDGNI/

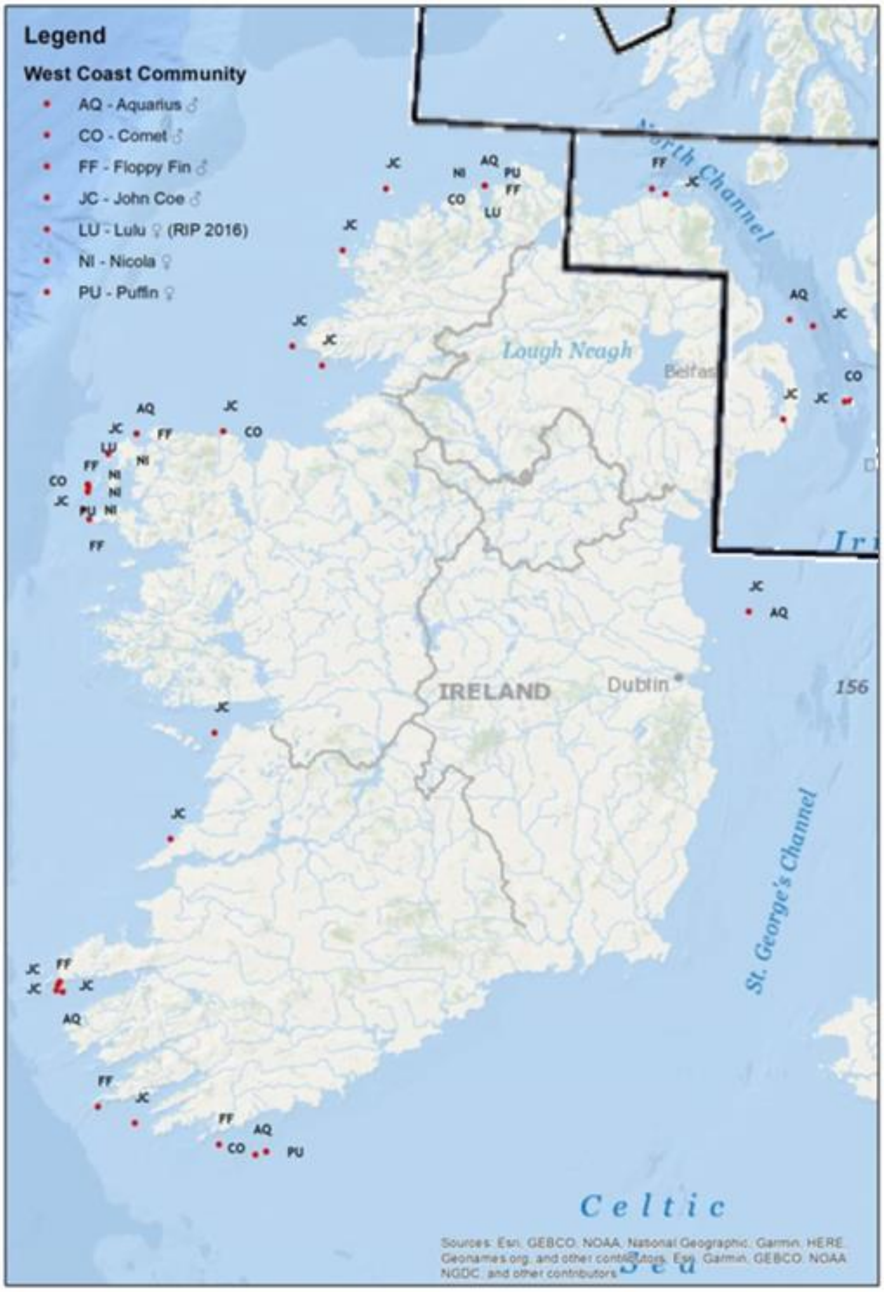


Figure 180: Ssightings of members of the West Coast Community killer whale pod between 2004 and 2020 (map sourced from IWDG - Northern Ireland [27]). Overlaid for reference are the approximate regional and DPO areas.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth recorded no encounters with killer whales between 2002 and 2016 during a total of 241 trips. However, further north in the Pentland Firth and around the

[27] https://www.facebook.com/IWDGNI/

Orkney Isles, coastal sightings between 1980 and 2010 were relatively frequent (Figure 182) (Evans et al. 2011).

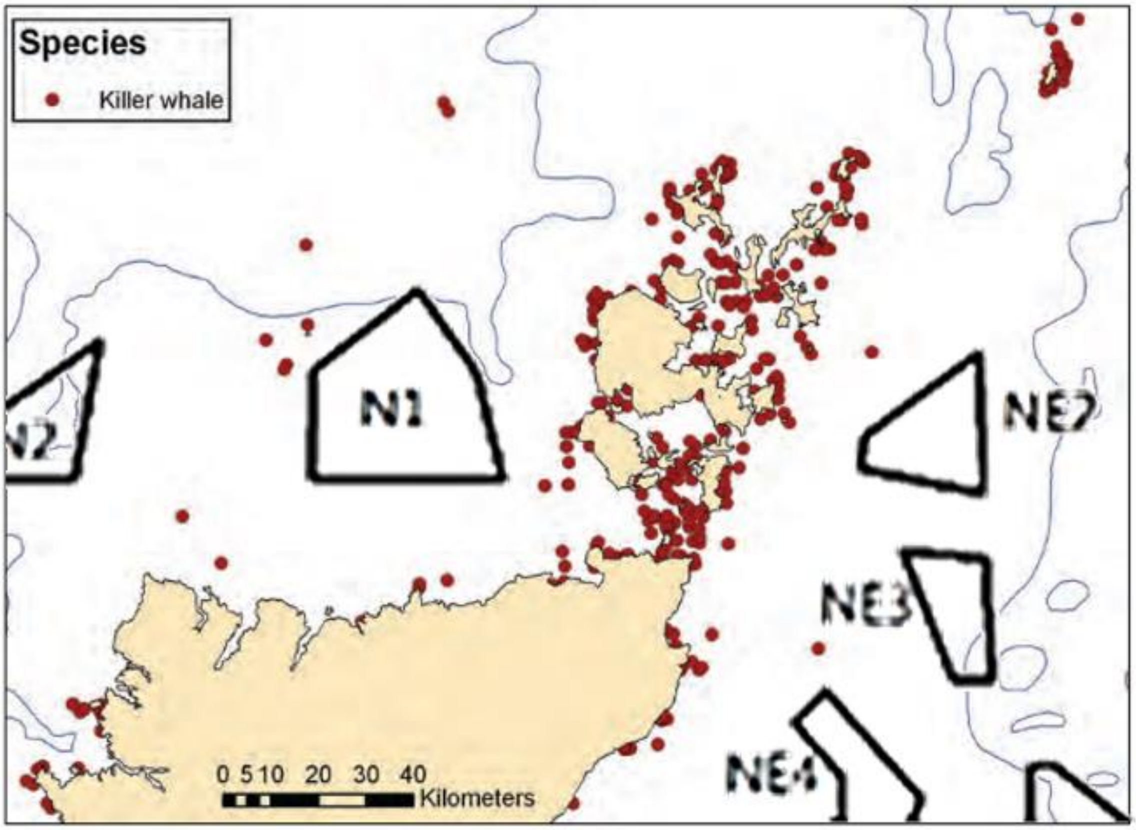


Figure 181: Distribution of killer whale sightings around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.3.12. Humpback whale

Based on the information presented below, humpback whales are likely present resident year-round in Scottish waters but in extremely low numbers, and so there is little expected overlap with DPO sites.

The most recent assessment of humpback whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019a). There were no sightings of humpback whales in the SCANS III or SCANS II surveys, and there were no humpback whale sightings stated within the associated SCANS I publication(s), although not all sightings were reported. Humpback whales were also not included in the data collation or modelling of abundance or species distribution presented by either Waggitt et al. (2020) or Paxton et al. (2016).

Therefore, the most recent sightings data for larger-scale surveys covering humpback whales are now two decades old. In the early 2000s, humpback whales sightings in Scottish waters were rare, as populations slowly recovered from severe depletion due to previous over-exploitation (Reid et al. 2003). For example, the sightings map presented within the Atlas of Cetacean Distribution shows the rarity of sightings during this time, with isolated records almost exclusively in deeper waters (Figure 183) (Reid et al. 2003). Similarly, during the surveys that contributed to the Cetaceans of the Atlantic Frontier (Weir et al. 2001), humpback whale sightings were rare, with only four records of five individuals. Sightings occurred between May and October over the 1,000 m isobath, whilst sightings in April were in water <200 m deep (Figure 184). Sightings rarely were within DPOs regions, and did not overlap DPOs site boundaries.

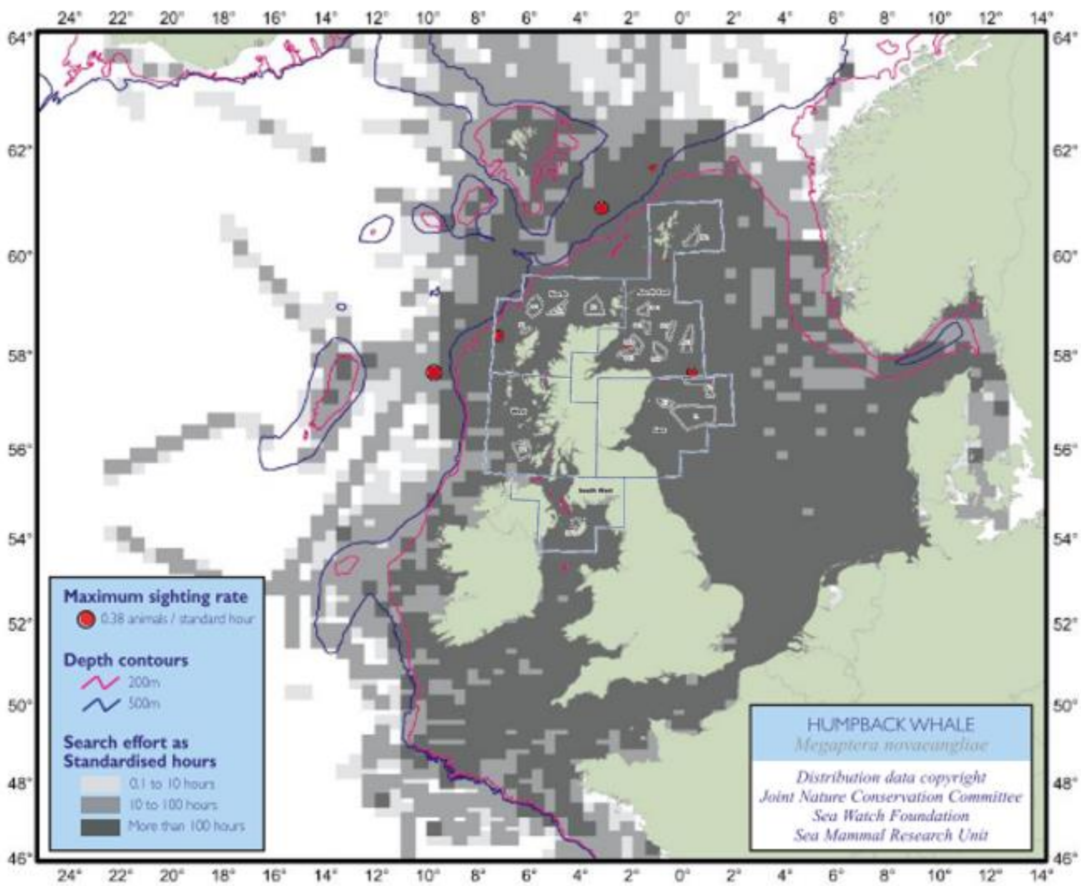


Figure 182: Humpback whale sightings reported by the Atlas of Cetacean Distribution (Reid et al. 2003). Overlaid for reference are the approximate regional and DPO areas.

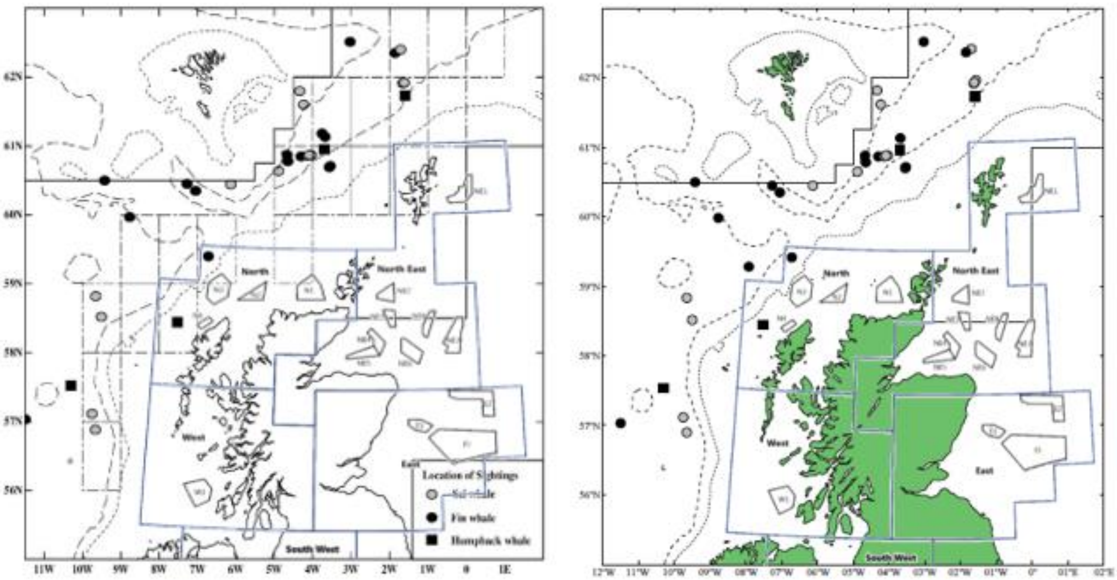


Figure 183: Left = Distribution of fin, sei and humpback whale sightings (1979-1998) presented in the Cetaceans of the Atlantic Frontier. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants). (Weir et al. 2001). Right = Distribution of fin, sei and humpback whale sightings (1979-1999) (Pollock et al. 2000). Note, same key for both figures. Overlaid for reference are the approximate regional and DPO areas.

Sightings of humpback whales increased towards latter end of the Cetaceans of the Atlantic Frontier surveys, leading Pollock et al. (2000) to suggest that this may indicate a return of some animals to the region. It appears this trend has continued in UK waters, and more recently humpback whale sightings are increasing in frequency. Citizen science social media groups have helped contribute to our understanding of humpback whale distribution and the potential increase in abundance in Scottish waters. There are infrequent but year-round sightings of humpback whales around the Shetland Isles, although re-sightings of the same individuals over a number of years has occurred in the inshore waters of the Shetland Isles since the early 1990s (Pollock et al. 2000). In the Firth of Forth, at least four individual humpback whales in the Inner Firth of Forth have been sighted between January and March of 2017 and 2018 (O’Neil et al. 2019). These sightings are reflected in the land-based shore watch data provided by WDC, which shows sightings of humpback whales mainly along the southern coast of the Moray Firth, the Aberdeenshire coastline, and from Tiumpan Head on the Isle of Lewis. Sightings were also reported in the Inner Firth of Forth and the Orkney Isles (Figure 185). Whilst sightings did not overlap and DPOs site boundaries, coastal sightings may be useful when choosing cable landfall locations.

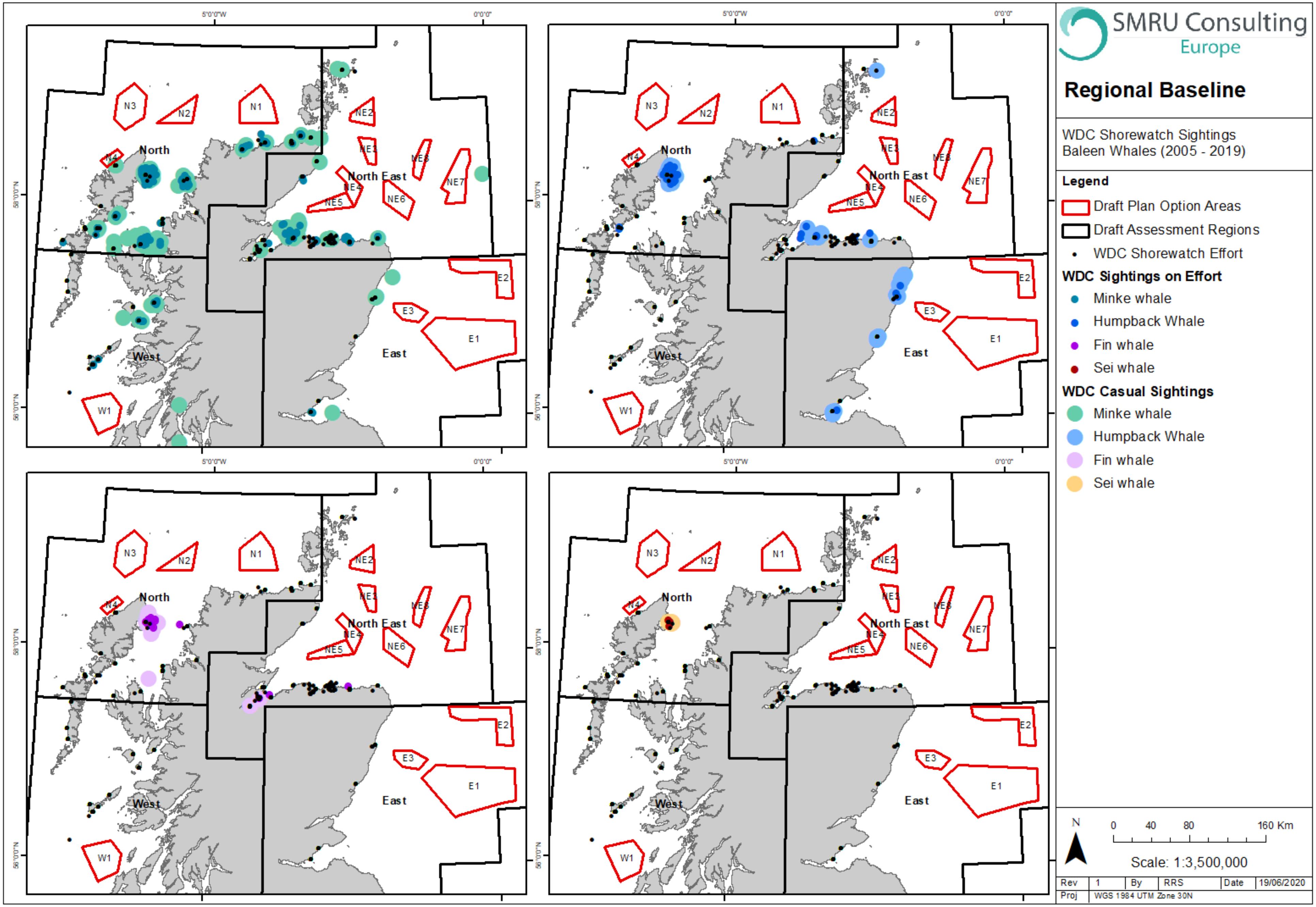


Figure 184: Sightings of minke, humpback, fin and sei whale recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

The Hebridean Whale and Dolphin Trust (HWDT) provided visual sightings survey data collected between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Humpback whales are sighted occasionally in the Hebrides, and are thought to be spotted during their migration, though sightings do occur year-round. Sightings from vessel-based surveys have all occurred north of Ardnamurchan Point, and tend to be concentrated around the Isle of Skye and Lewis. There were no sightings of humpback whales within the DPO sites covered by the HWDT surveys (Figure 180).

With similar spatial coverage to the HWDT surveys, preliminary analyses of acoustic data recorded by the COMPASS project during March and April 2018 found detections of humpback whales at three sites: Tolsta, Stoer Head and Stanton Banks (Risch et al. 2019a) (Figure 187). These sites are reasonably close to DPOs areas N2, N3 and N4 and W1. Further analysis is ongoing.

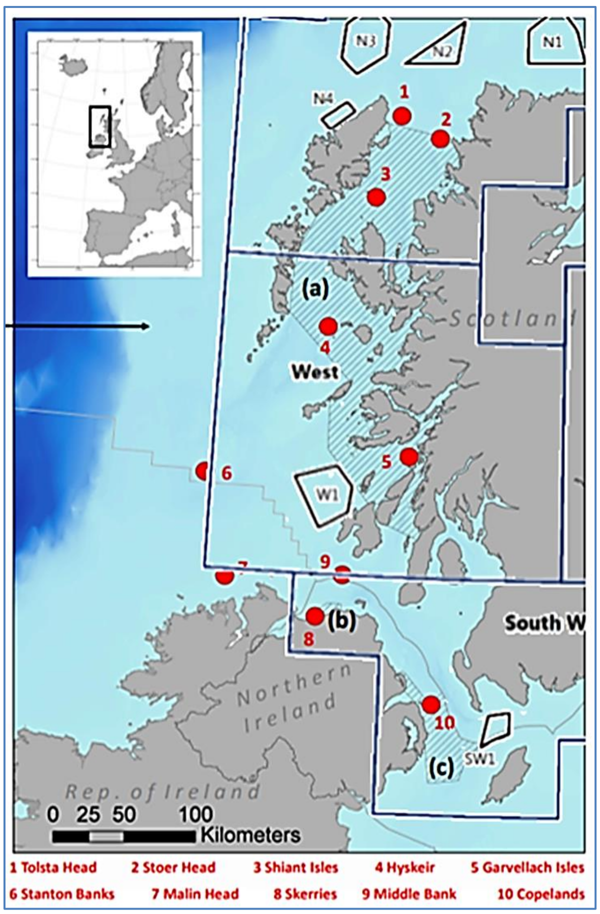


Figure 186: Location of C-PODs deployed since 2017 as part of the COMPASS project. Crosshatched areas represent Special Area of Conservation for harbour porpoise: a) Inner Hebrides and Minches SAC b) Skerries and Causeway SAC c) North Channel SAC (Edwards et al. 2019). Approximate DPOs regions and sites are Overlaid for reference.

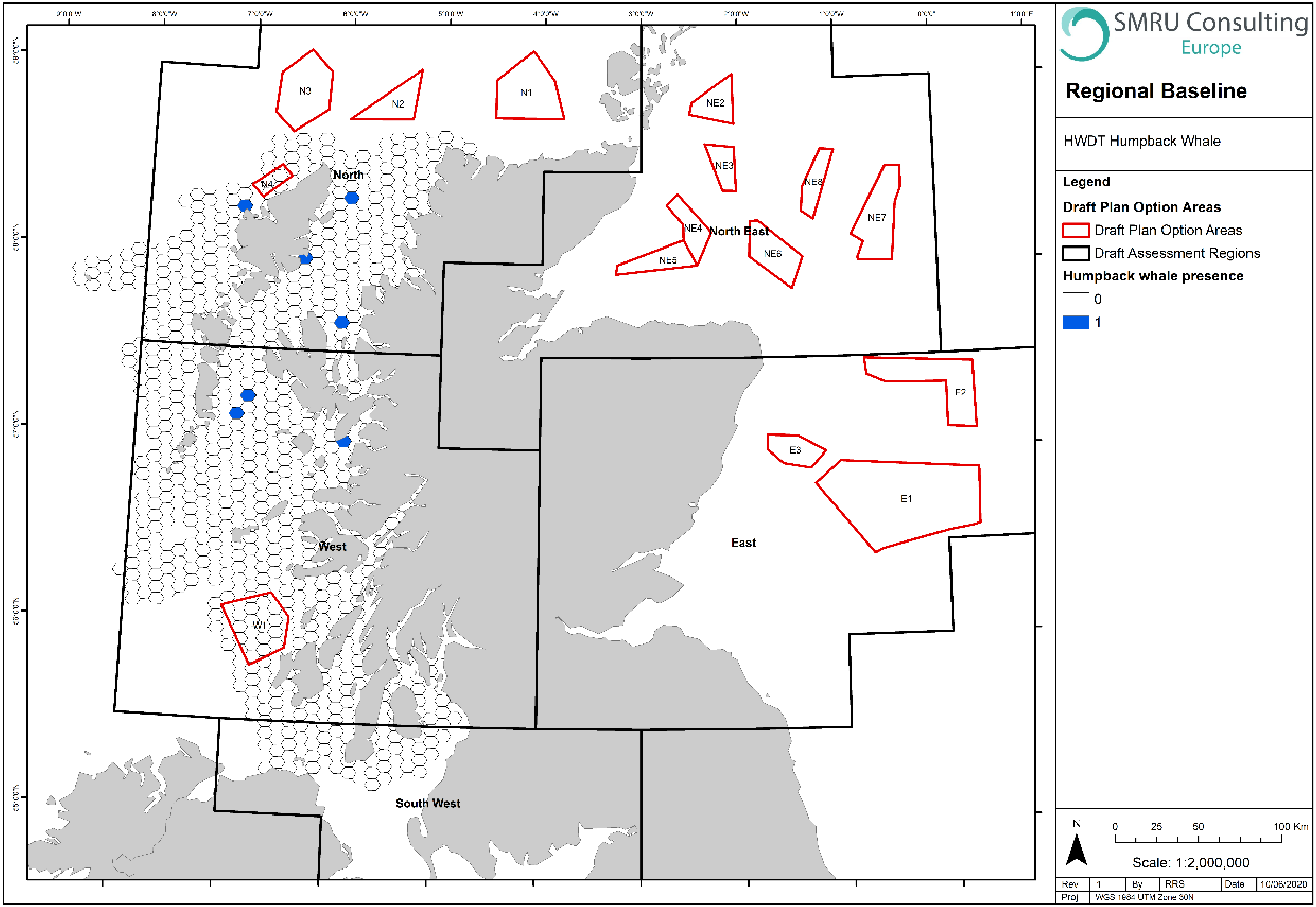


Figure 185: Sightings per unit effort, and off effort sightings, of humpback whales recorded by the Hebridean Whale and Dolphin Trust during vessel based surveys between 2003 and 2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, humpback whales were sighted mainly in deep waters and waters over the continental shelf edge (i.e. depths greater than 200 m) to the north and west (Stone 2015). A humpback was also recorded close inshore on the east coast of Shetland. In terms of the DPOs regions, humpback whales were sighted only in the North East region, and in very low frequency compared to other marine mammals sighted during these surveys (Figure 188). No sightings overlapped any DPO sites.

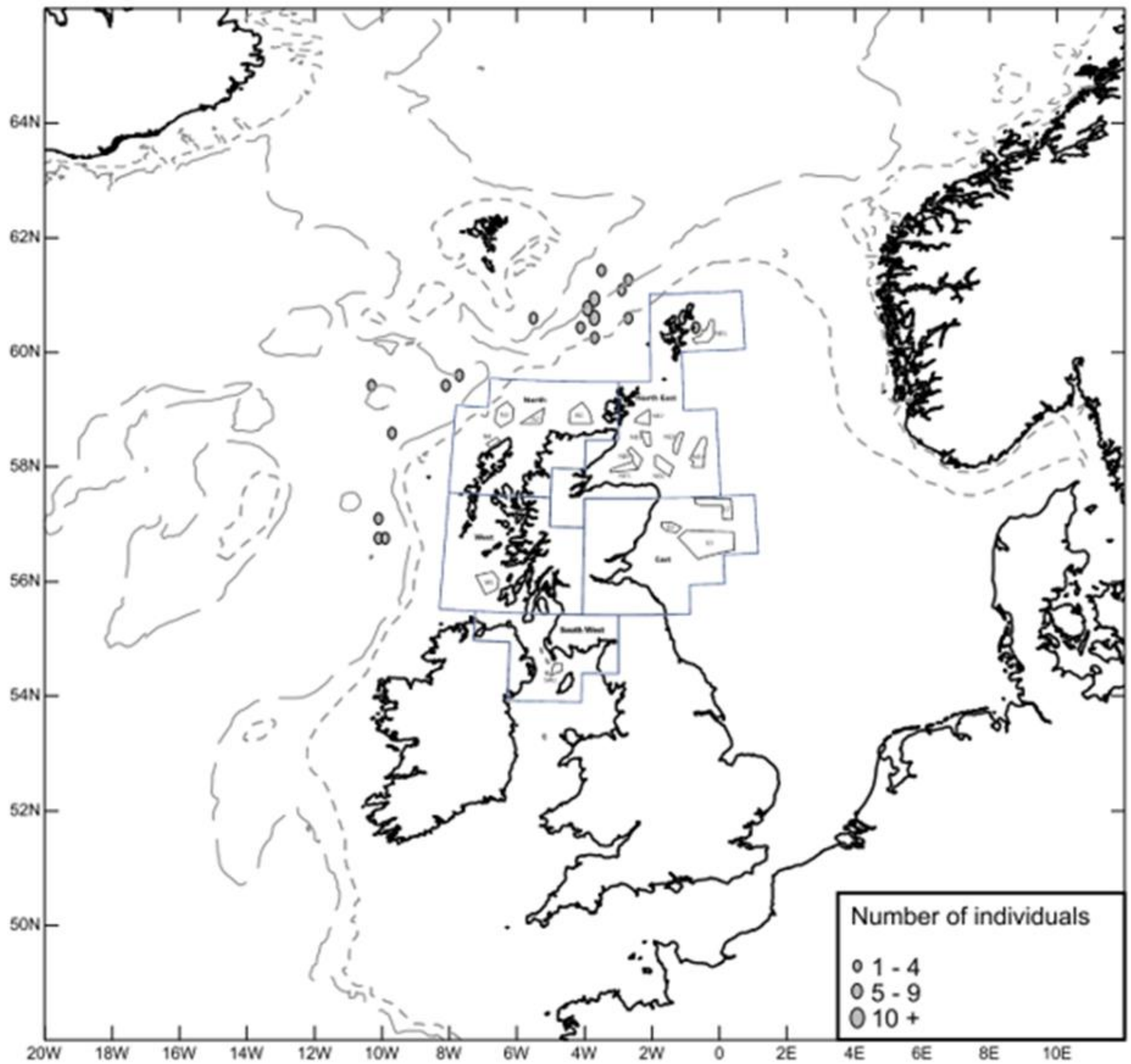


Figure 187: Humpback whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; the long dashed line = 1,000 m isobath.

Sightings of humpback whales by the NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009 were rare, with no overlap with DPOs regions or site boundaries (Figure 189).

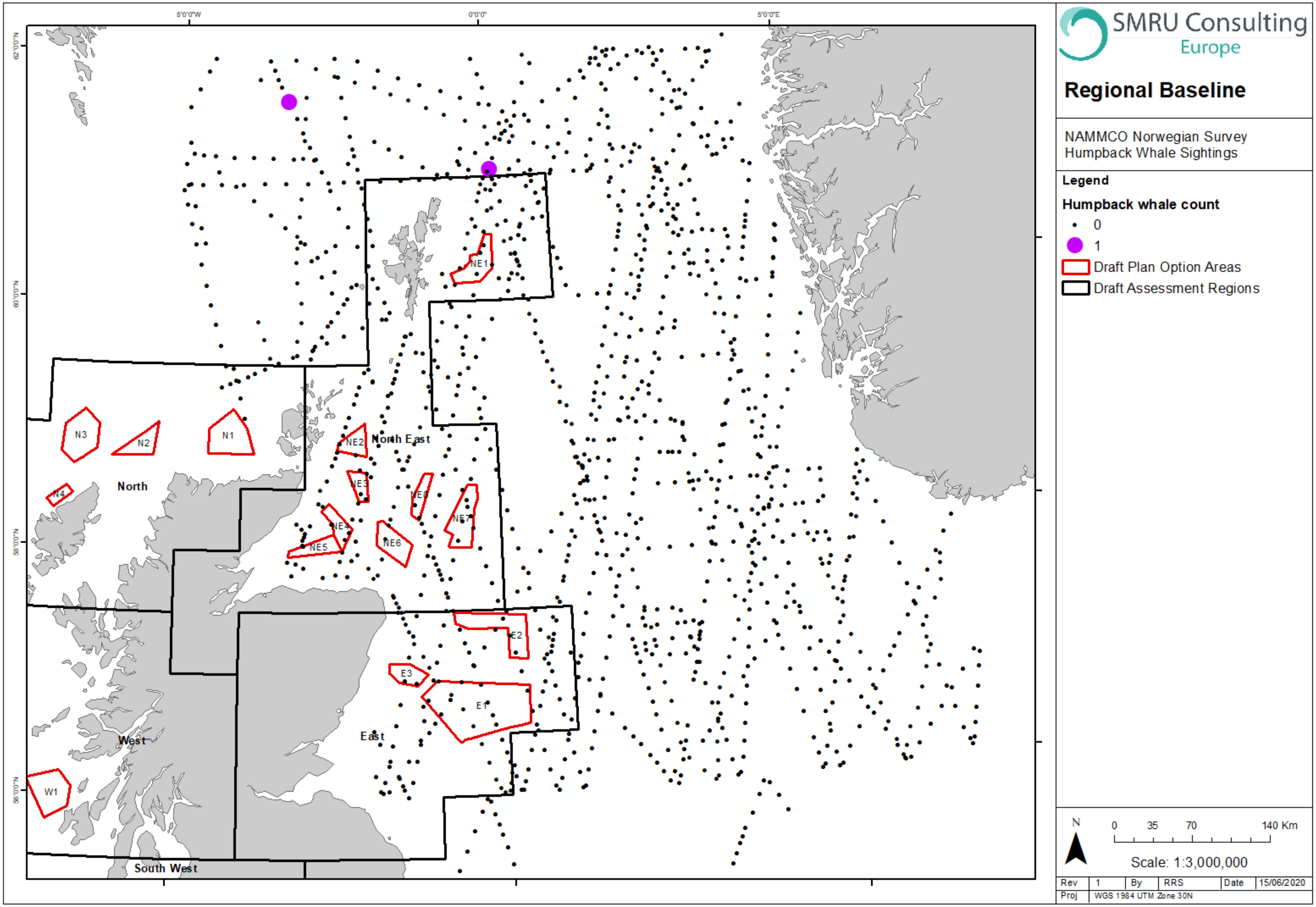


Figure 188: Humpback whale sightings (pink dots) during NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009. Data provided free of charge. DPO regions and areas Overlaid for reference.

The University of Aberdeen Lighthouse Field Station photo-identification surveys within the Inner Moray Firth recorded a single encounter with a humpback whale between 2002 and 2016 during a total of 241 trips. Further north around the Pentland Firth and Orkney Isles, humpback whales are infrequently sighted, with only 14 sightings in the 30 years between 1980 and 2010 reported by Evans et al. (2011), which were mostly clustered around Orkney with no apparent seasonal pattern (Figure 190).

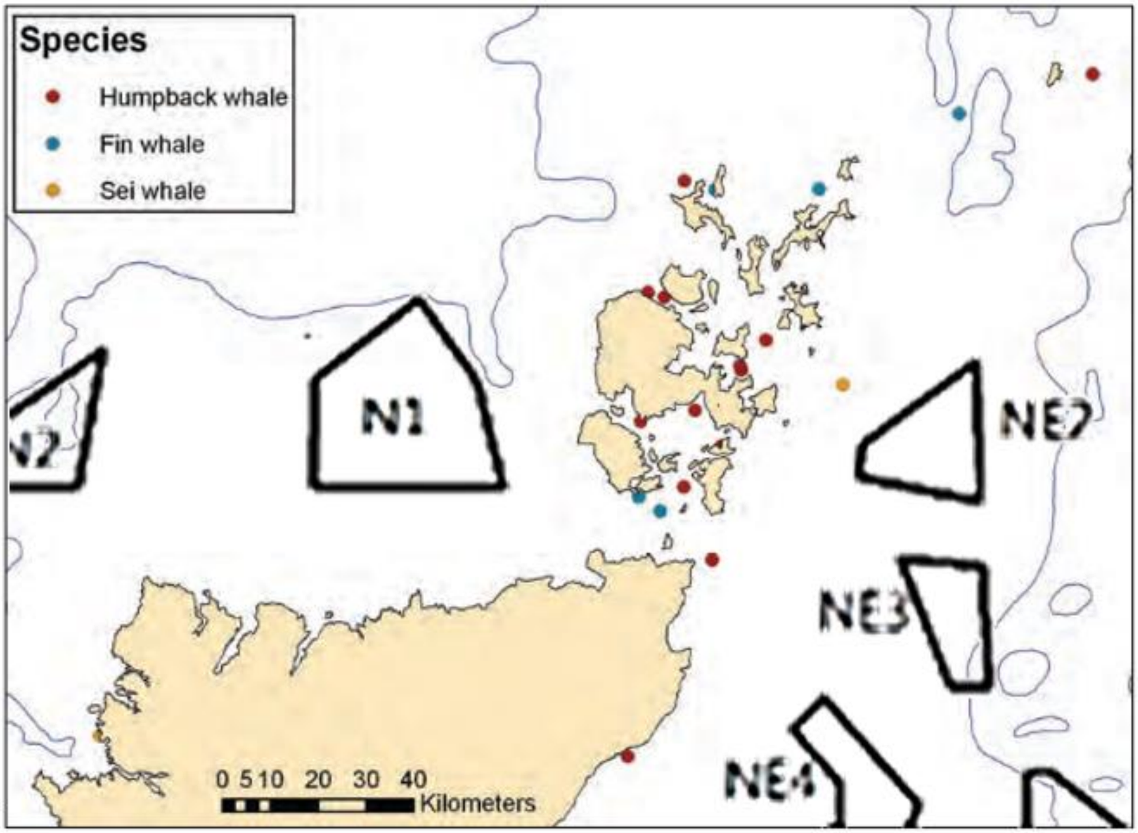


Figure 189: Distribution of sightings of rarer baleen whale species around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010. Humpback whale sightings are indicated by red circles (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.3.13. Sperm whale

Based on the information presented below, sperm whales are rare in the DPO regions, and sightings mainly occur in deeper waters further offshore. Therefore, they are not expected to overlap with any of the DPO sites.

The most recent assessment of sperm whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019m).

The most recently collected broad scale data on sperm whale abundance and distribution are available from the SCANS III survey. The SCANS III sightings data show a very clear offshore distribution of sperm whales, with almost all sightings located in Survey Block 8 (Atlantic - west of Scotland) where densities reached up to 0.060 sperm whales/km^2 (Figure 191). No sperm whale sightings during SCANS III overlap the DPOs regions or sites (Figure 192).

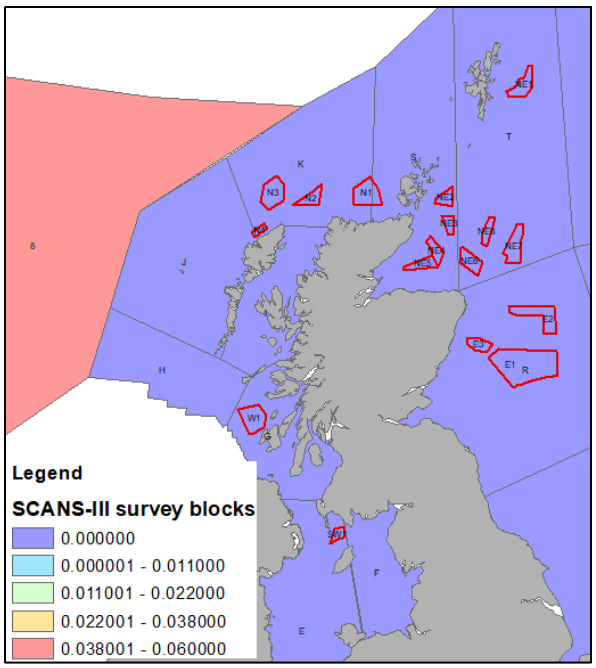


Figure 190: SCANS III block-wide uniform density estimates for sperm whales in Scottish waters (Hammond et al. 2017). Overlaid for reference are DPO areas.

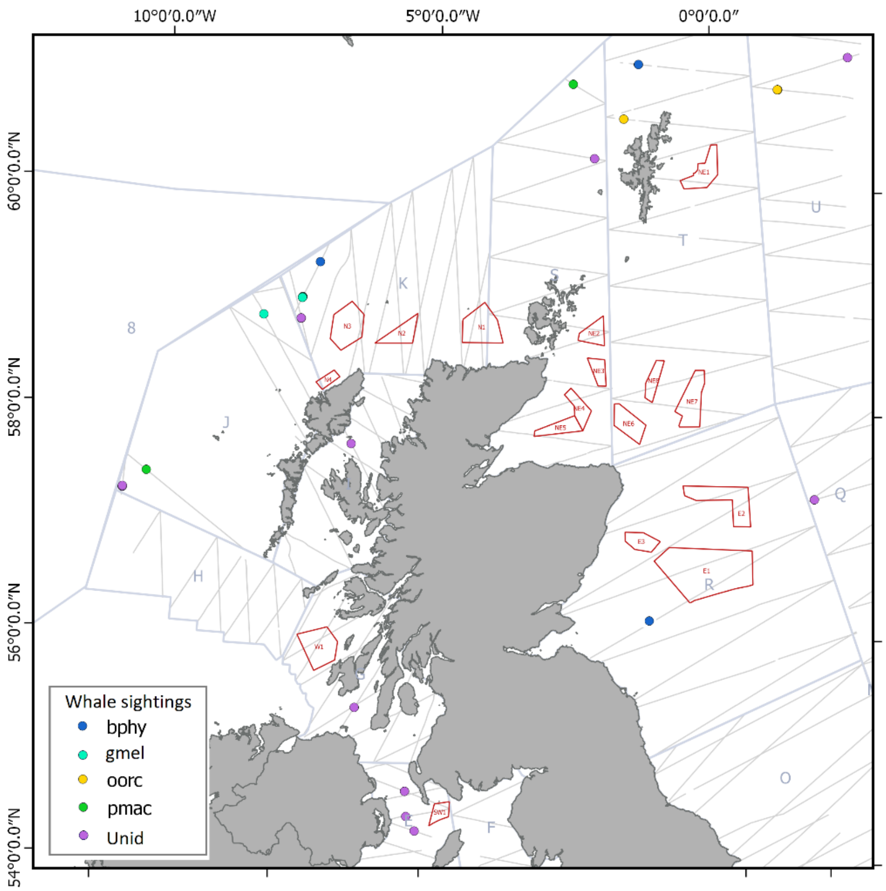


Figure 191: Sightings of whale species seen during the SCANS-III survey blocks containing DPO Areas (red). Bphy = fin whale (*Balaenoptera physalis*), gmel= long-finned pilot whale (*Globicephala melas*), oorc= killer whale (*Orcinus orca*), pmac= sperm whale (*Physeter macrocephalus*) and Unid= whales not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

Species distribution map presented by Waggitt et al. (2020) documented that sperm whales persisted in the whole North-East Atlantic study area year-round, although suggested that sperm whales move into deeper waters during the summer months. However, with regards to Scottish waters only, distribution appears to remain reasonably similar, with offshore distribution year-round (Figure 193). Waggitt et al. (2020) do not predict any overlap of sperm whale distribution with any of the DPOs sites.

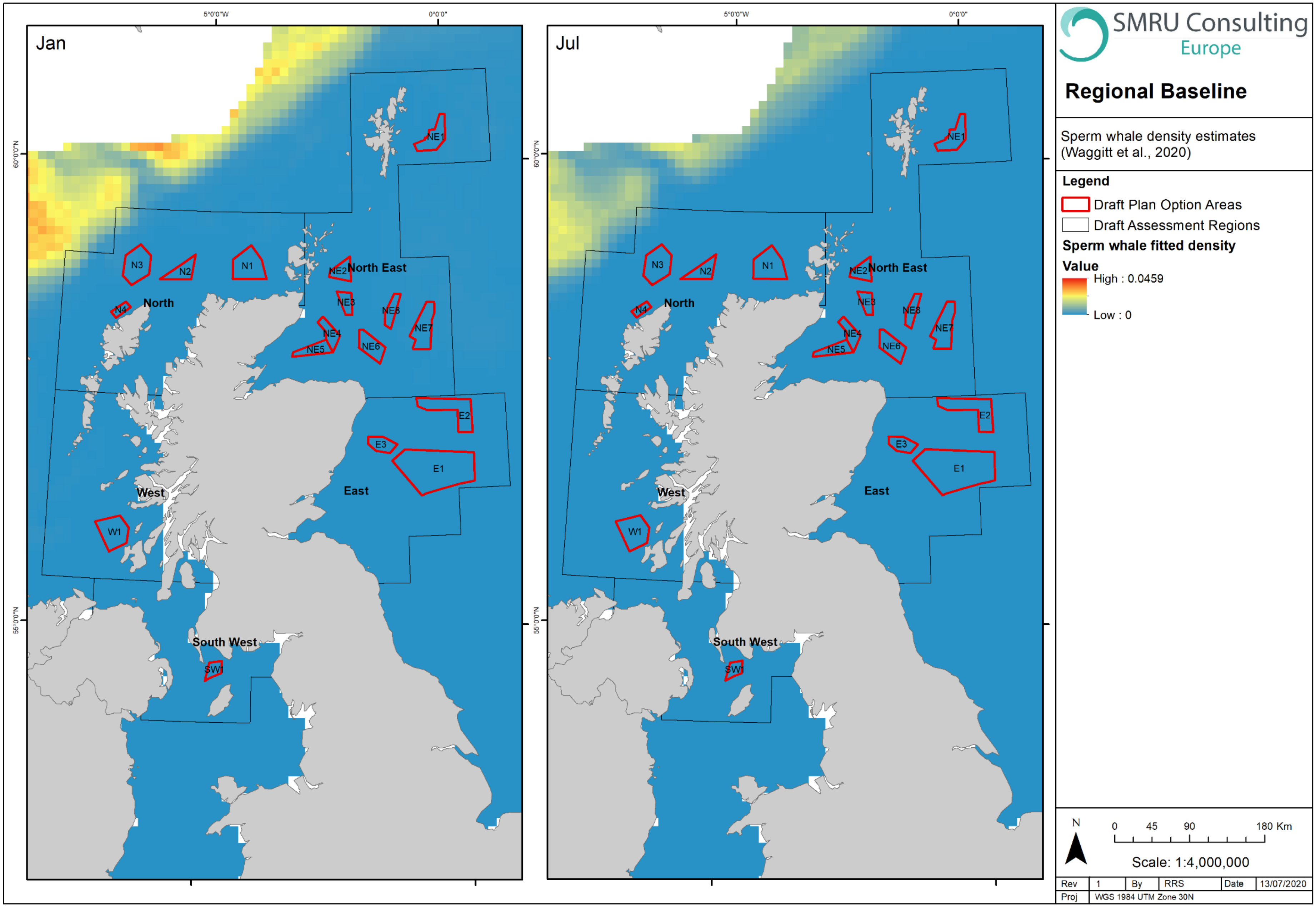


Figure 192: Spatial variation in predicted sperm whale densities (animals per km²). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Rogan et al. (2017) modelled a combination of SCANS-II, CODA and T-NASS survey data covering 2005 and 2007 to predict abundance of sperm whales in the North-East Atlantic. All sightings were in the deeper waters, with abundance of groups highest in waters between 1000 and 4000 m depth (Figure 194). There were no sightings of sperm whales in any of the DPO regions or sites.

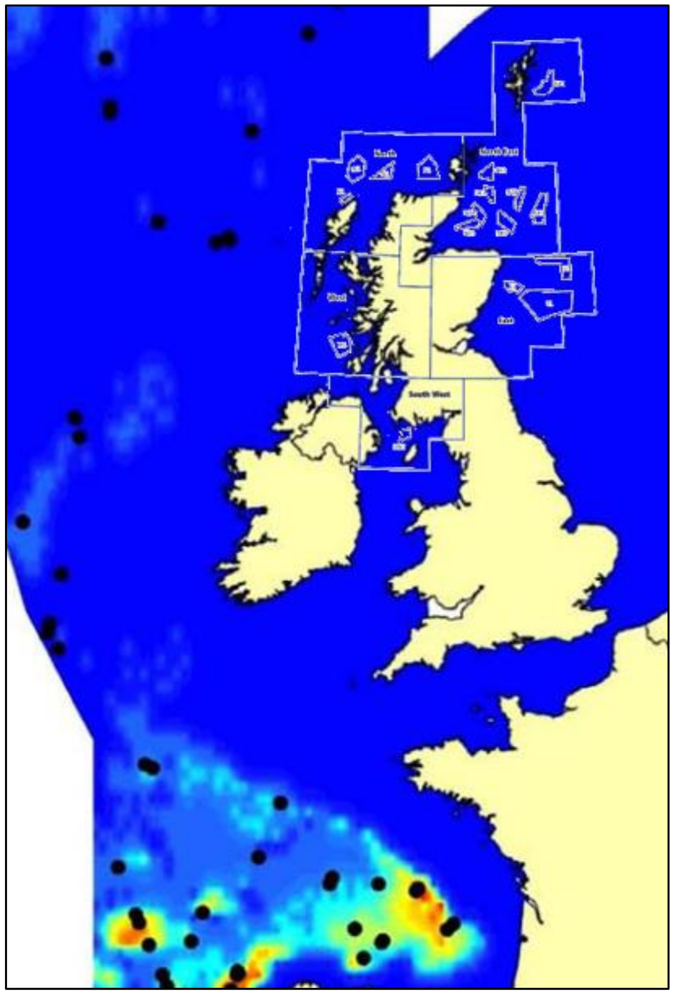


Figure 193: Surface map of smoothed predicted abundance (numbers/km^2) for sperm whales (Rogan et al. 2017). Overlaid for reference are the approximate regional and DPO areas.

The Scottish Marine Atlas describes sperm whale habitat as continental slope and oceanic waters >1000 m deep, with sightings offshore to the north and west of Scotland, occasionally seen inshore off Shetland (Baxter et al. 2011). Mapped encounter rates do not overlap with any DPOs regions or sites, and are instead focused offshore to the north and west of Scotland (Figure 195).

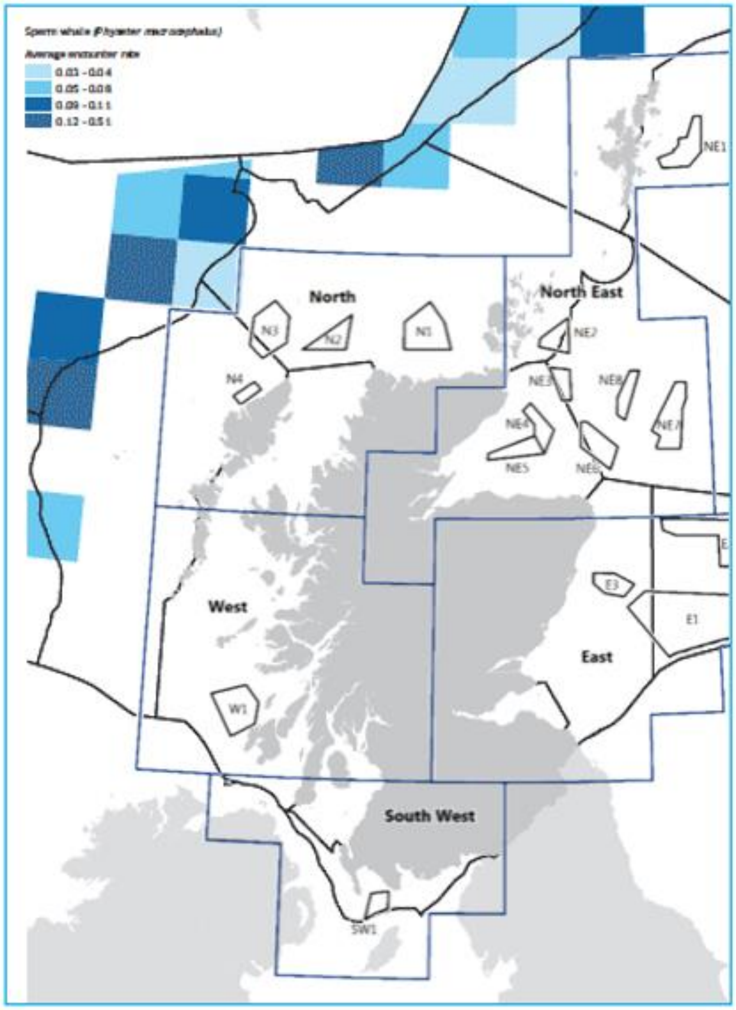


Figure 194: Sperm whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

Embling (2007) used passive acoustic monitoring hydrophones towed behind platform of opportunity vessels in the offshore waters west of Scotland to acoustically detect sperm whales between July 2003 and October 2005. Sperm whales were primarily detected in deep water areas where there were weak thermoclines and strong haloclines (Figure 196). None of the areas where sperm whales were detected overlapped with the DPO areas, as detections were all further offshore.

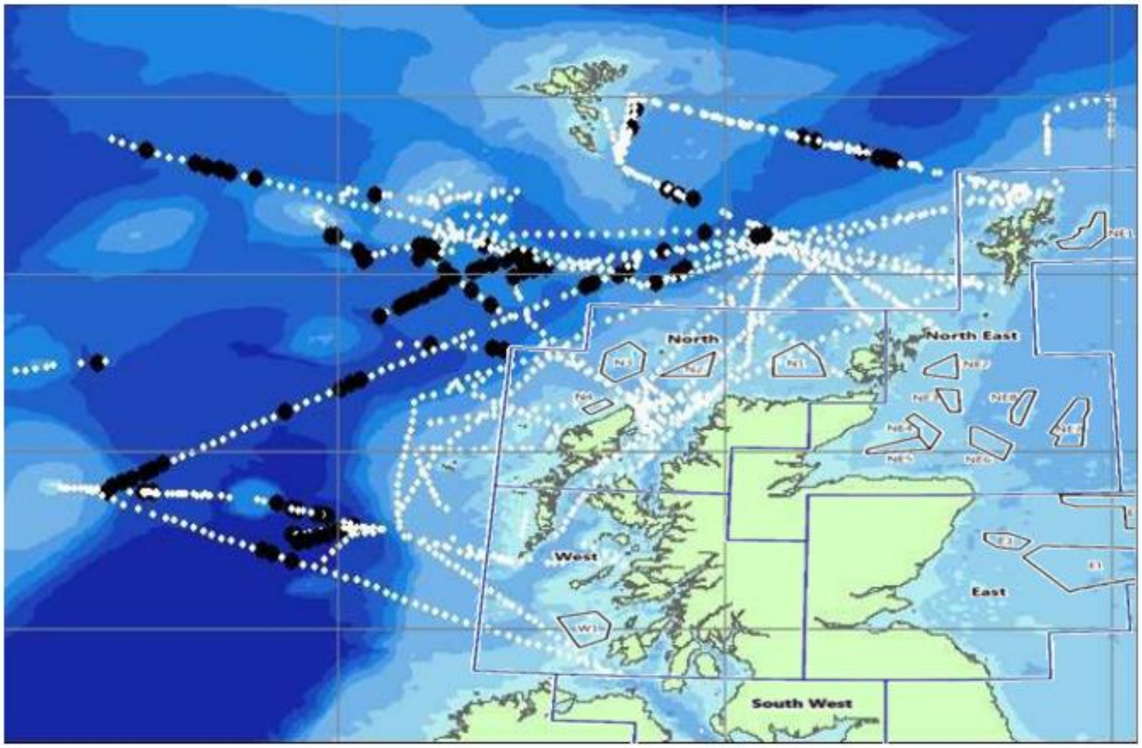


Figure 195: Survey effort (white dots) and sperm whale detections (black dots) for the west coast of Scotland surveys carried out between July 2003 and October 2003. (Embling 2007). Overlaid for reference are the approximate regional and DPO areas.

Earlier survey data show sperm whales are mainly distributed in deeper waters (>200 m) in north-west Atlantic, around Iceland, west of Norway, and beyond the continental shelf in northwest Scotland (Reid et al. 2003). Most sightings of sperm whales in Scottish waters are in deeper waters off the continental shelf or adjacent areas, especially the waters around Rockall, north of the Outer Hebrides, north and west of Shetland in the Faroe-Shetland Channel (Evans et al. 2011). Sightings in the UK have mainly been between July and December. Predicted sperm whale distribution did not overlap with any of the DPO areas (Figure 197) (Reid et al. 2003), as the species tend to be distributed in deeper and more offshore areas.

Again, Weir et al. (2001) recorded sperm whales as the most regularly sighted large whale in the Atlantic Frontier, recording sightings in every month except February and March with sightings distributed adjacent far offshore, at or over the 1,000 m isobath at the north and west of Scotland (Figure 198). Their offshore distribution is likely due to the habitat preferences of their cephalopod prey (Pollock et al. 2000). Similarly, sperm whales were also recorded primarily in the Outer Hebrides and in deep offshore waters during the Macleod et al. (2003) survey.

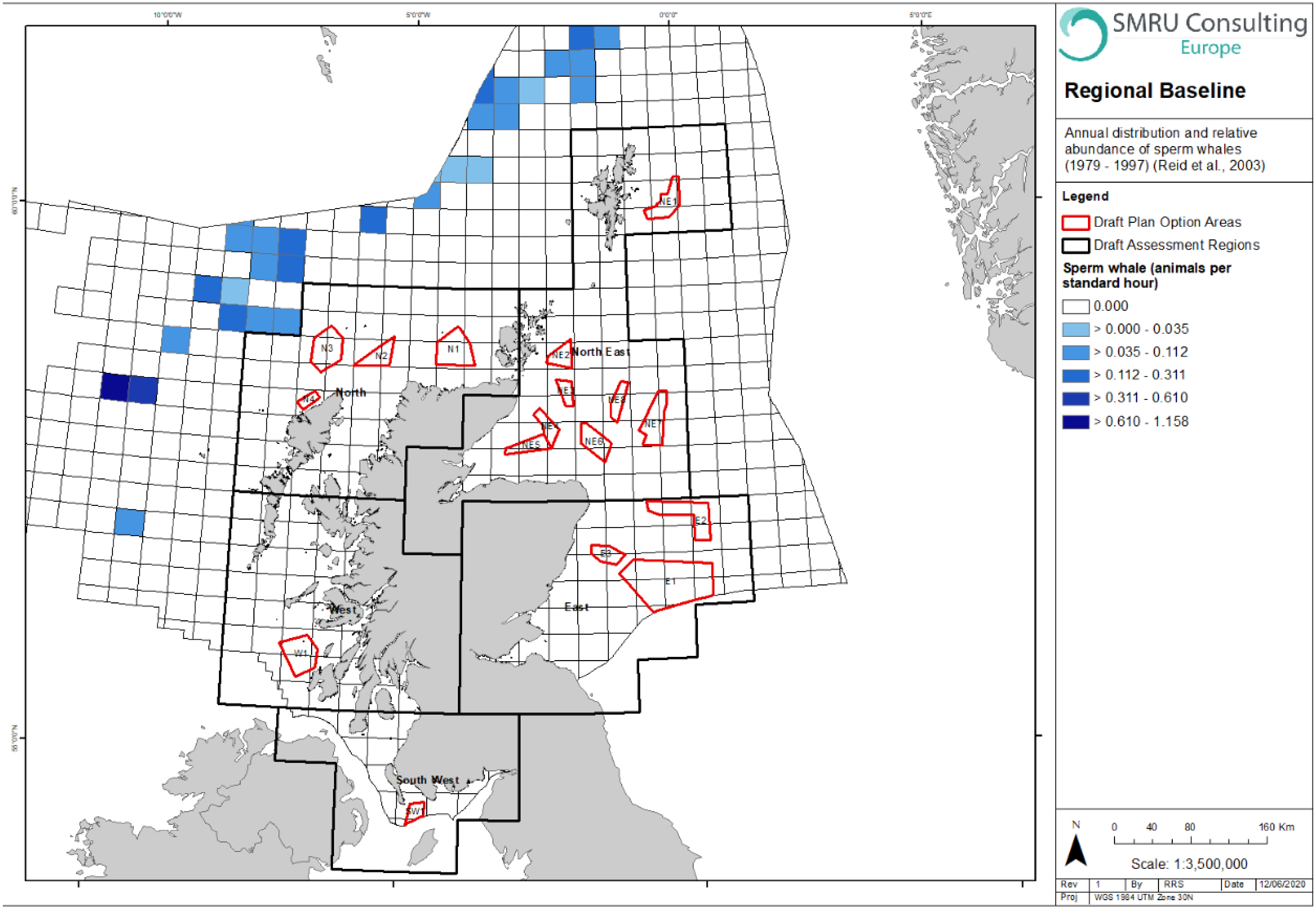


Figure 196: Aggregated annual distribution and relative abundance of sperm whales (1979-1997) (per unit effort: animals per standard hour) on quarter ICES rectangles based on data presented in Reid et al. (2003).

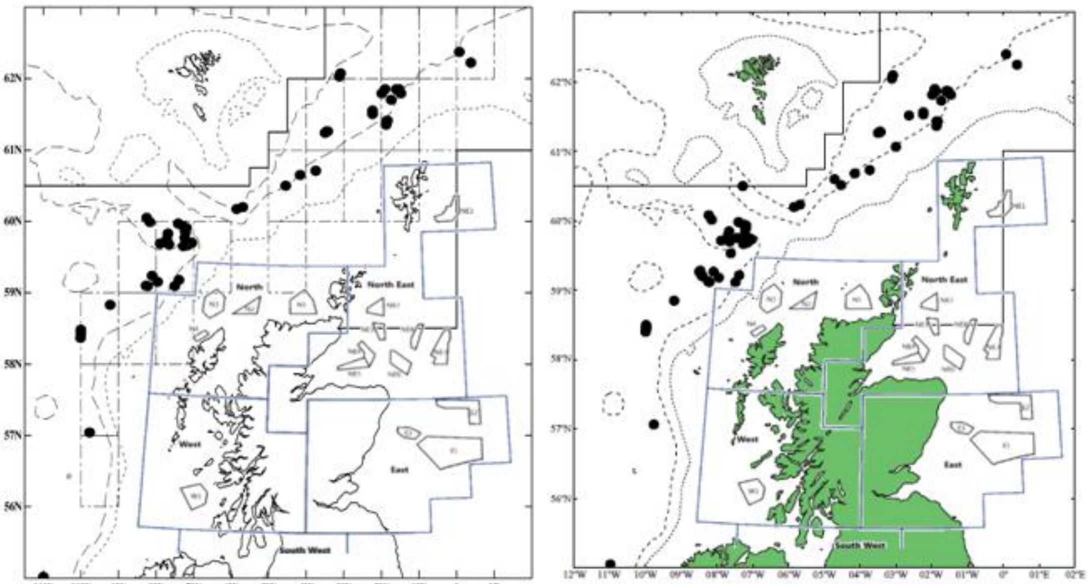


Figure 197: Left: Distribution of sperm whale sightings (1979–1998) Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001). Right: Distribution of sperm whale sightings (1979–1999) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, sperm whales were found in deep waters and waters over the continental shelf edge (i.e. depths greater than 200 m) to the north and west, particularly in the Shetland-Faroes channel (Stone 2015). In terms of the DPOs regions, sperm whales were sighted only in the North East and North regions, and in very low frequency compared to other marine mammals sighted during these surveys (Figure 199). No sightings overlapped any DPO sites.

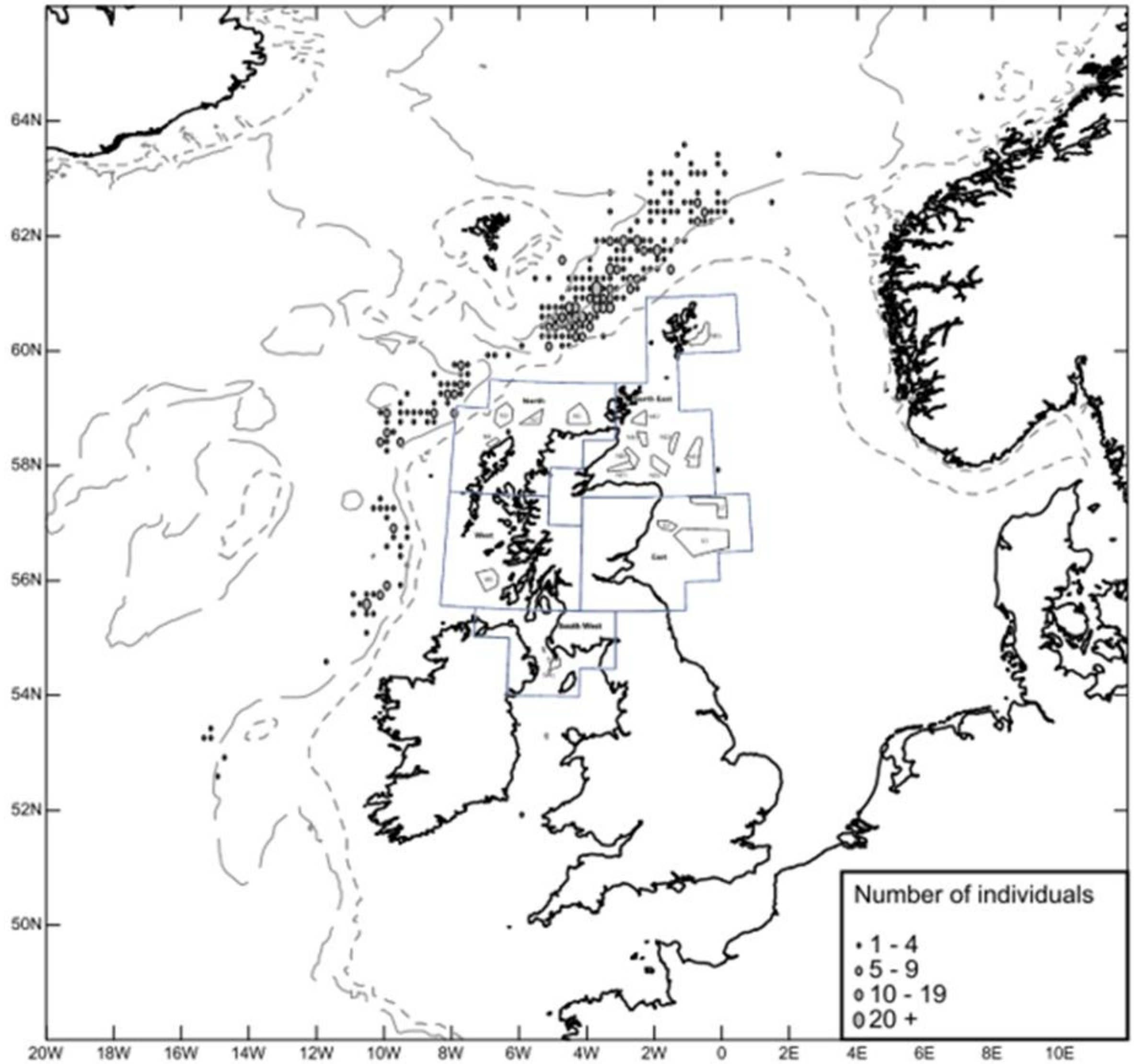


Figure 198: Sperm whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath.

Sightings of sperm whales by the NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009 were rare, with no overlap with DPOs regions or site boundaries (Figure 200).

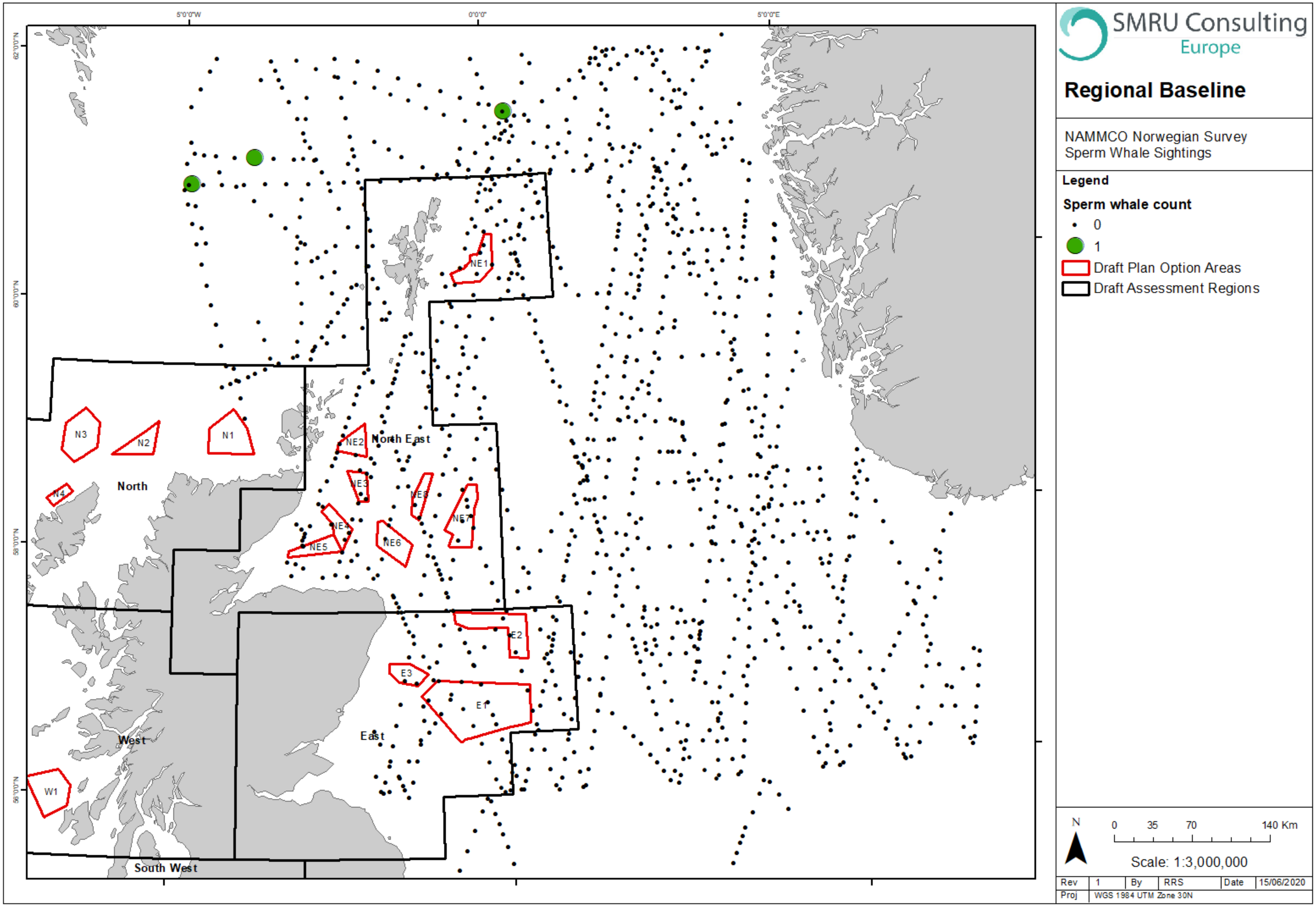


Figure 199: Sperm whale sightings (green dots) during NAMMCO surveys in 1989, 1995, 1998, 2004, 2009. Data provided free of charge.

During land-based Shorewatches, sightings of sperm whales were extremely rare, with sightings only recorded at Tiumpan Head on the Isle of Lewis, and thus there was no overlap of sightings within any DPOs sites (Figure 201).

Despite the consistent offshore distribution recorded in the larger-scale surveys, the University of Aberdeen Lighthouse Field Station photo-identification surveys did report one encounter with a sperm whale within the inner Moray Firth during the surveys held between 2002 and 2016 during a total of 241 trips. Again, over the thirty year study period Evans et al. (2011) presents sightings records of within the Pentland Firth and Orkney Isles, there were only seven main coastal sightings events between 1993 and 2007, where larger groups of sperm whales were sighted in the area (Figure 202).

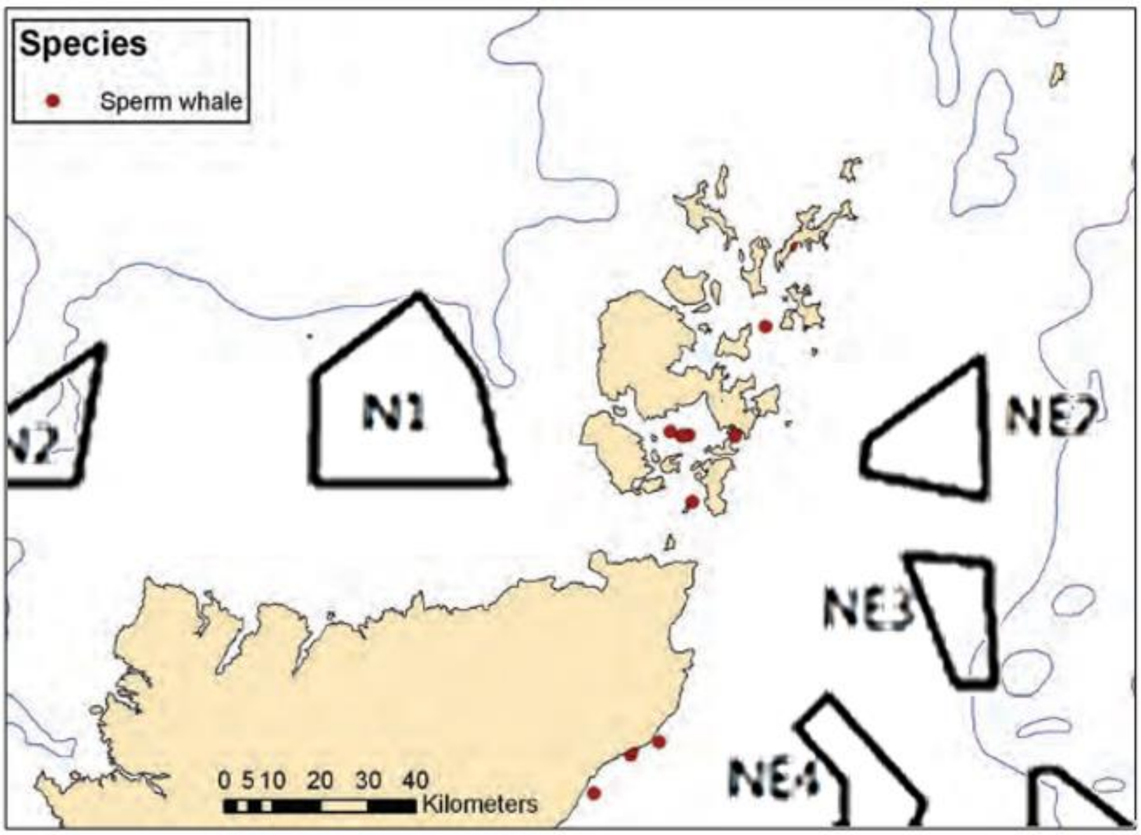


Figure 201: Distribution of sperm whale sightings around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010 (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

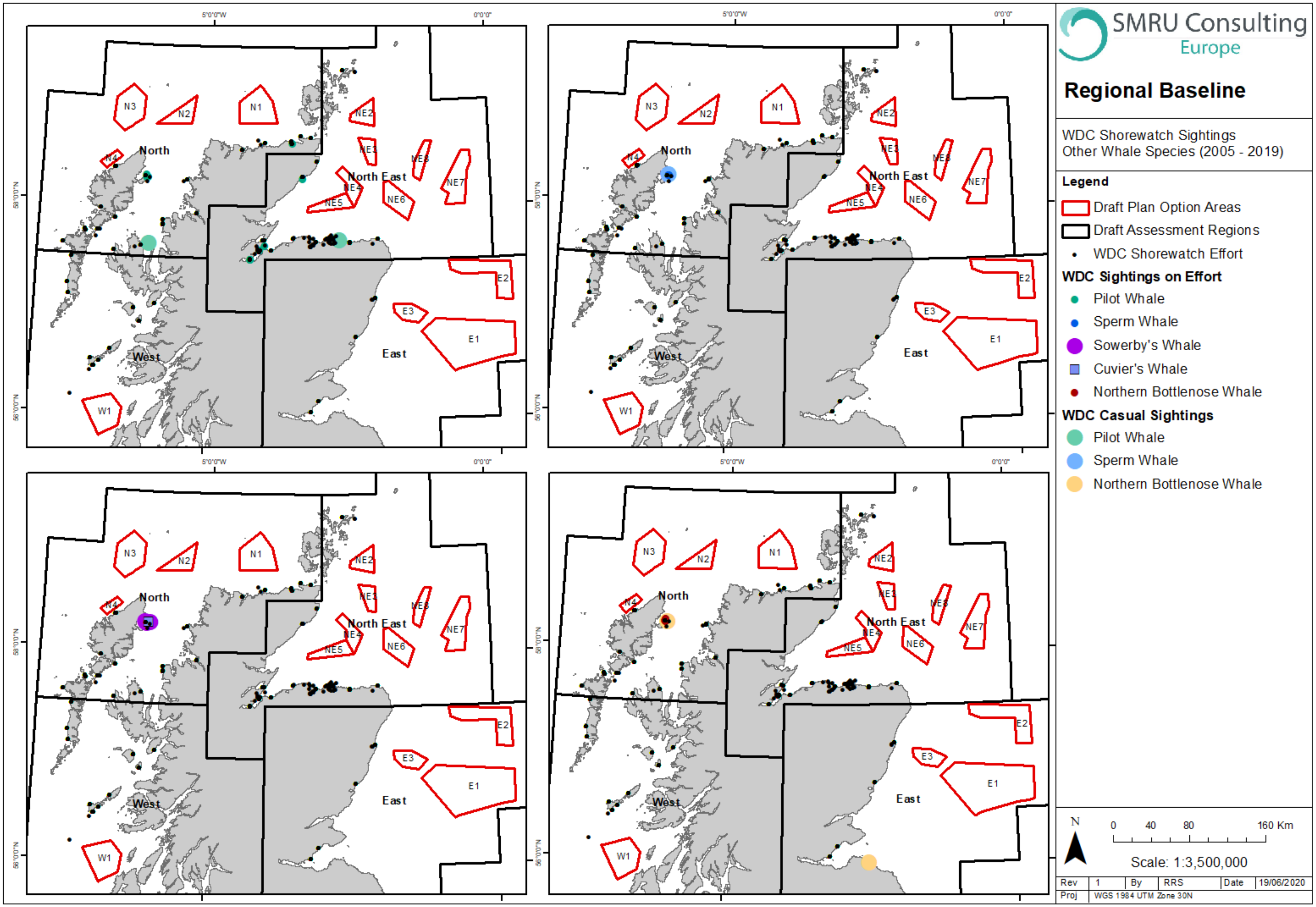


Figure 200: Sightings of long-finned pilot whale, sperm whale, Sowerby's beaked whale, Cuvier's beaked whale and northern bottlenose whale recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

3.3.14. Fin whale

Based on the information presented below, fin whales are rare in Scottish waters and have a preference for deeper waters over the continental shelf edge, and so it is unlikely their distribution will consistently overlap with any DPO sites.

The most recent assessment of fin whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019l).

The most recently collected broad-scale data on fin whale abundance and distribution are available from the SCANS III survey. The SCANS III sightings data show a very clear offshore distribution to the west coast of Scotland for fin whales, with almost all sightings located in survey Block 8 (Atlantic - west of Scotland) where densities reached up to 0.005 fin whales/km^2 (Figure 203). Fin whales were sighted in other areas of Scottish waters during the SCANS III surveys, but none overlap with any DPO sites (Figure 204).

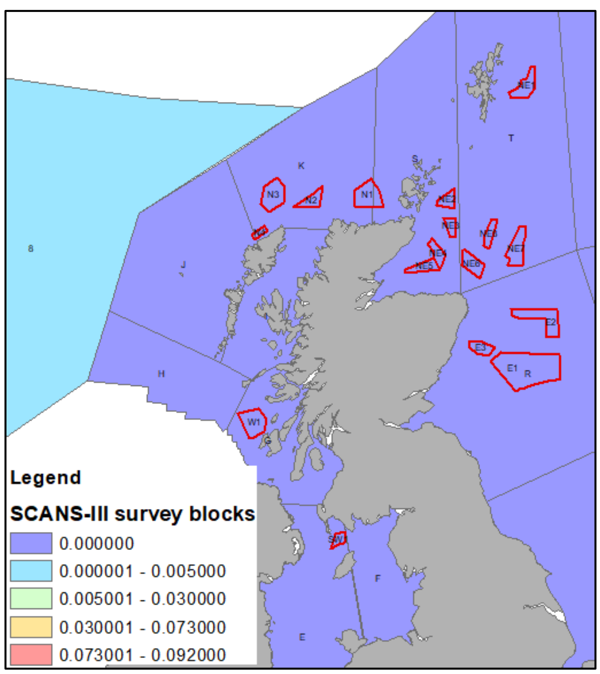


Figure 202: SCANS III block-wide uniform density estimates for fin whales in Scottish waters (Hammond et al. 2017). Overlaid for reference are the DPO areas.

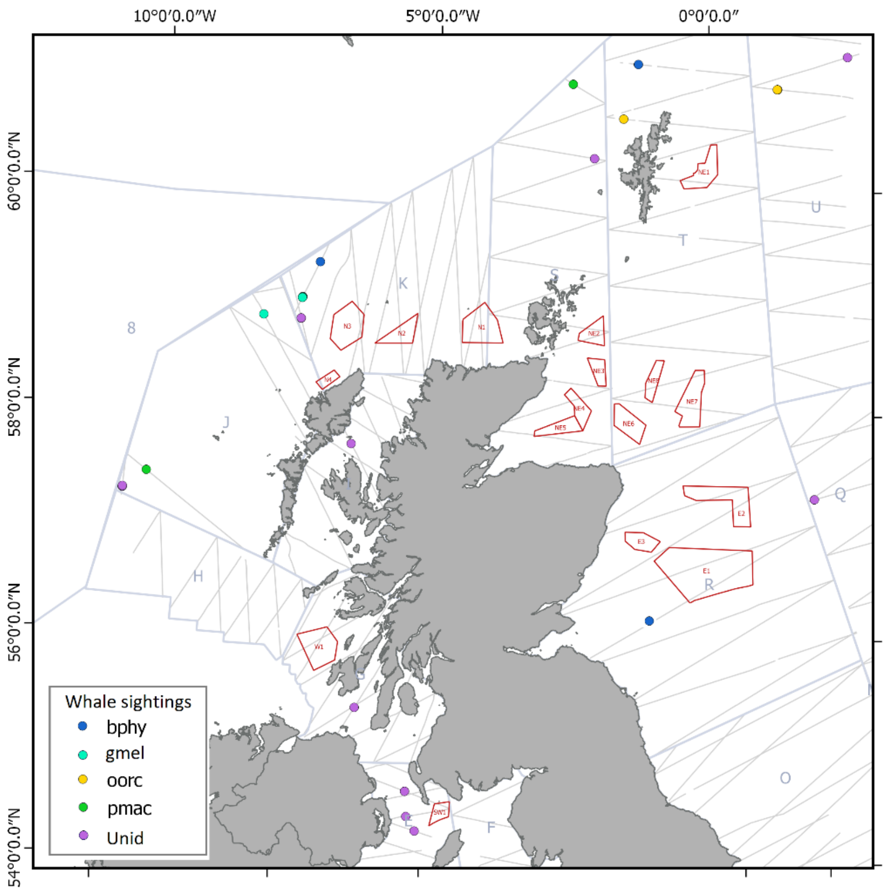


Figure 203: Sightings of whale species seen during the SCANS-III survey blocks containing DPO Areas (red). Bphy = fin whale (*Balaenoptera physalis*), gmel= long-finned pilot whale (*Globicephala melas*), oorc= killer whale (*Orcinus orca*), pmac= sperm whale (*Physeter macrocephalus*) and Unid= whales not identified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

The species distribution maps presented by Waggitt et al. (2020) documented very low densities of fin whales, with a slight increase in density far offshore of north-western Scotland during the summer months (Figure 205). Predicted densities were extremely low for all DPO regions and sites. Note: the Waggitt et al. (2020) distribution maps are available for all months, however only January and July are presented here for illustrative purposes.

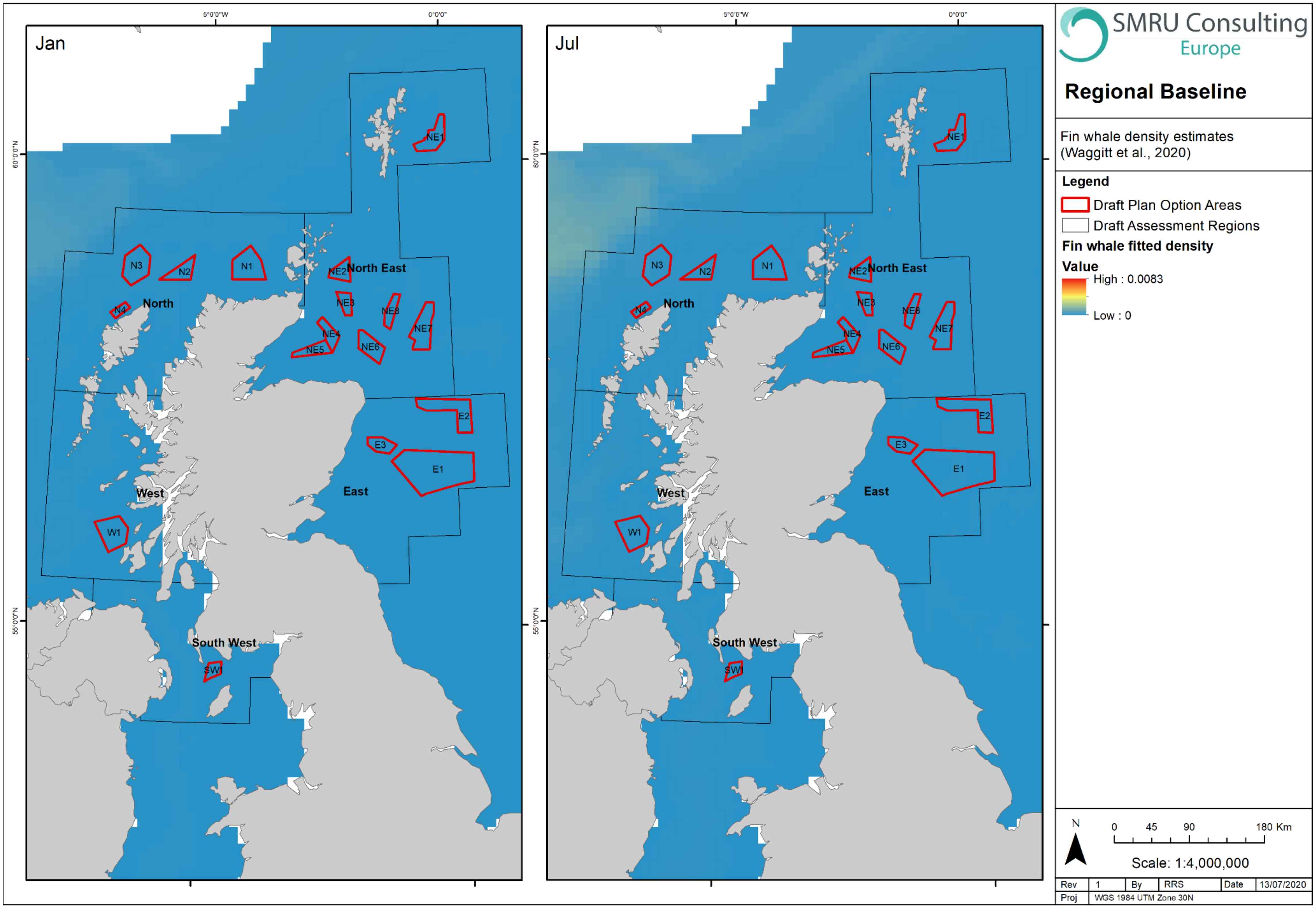


Figure 204: Spatial variation in predicted fin whale densities (animals per km2). Left = January, Right = July. Values are provided at 10 km resolution (Waggitt et al. 2020).

Fin whales are relatively rare in Scottish waters, and are mainly distributed along or beyond the 500 m depth contour, including the Faroe-Shetland Channel and the Rockall Trough (Figure 206), occurring mainly between June and December (Reid et al. 2003). Most sightings of fin whales in northern Britain occur between June and August, with peak sightings during the Cetaceans of the Atlantic Frontier surveys in May and August (Weir et al. 2001), although there were only 29 sightings of fin whales over the 20-year survey period (Pollock et al. 2000). During these surveys distribution was centred near or over the 1,000 m isobath, centred north of 60°N on the south side of the Faroe Isles (Figure 207). Fin whales were also recorded in the Macleod et al. (2003) surveys, with highest fin whale sightings in the Faroe-Shetland Channel and no sightings in the Outer Hebrides.

Whilst Reid et al. (2003) did predict a small distribution of fin whales in the Inner Moray Firth, overlapping with DPO NE5, the rarity of fin whales and their preference for deeper waters means it is unlikely their distribution will consistently overlap with any DPO sites.

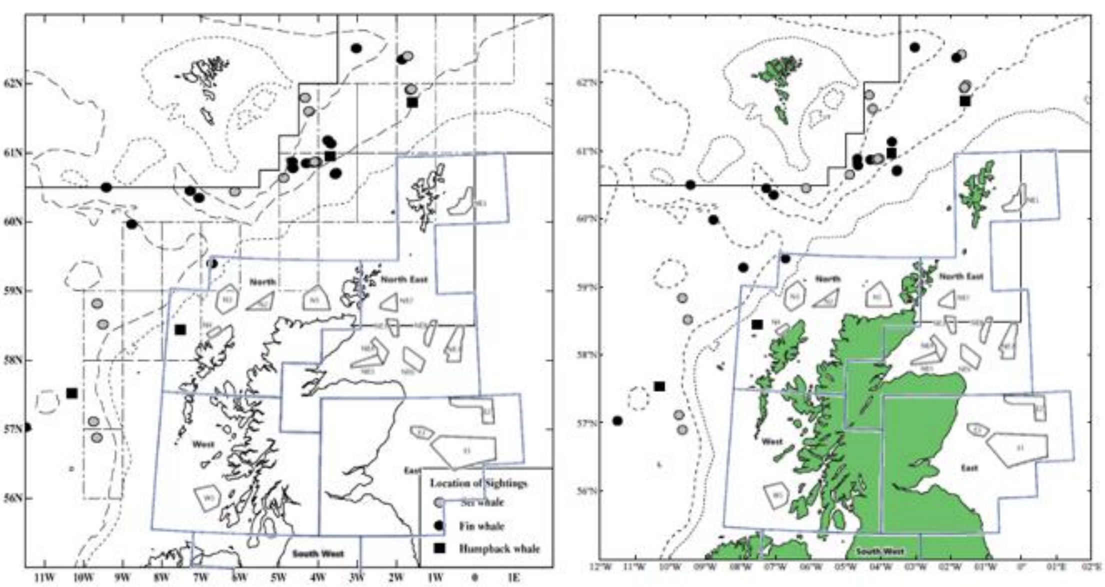


Figure 206: Left = Distribution of fin, sei and humpback whale sightings (1979-1998) Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants). (Weir et al. 2001). Right = Distribution of fin, sei and humpback whale sightings (1979-1999) (Pollock et al. 2000). Note, same key for both figures. Overlaid for reference are the approximate regional and DPO areas.

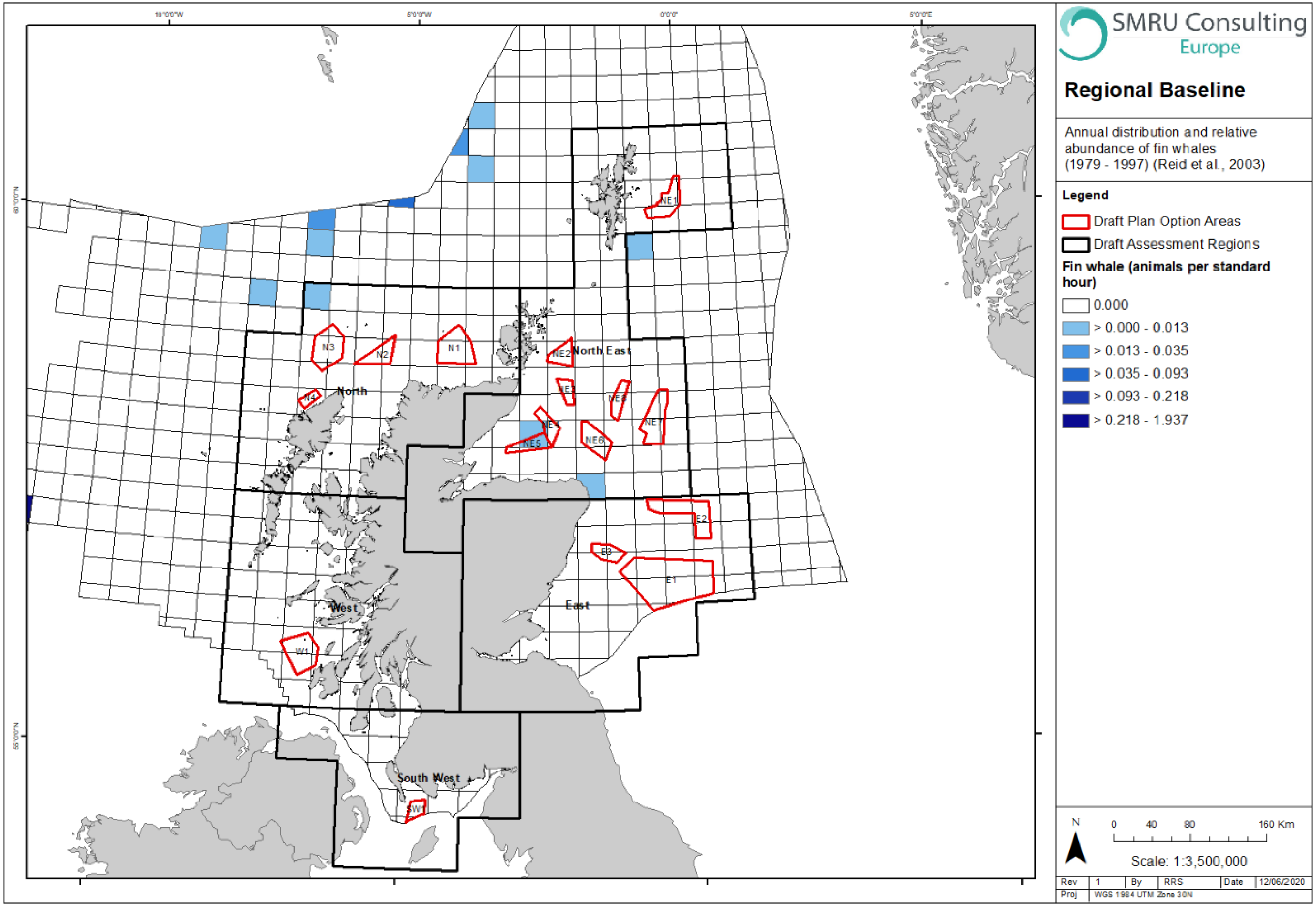


Figure 205: Aggregated annual distribution and relative abundance of fin whales (1979-1997) (per unit effort: animals per standard hour) on quarter ICES rectangles based on data presented in Reid et al. (2003).

The Scottish Marine Atlas describes fin whale habitat as deep water (400-2000 m) beyond the edge of the continental shelf, with a preference for banks, mounds and areas of upwelling and frontal zones. Sightings are distributed beyond the continental shelf margin in northern waters (Baxter et al. 2011). Mapped encounter rates show some overlap with DPOs sites in the Moray Firth and at site N3, however, overall encounter rates are very low in Scottish waters (Figure 208, Figure 195).

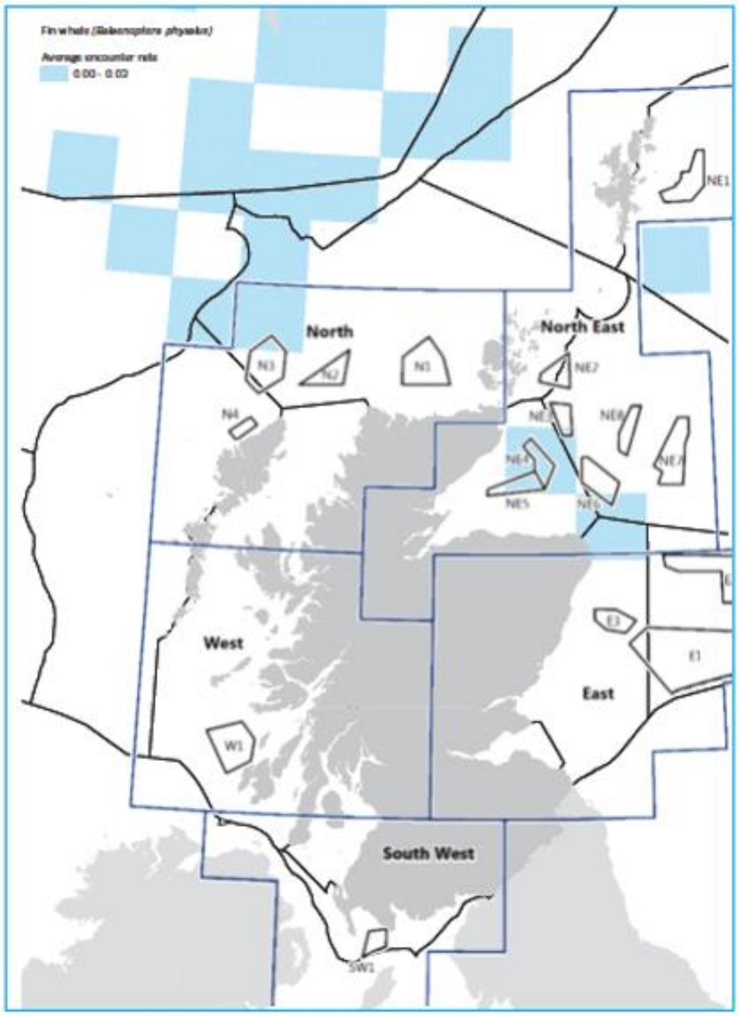


Figure 207: Fin whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, fin whales were found in deep waters and waters over the continental shelf edge (i.e. depths greater than 200 m) to the north and west (Stone 2015). A single fin whale was also sighted in shelf waters to the east of Shetland and a single animal also seen in the central North Sea. Analysis of sightings data showed a shift in distribution over time, where fin whales were previously mainly encountered to the west of Shetland, but between 2006 and 2010 sightings were much lower in that area compared to previous years (Table 8) (Stone 2015). In terms of the DPOs regions, fin whales were sighted only in the North East region, and in very low frequency compared to other marine mammals sighted during these surveys (Figure 209). Further, no sightings overlapped any DPO sites.

Table 8

Sightings rates of fin whales per 1,000 hours survey effort by marine mammal observers (Table reproduced using data from Stone (2015)).

Area	1996-2000	2001-2005	2006-2010
West of Shetland	25.97	17.63	1.77

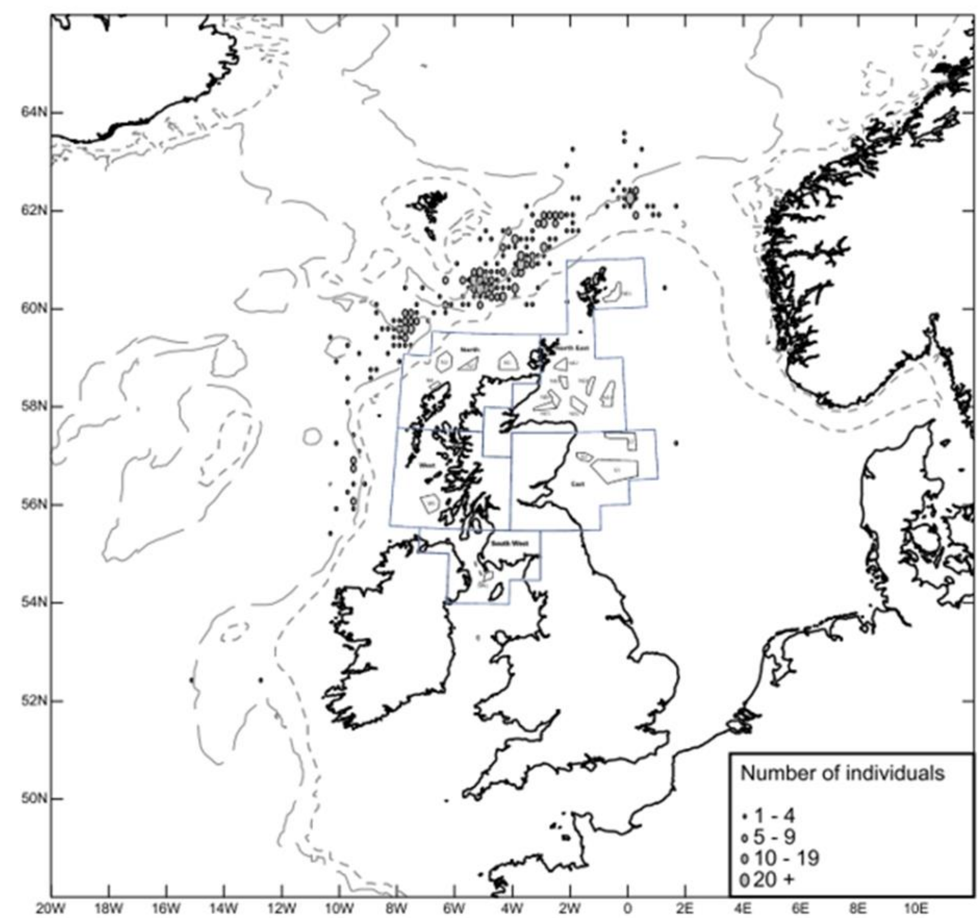


Figure 208: Fin whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; the long dashed line = 1,000 m isobath.

During land-based Shorewatches, fin whales were sighted fairly infrequently, with sightings most commonly within the Inner Moray Firth and from Tiumpan Head on the Isle of Lewis (Figure 210). No sightings overlapped with DPO site boundaries.

Sightings of fin whales during the NAMMCO surveys in 1989, 1995, 1998, 2004 and 2009 were rare, with no overlap with DPOs regions or site boundaries (Figure 211). Sightings instead were concentrated within the Faroe-Shetland channel.

Fin whales are very rarely sighted around the Pentland Firth and Orkney Isles, with only four sightings between 1980 and 2010 reported by Evans et al. (2011) (Figure 212).

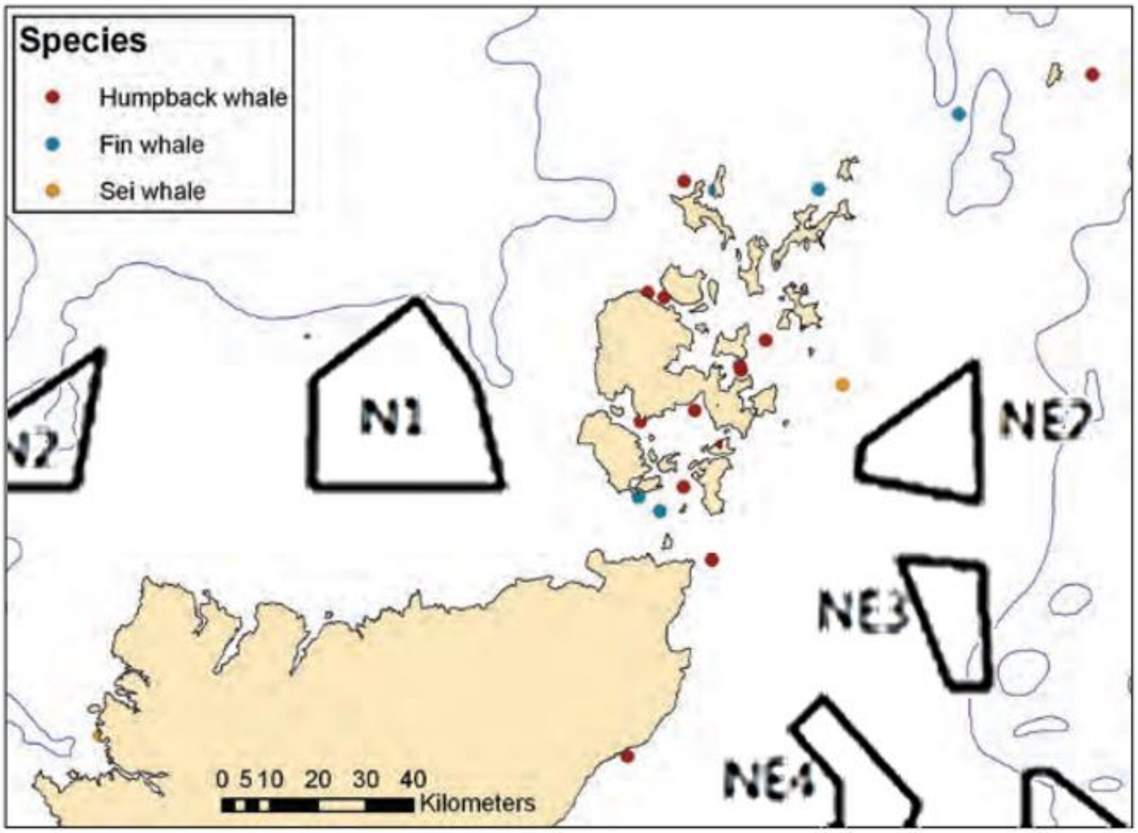


Figure 211: Distribution of sightings of rarer baleen whale species around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010. Fin whale sightings are indicated by blue circles (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

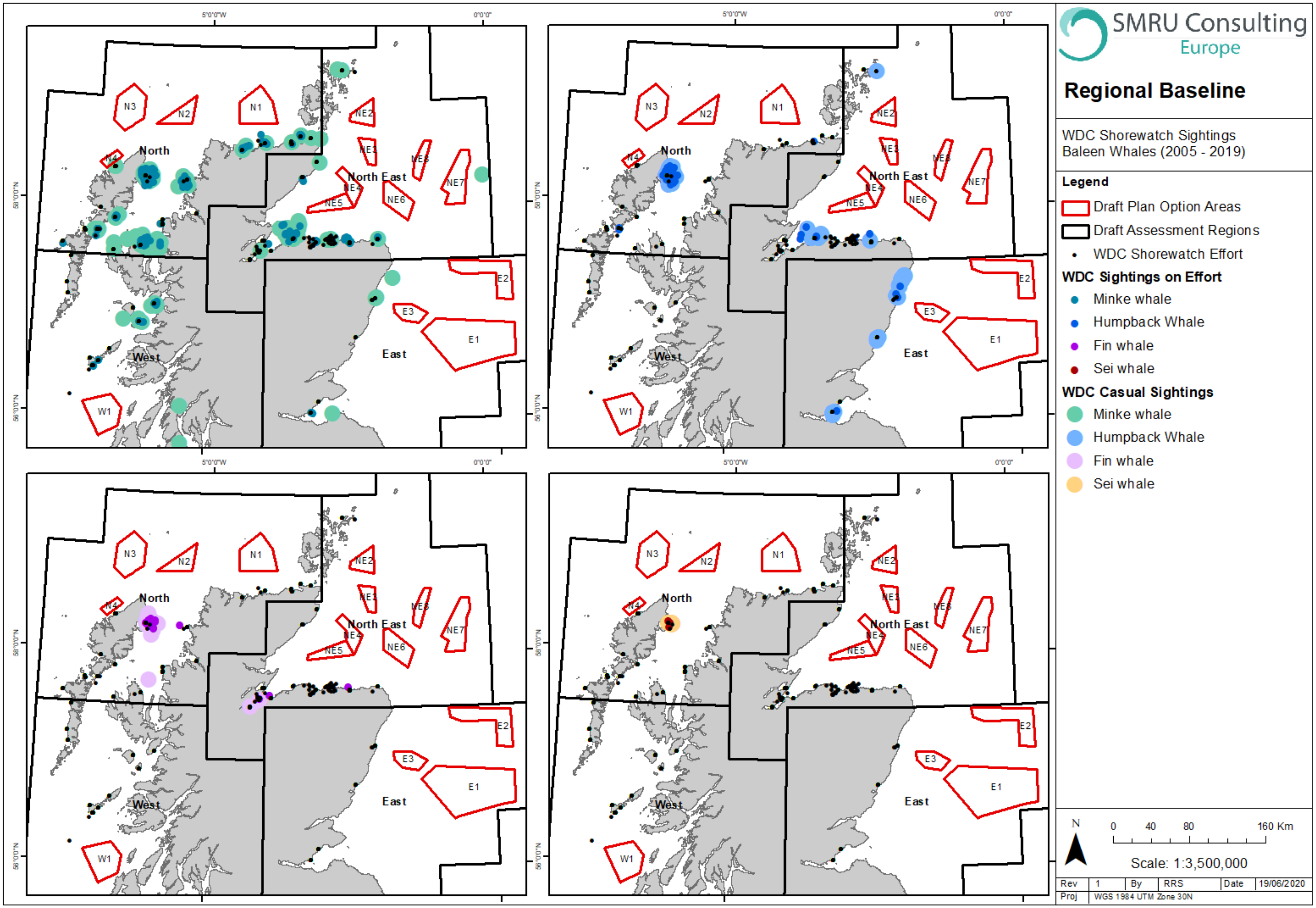


Figure 209: Sightings of minke whale (top left), humpback whale (top right), fin whale (bottom left) and sei whale (bottom right) recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

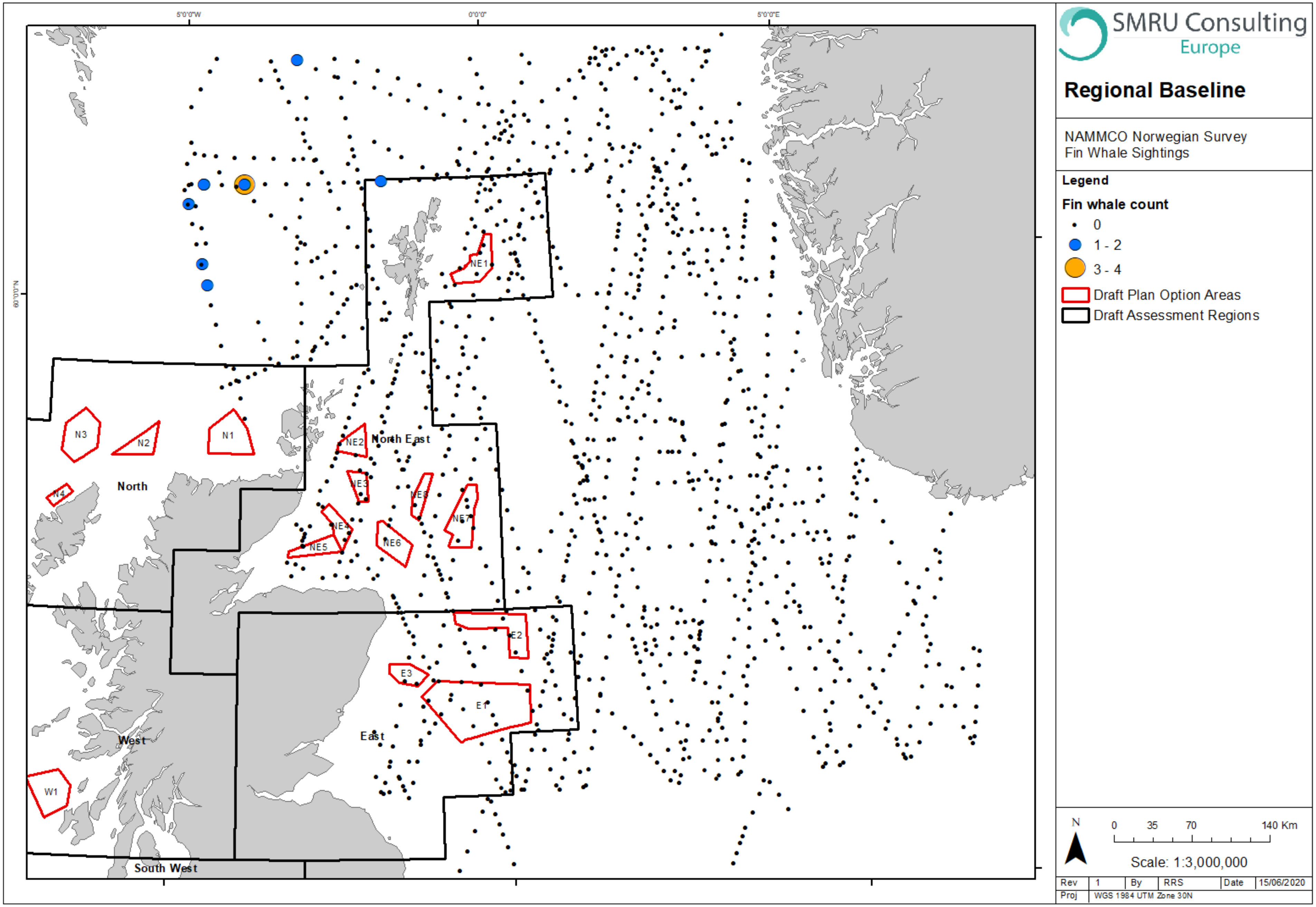


Figure 210: Fin whale sightings (blue and orange dots) during NAMMCO surveys in 1989, 1995, 1998, 2004, 2009. Data provided free of charge.

3.3.15. Beaked whale spp.

The rarity of beaked whales in Scottish waters, and their usual preference for deeper offshore waters, means it is unlikely their distribution will overlap with any DPOs Areas.

Below, we present the available data we collated as part of this review on beaked whale species, which includes sightings information on three species: Cuvier's beaked whale; Sowerby's beaked whale and the northern bottlenose whale. This is not an exhaustive list of all beaked whale species found in Scottish waters. Other species have been sighted or are have stranded within Scottish waters, but are considered extremely rare.

The most recently collected broad-scale data on beaked whale abundance and distribution are available from the SCANS III survey. The SCANS III surveys recorded sightings of the following beaked whale species in Scottish waters: Cuvier's beaked whale, Sowerby's beaked whale, northern bottlenose whale and 'unidentified beaked whale'. The SCANS III sightings data show a very clear offshore distribution of beaked whales, with almost all sightings located in offshore waters west of the Hebrides where densities reached up to 0.022 beaked whales/km^2 (Figure 213, Figure 214).

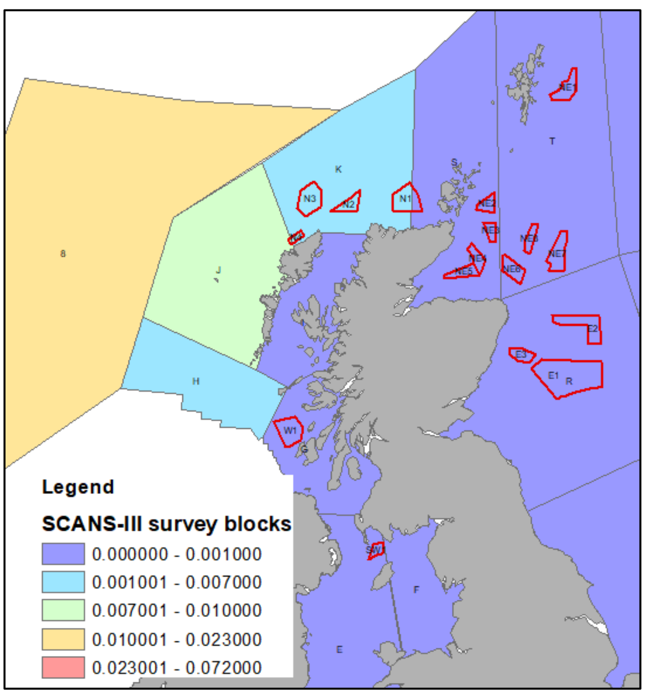


Figure 212:SCANS III block-wide uniform density estimates for beaked whales (combined species) in Scottish waters (left) (Hammond et al. 2017). Overlaid for reference are the DPO areas.

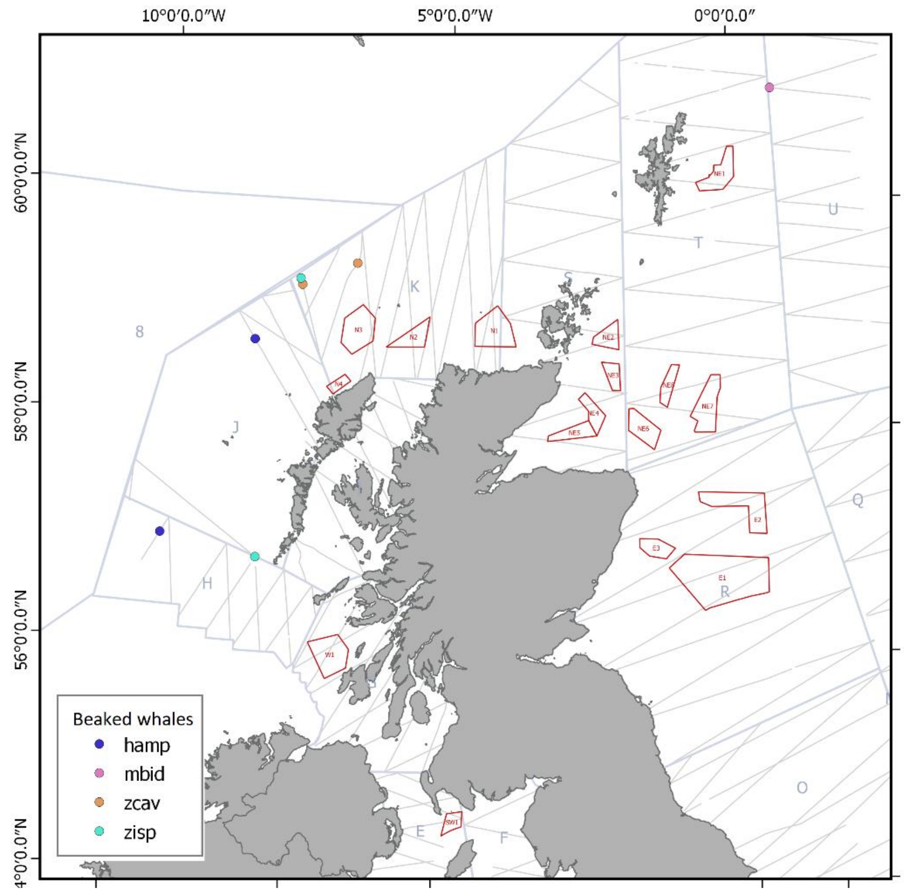


Figure 213: Sightings of beaked whale species seen during the SCANS-III survey blocks containing DPO Areas (red). hamp = Northern bottlenose whale (*Hyperoodon ampullatus*), mbid = Sowerby's beaked whale (**Mesoplodon bidens**), zcav = Cuvier's beaked whale (**Ziphius cavirostris**) and zisp= beaked whales unidentified to species. Reproduced from Hammond & Lacey short note, provided in Appendix 3: SCANS surveys.

Knowledge of beaked whale abundance and distribution in Scottish waters is sparse. They are rarely seen due to their long dive duration and inconspicuous surfacing behaviour, and the short duration of encounters means they can be difficult to identify to species-level (Pollock et al. 2000, Weir et al. 2001). Neither Waggitt et al. (2020) or Paxton et al. (2016) included beaked whales in the data collation or modelling of abundance or species distribution presented by the MERP project or JCP database, and most sightings data are now out of date. During the Cetaceans of the Atlantic Frontier surveys, 21 sightings of unidentified beaked whale species were recorded (Weir et al. 2001). However, a JNCC report covering the same surveys and also including an additional year of survey data cites 62 unidentified beaked whale sightings, suggesting there were 41 sightings in 1999 (Pollock et al. 2000). Sightings occurring in May and between August and January. Sightings were only recorded north of 58°N, and all on or near the 1,000 m isobath (Figure 215), mostly to the north-west of the Outer

Hebrides. Their preference for deeper waters is likely due to the habitat preference of their squid prey (Weir et al. 2001).

Of the beaked whale species that were identified during the Cetaceans of the Atlantic Frontier surveys, the northern bottlenose whale was the most frequently recorded (seven sightings involving a total of 17 animals (Pollock et al. 2000)), near or further offshore of the 1000 m isobath, whilst a Sowerby’s beaked whale was positively identified only once in deep water north-west of the Outer Hebrides (Weir et al. 2001).

Sowerby's beaked whale are the most frequently seen and stranded species of beaked whale in the north-east Atlantic, with a preference for waters over a 1000 m deep (Figure 216), usually to the north and west of Britain, although there are sparse records in the North Sea (Reid et al. 2003).

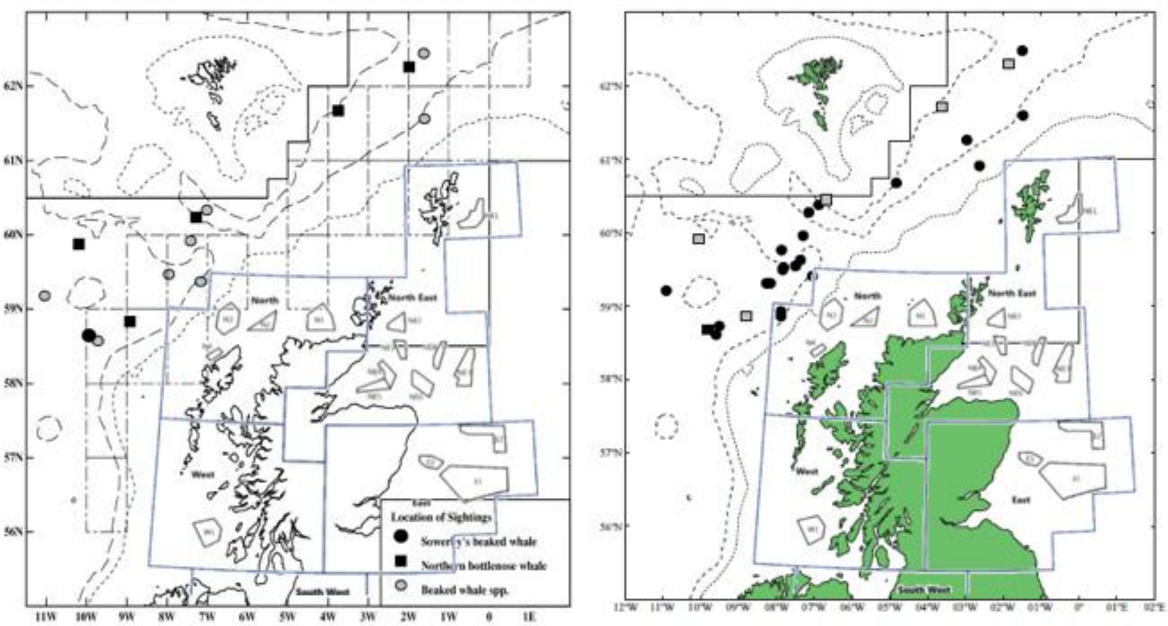


Figure 214: Left: Distribution of beaked whale sightings (1979-1998) presented in the Cetaceans of the Atlantic Frontier. Bathymetry: short dash (200 m isobath); long dash (1000 m isobath); dot-dash (Licence quadrants) (Weir et al. 2001). Right: Distribution of beaked whale sightings (1979-1999) (Northern bottlenose whales=grey square, Sowerby’s beaked whale=black square, unidentified beaked whale=black circle) (Pollock et al. 2000). Overlaid for reference are the approximate regional and DPO areas.

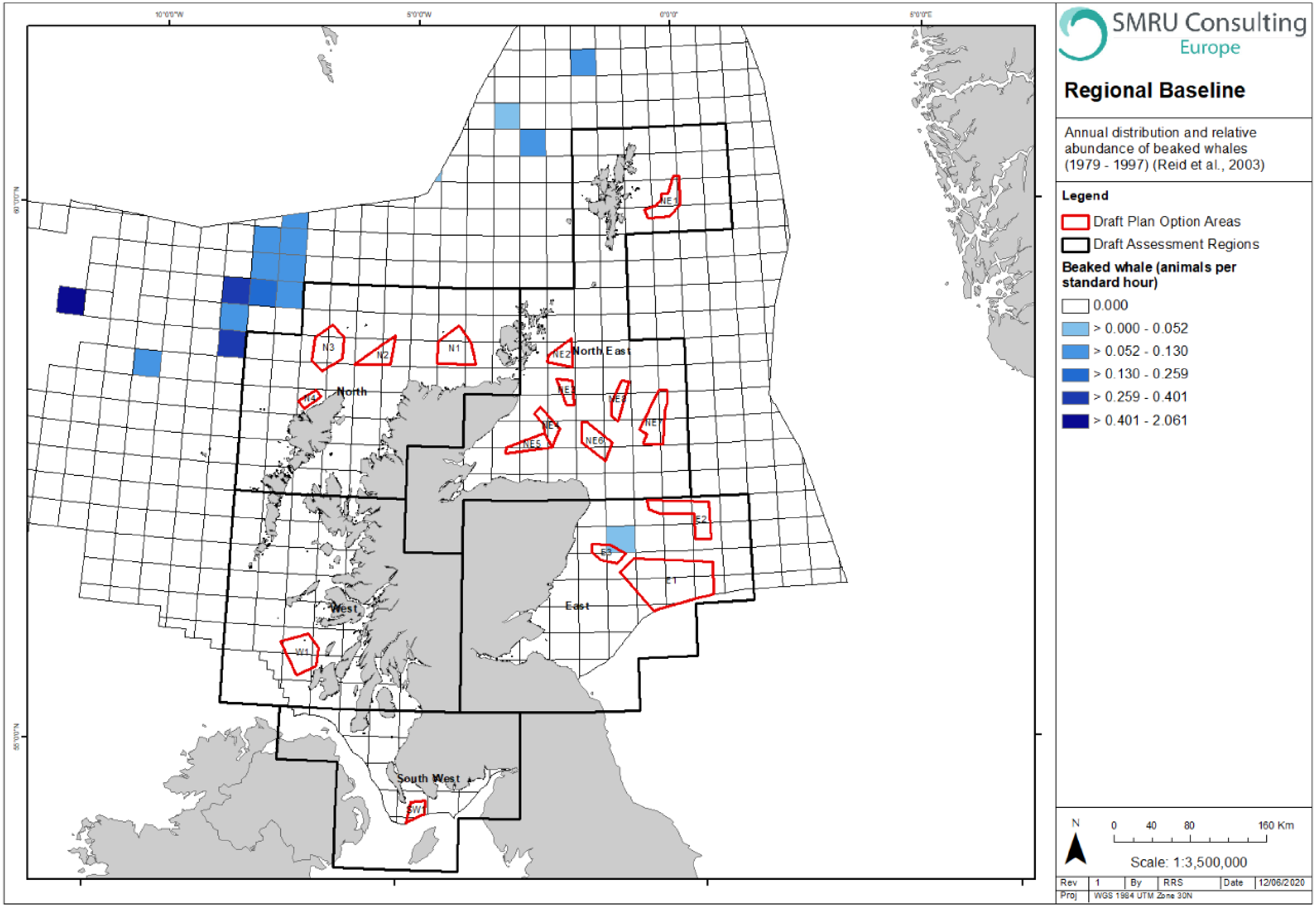


Figure 215: Aggregated annual distribution and relative abundance of bottlenose dolphins (1979 - 1997) (per unit effort: animals per standard hour) on quarter ICES rectangles based on data presented in Reid et al. (2003). DPOs regions and sites are Overlaid for reference.

Rogan et al. (2017) modelled a combination of SCANS-II, CODA and T-NASS survey data covering 2005 and 2007 to predict abundance of beaked whales in the North-East Atlantic. Beaked whales were strongly associated with the 2000 m depth contour, and only sighted in offshore waters (Figure 217). There were no sightings of beaked whales in any of the DPO regions or sites.

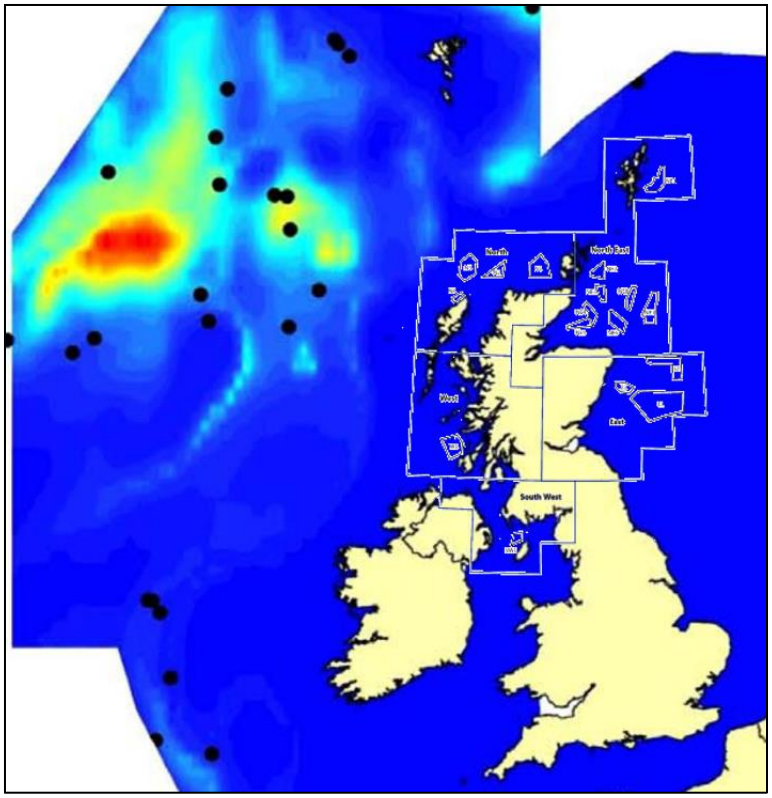


Figure 216: Surface map of smoothed predicted abundance (numbers/km^2) for beaked whales (Rogan et al. 2017). Overlaid for reference are the approximate regional and DPO areas.

Northern bottlenose whale and Sowerby’s beaked whale are the beaked whale species included in the Scottish Marine Atlas. Northern bottlenose whale habitat is described as cold temperate to subarctic deep waters beyond the edge of the continental shelf at depths of between 500-1500 m, often near submarine canyons, whilst Sowerby’s beaked whale occur almost exclusively in deep waters beyond the continental shelf edge (Baxter et al. 2011). Mapped encounter rates of Northern bottlenose whale do not overlap with any DPOs regions or sites, and are instead focused offshore to the north and west of Scotland, with a small increase in encounter rates north of the Isle of Skye (Figure 218, Figure 195).There are no mapped encounter rates provided in the Scottish Marine Atlas for Sowerby’s beaked whale, though sightings records are documented as being mostly from north-west and east Scotland.

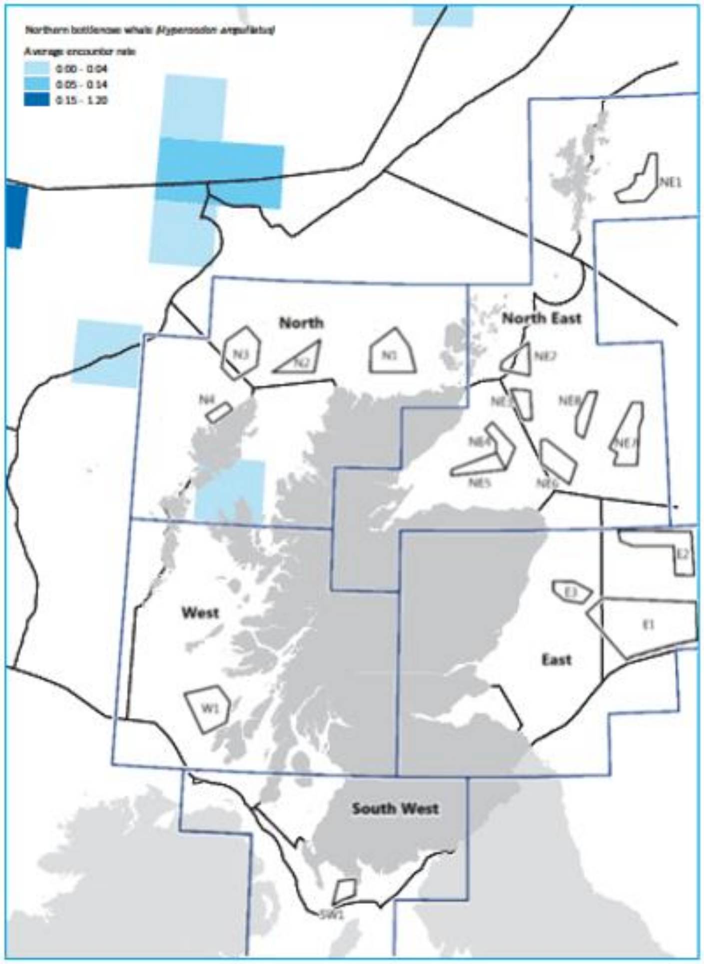


Figure 217: Northern bottlenose whale average encounter rate (Baxter et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

In sightings data recorded by marine mammal observers working on seismic survey vessels between 1994-2010, northern bottlenose whales and Sowerby's beaked whales were found in deep water and shelf edge areas in low numbers, although a single northern bottlenose whale was also seen close inshore off Aberdeen (Stone 2015). In terms of the DPOs regions, northern bottlenose whales were sighted only in the East region, and Sowerby's beaked whales were not sighted in any DPO regions (Figure 219, Figure 220). No sightings overlapped DPO sites.

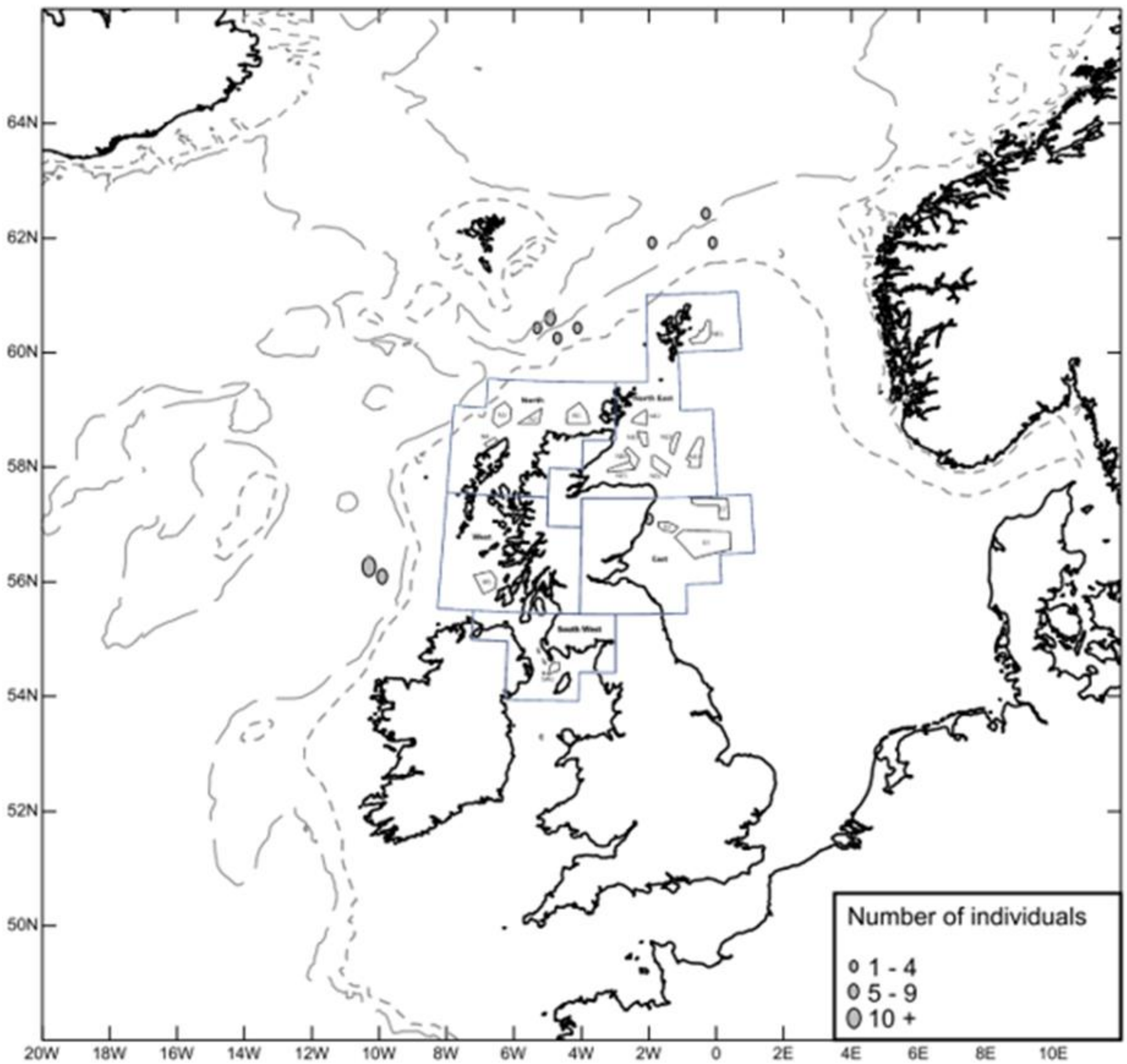


Figure 218: Northern bottlenose whales encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Approximate DPO regions and sites are Overlaid for reference.

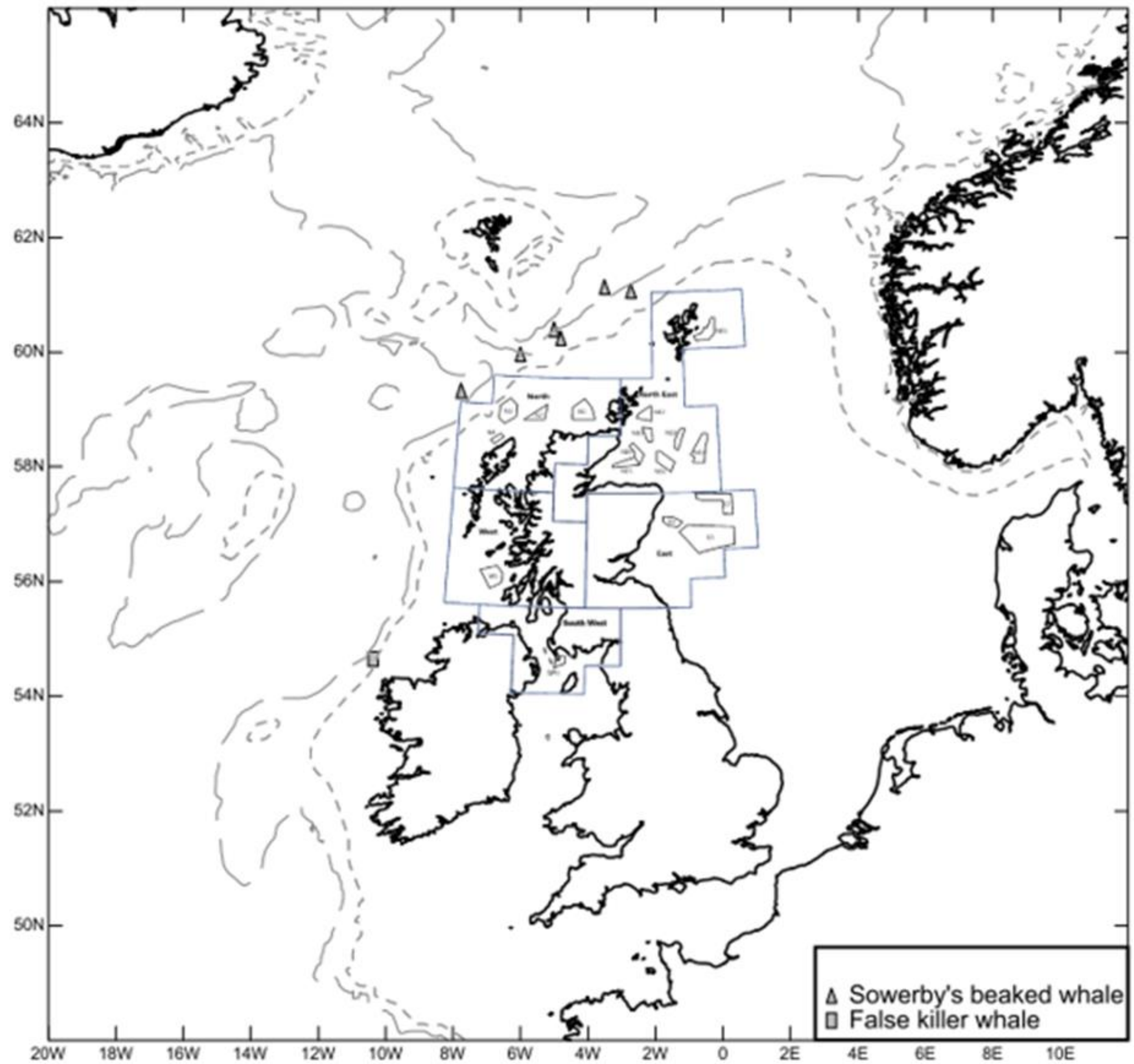


Figure 219: Sowerby's beaked whales (triangles) and false killer whales (squares) encountered during seismic surveys, 1994-2010 (Stone 2015). Short dashed line = 200 m isobath; long dashed line = 1,000 m isobath. Approximate DPO regions and sites are Overlaid for reference.

Land-based Shorewatches sighted Northern bottlenose whales extremely rarely, with sightings reported off Tiumpan Head on the Isle of Lewis, and on the southern outer edge of the Firth of Forth coastline (Figure 221). Whilst no sightings overlap DPOs sites, coastal sightings may be useful when determining cable landfall locations.

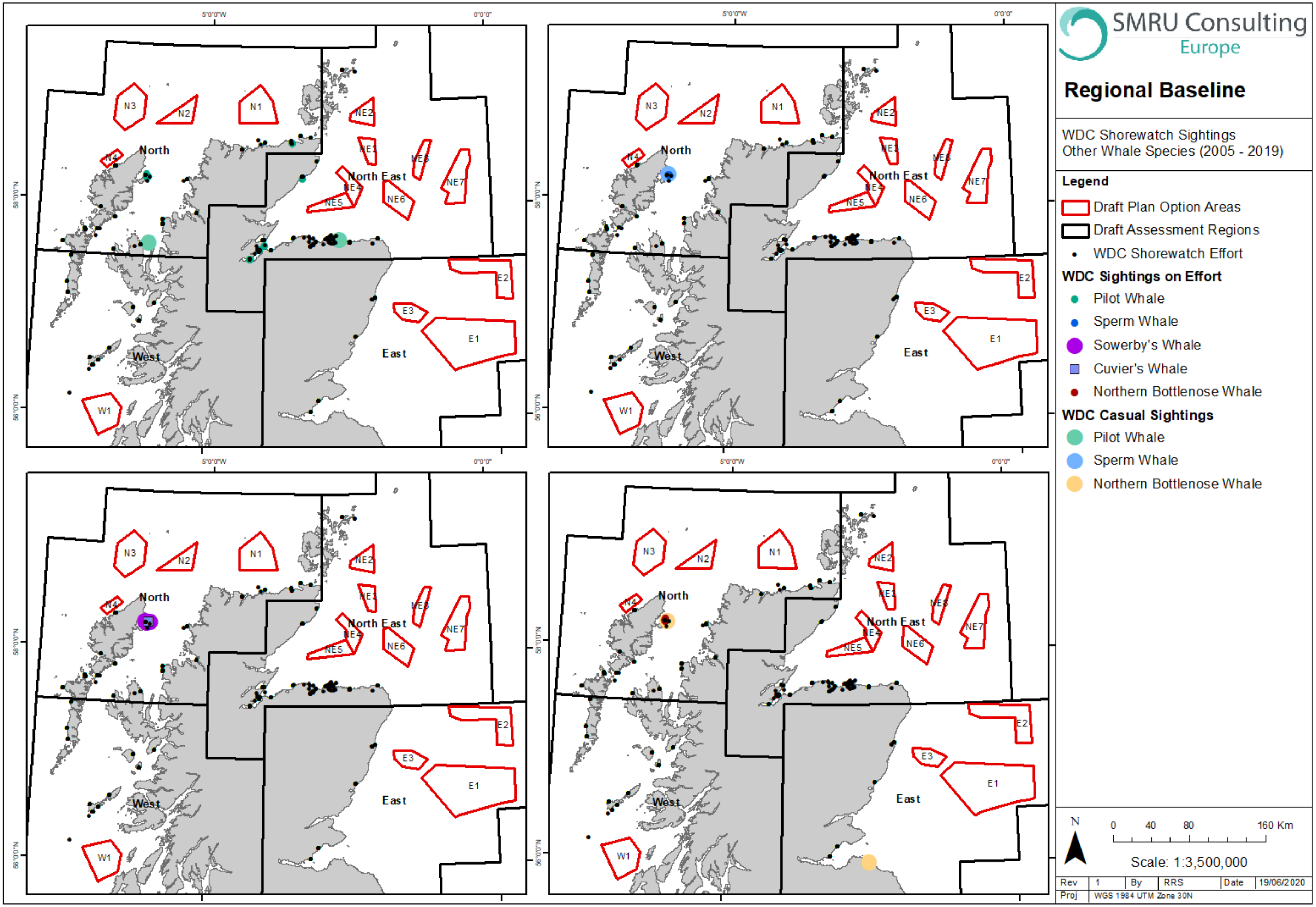


Figure 220: Sightings of long-finned pilot whale, sperm whale, Sowerby's beaked whale, Cuvier's beaked whale and northern bottlenose whale recorded by WDC Shorewatch between 2005 and 2019. Data provided free of charge by WDC.

There was only one reported sighting of a Cuvier's beaked whale sighted around the Pentland Firth and Orkney Isles between 1980 and 2010 presented by Evans et al. (2011) (Figure 222).

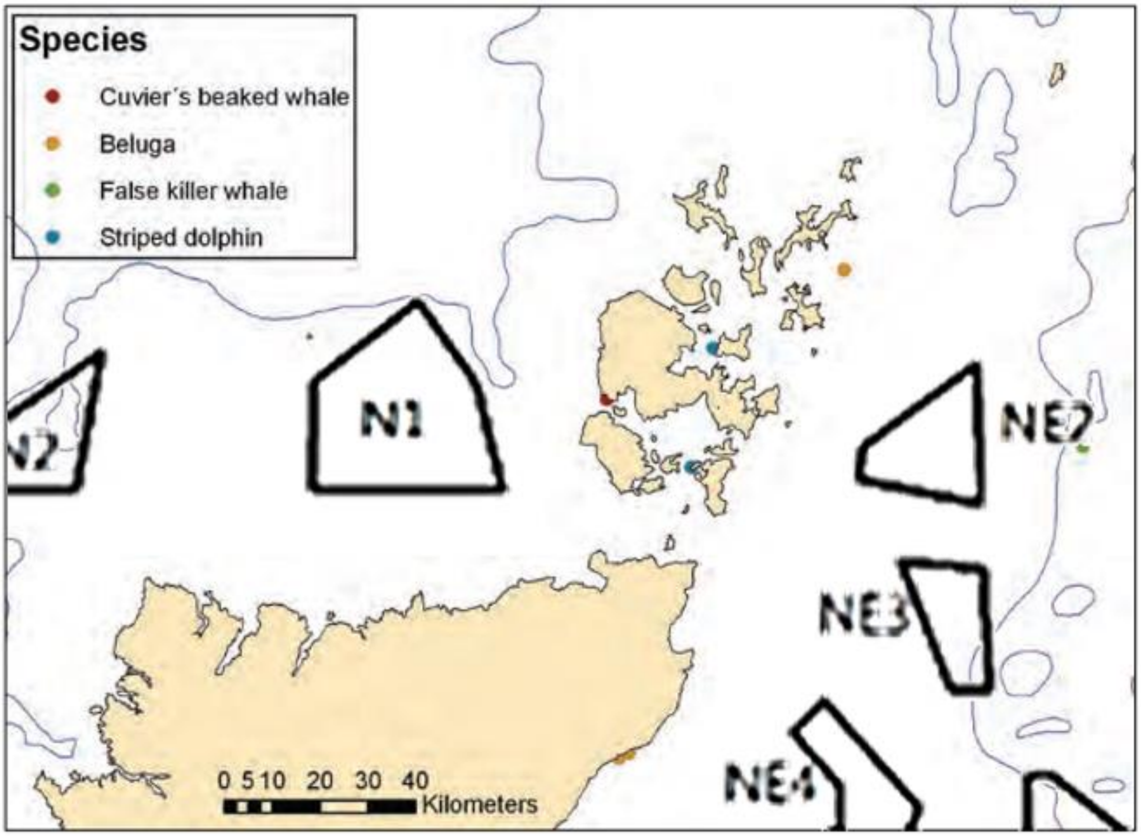


Figure 221: Distribution of sightings of rarer odontocete species around northern mainland Scotland, the Pentland Firth, Orkney and Fair Isles between 1980 and 2010. Cuvier's beaked whale sightings are indicated by red circles (Evans et al. 2011). Overlaid for reference are the approximate regional and DPO areas.

3.4

3.5 DPO species summary

As supplementary material to this report, we have provided an Excel document that details all density estimates within each DPO site for each species. This is also available in Appendix 5: Supplementary Material – Density Estimates. Table 9 provides a high-level summary of this document, indicating which species are expected to be present in each DPO area, and whether they are expected to be present year-round, seasonal visitors or rare.

In order to produce the Supplementary Material, for each survey that provided density estimates, we created a shapefile of the data and then intersected each shapefile by DPO region and site to provide a density estimate for each species for that DPO region and site.

Table 9

Marine mammal species sighting within DPO sites and regions, with relative frequency of sightings estimated

	Marine mammal species sighted within the DPO sites			Sighted in region but not within DPO site
DPO	**Present year-round**	**Seasonal**	**Rare**	
SW1	Harbour seal Grey seal Harbour porpoise			Bottlenose dolphin Risso's dolphin White-beaked dolphin Minke whale Short-beaked common dolphin Atlantic white-sided dolphin Long-finned pilot whale Killer whale
W1	Harbour seal Grey seal Harbour porpoise Risso's dolphin White-beaked dolphin	Minke whale		Bottlenose dolphin Short-beaked common dolphin Atlantic white-sided dolphin Long-finned pilot whale Killer whale
N1	Grey seal Harbour porpoise White-beaked dolphin	Risso's dolphin Minke whale	Harbour seal Bottlenose dolphin Short-beaked common dolphin	Atlantic white-sided dolphin Long-finned pilot whale Killer whale Humpback whale Sperm whale Fin whale Beaked whale spp.
N2	Grey seal Harbour porpoise White-beaked dolphin	Risso's dolphin Short-beaked common dolphin Minke whale	Harbour seal Bottlenose dolphin	Atlantic white-sided dolphin Long-finned pilot whale Killer whale

				Humpback whale Sperm whale Fin whale Beaked whale spp.
N3	Grey seal Harbour porpoise White-beaked dolphin	Risso's dolphin Short-beaked common dolphin Minke whale	Harbour seal Bottlenose dolphin Long-finned pilot whale Atlantic white-sided dolphin	Long-finned pilot whale Killer whale Humpback whale Sperm whale Fin whale Beaked whale spp.
N4	Grey seal Harbour porpoise White-beaked dolphin Killer whale Harbour seal	Risso's dolphin Minke whale Short-beaked common dolphin	Bottlenose dolphin Atlantic white-sided dolphin	Long-finned pilot whale Killer whale Humpback whale Fin whale Beaked whale spp.
NE1	Harbour seal Grey seal Harbour porpoise White-beaked dolphin	Minke whale		Bottlenose dolphin Atlantic white-sided dolphin Long-finned pilot whale Killer whale Humpback whale Fin whale Short-beaked common dolphin
NE2	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Bottlenose dolphin	Atlantic white-sided dolphin Long-finned pilot whale Killer whale Humpback whale Fin whale Short-beaked common dolphin
NE3	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Bottlenose dolphin Short-beaked common dolphin	Atlantic white-sided dolphin Long-finned pilot whale Killer whale Humpback whale Fin whale
NE4	Harbour seal Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Long-finned pilot whale Fin whale Atlantic white-sided dolphin	Bottlenose dolphin Long-finned pilot whale Killer whale Humpback whale Short-beaked common dolphin
NE5	Harbour seal Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Long-finned pilot whale Fin whale Bottlenose dolphin Killer whale	Atlantic white-sided dolphin Long-finned pilot whale Humpback whale Fin whale Short-beaked common dolphin
NE6	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Bottlenose dolphin Short-beaked common dolphin	Atlantic white-sided dolphin Long-finned pilot whale Killer whale Humpback whale Fin whale
NE7	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Atlantic white-sided dolphin	Bottlenose dolphin Long-finned pilot whale Killer whale Humpback whale

			Short-beaked common dolphin	Fin whale
NE8	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Short-beaked common dolphin	Bottlenose dolphin Long-finned pilot whale Killer whale Humpback whale Fin whale
E1	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Atlantic white-sided dolphin	Bottlenose dolphin Humpback whale
E2	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Atlantic white-sided dolphin	Bottlenose dolphin Humpback whale
E3	Grey seal Harbour porpoise White-beaked dolphin	Minke whale	Harbour seal Atlantic white-sided dolphin Sowerby's beaked whale	Bottlenose dolphin Humpback whale

4. Vital rates

In March 2020, SMRU Consulting conducted a review of the demographic rates for the five main UK marine mammal species included in the iPCoD model: harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal (Sinclair et al. 2020). This review concluded in a set of recommended values for each management unit for each of the five species (Table 10).

For those species not included in Table 10, a brief literature review has been conducted to obtain any data on published demographic rates. A summary for each species is provided in the following sections, with a more thorough overview and data tables provided in Appendix 2: Vital Rates. Please note, this was not an exhaustive search.

Table 10

Summary of recommended demographic parameters for the five UK species included in iPCoD (Sinclair et al. 2020).

Species	MU/SMU	Age independent	Age of first birth	Calf/Pup Survival	Juvenile Survival	Adult Survival	Fertility	Growth Rate
Harbour Porpoise	North Sea	1	5	0.8455	0.85	0.925	0.34	1.000
Grey Seal	All UK	1	5	0.222	0.94	0.94	0.84	1.010
Harbour seal	Shetland	1	4	0.4	0.78	0.92	0.85	1.000
	Orkney & north coast	1	4	0.24	0.86	0.80	0.90	0.8956
	Moray Firth	1	4	0.4	0.78	0.92	0.85	1.000

	East Coast	1	4	0.4	0.78	0.92	0.85	1.000
	South-west Scotland	1	4	0.4	0.78	0.92	0.85	1.000
	West Scotland - North	1	4	0.397	0.86	0.95	0.9	1.0486
	West Scotland - Central	1	4	0.32	0.86	0.9588	0.9	1.0402
	West Scotland - South	1	4	0.4	0.78	0.92	0.85	1.000
	Western Isles	1	4	0.4	0.78	0.92	0.85	1.000
Minke whale	European waters	1	9	0.70	0.77	0.96	0.91	1.000
Bottlenose dolphin	Coastal East Scotland	3	9	0.925	0.962	0.98	0.24	1.0365

4.1. Harbour seal

There are reasonably good vital rate information available for the different harbour seal MUs. Because the population trajectory varies considerably between harbour seal MUs (see Table 11), there must be differences in underlying vital rates to achieve the observed population trends. There are several sources for vital rate data for harbour seals, some from the UK and others from other populations, however, some of the vital rates presented in the published literature varied greatly between sources, likely reflecting geographical variation in the status of populations. For example, pup survival estimates ranged from 0.12 to 0.96 (Harding et al. 2005, Hastings et al. 2012, Svensson 2012, Hanson et al. 2013, Matthiopoulos et al. 2014). The vital rate data that is best known for UK harbour seals is age at first birth, adult survival and fertility rates due to the available data obtained from long-term individual based studies (Cordes and Thompson 2014, Graham et al. 2017). Ongoing studies such as the harbour seal decline project are continuing to collate individual based data and as such will further update the vital rate data that is available (e.g. Arso Civil et al. 2018b).

Table 11

Trends in harbour seal counts by management unit as described in Thompson et al. (2019).

SMU	Trend	Notes
East Scotland	stable	Counts in Firth of Tay & Eden Estuary SAC declined 18.6% p.a. between 2002-2017
Moray Firth	stable	Trends fitted to data between Loch Fleet and Findhorn. Decline of 5.6% p.a. between 1994-2000, decline of 28% between 2000-2003 and stable since.
North Coast & Orkney	declining	Decline of 46% between 2001-2006. Between 2006-2015 continued decline of 10.41% p.a.
Shetland	stable	Decline of 40% between 2001-2005, stable between 2006-2016
Western Isles	stable	Stable between 1992 and 2017
Southwest Scotland	stable	Stable between 1989 and 2015
West Scotland	North: increasing Central: increasing South: stable	North: increase by 4.86% p.a. between 1991-2017 Central: increase by 4.02% p.a. between 1989-2014 South: stable between 1990 and 2014

4.2. Grey seal

For grey seals, historical individual based monitoring studies are no longer being carried out (e.g. studies on North Rona and the Isle of May) (e.g. Pomeroy et al. 1999) and as such there is a lack of recent empirical vital rate data for grey seals in UK waters. Therefore best estimates of the vital rate data are available from the grey seal population modelling work conducted for SCOS reporting purposes (see SCOS 2019, Thomas et al. 2019).

4.3. Harbour porpoise

There are some estimates for harbour porpoise demographic parameters (e.g. Winship et al. 2008, Murphy et al. 2015). Winship et al. (2008) estimated calf/juvenile survival rates (0.85), adult survival rates (0.925), age at maturity (four years) and maximum birth rates (0.28-0.35) that were compatible with data from by-caught animals and survey data. Murphy et al. (2015) used data from stranded and by-caught porpoise obtained from UK waters between 1990 and 2012 (n=329, F=127) to estimate pregnancy rates and found that the pregnancy rate across all stranded females was 34% and the age at sexual maturity was 4.73 years (50% and 4.92 years for those stranded in “healthy” condition). These pregnancy rate estimates were considerably lower than those estimated in other North Atlantic studies (Read and Hohn 1995, Ólafsdóttir et al. 2003) which suggested that the UK harbour porpoise population had experienced reproductive failure, likely due to exposure to PCBs (polychlorinated biphenyls).

4.4. Bottlenose dolphins

There are good estimates of demographic parameters for the coastal East Scotland bottlenose dolphin population, including population specific calf, juvenile and adult survival rates and birth rates (e.g. Quick et al. 2014, Arso Civil et al. 2017, Robinson et al. 2017, Arso Civil et al. 2018a, Cheney et al. 2018, Cheney et al. 2019). These estimates are currently being updated using additional data collected between 2017-2019 and will be reported in early 2021 (P. Hammond, personal communications). The review conducted by Sinclair et al. (2020) identified that the demographic parameter that is most uncertain is calf survival between birth and age three.

4.5. Risso's dolphin

There are no data available on European Risso's dolphin demographic parameters. Following a literature review, Taylor et al. (2007) estimated an age at reproduction of 11 years, an interbirth interval of 2.4 years, calf survival rate to be 0.798 and adult survival to be 0.95. Chen et al. (2011) compared age at sexual maturity, varying from 8-10 years of age.

4.6. White-beaked dolphin

There are no data available directly on European white-beaked dolphin demographic parameters. Taylor et al. (2007) estimated an age at reproduction of ten years, an interbirth interval of 2.5 years, calf survival rate to be 0.798 and adult survival to be 0.95.

4.7. Minke whale

There are still very little data available on European minke whale demographic parameters. Hauksson et al. (2011) estimated that 92.2% mature females were reproductively active, age at first breeding of 8-10 years based on samples from the Icelandic whaling industry. Taylor et al. (2007) estimated calf, juvenile and adult survival rates (0.806, 0.96, 0.96 respectively) as well as age at first birth (eight years) based on life history parameters for southern right whales, humpback whales and bottlenose dolphins.

4.8. Short-beaked common dolphin

Winship and Hammond (2009) developed a model for common dolphins to estimate the impact of bycatch. The model used the following demographic parameter values: age at which 50% of animals are sexually mature of 8.23 years, age-specific natural annual survival rate of <1 to be 0.8, age 26 years 0.92, age 30 years 0.72 and a maximum birth rate of 0.18 or 0.25. Taylor et al. (2007) estimated age at first reproduction to be nine years, an interbirth interval of 2.1 years, a calf survival rate of 0.798 years and an adult survival rate of 0.950.

4.9. Atlantic white-sided dolphin

Cipriano (2009) estimated age at sexual maturity of Atlantic white-sided dolphins do be 6-12 years, with a gestation period of 12 months. Taylor et al. (2007) estimated age at first reproduction to be ten years, interbirth interval to be 2.5 years, calf survival to be 0.798 and adult survival to be 0.95.

4.10. Long-finned pilot whale

Perhaps most geographically relevant to Scottish waters, Bloch (1993) predicted calf survival of Faroe Island long-finned pilot whales to be 0.62. Within the Strait of Gibraltar, Verborgh et al. (2009) predicted adult survival to be 0.982, although more recent adult survival estimates were much lower (2006-2007=0.779, 2010-2011=0.754), with an interbirth interval of 4.5 years (Verborgh 2015). For the same geographic region, Gauffier et al. (2013) predicted calf survival rate of 0.629 and juvenile survival rate of 0.869. In the Alborán Sea, Wierucka et al. (2014) predicted adult survival of 0.919-0.995, though adult survival rate estimates for 1992-2005 (0.919) were much higher than rates estimated for 2006-2008 (0.547). Overall, Taylor et al. (2007) estimated age at first reproduction to be 12 years, an interbirth interval of 3.3 years, a calf survival rate of 0.828 and an adult survival rate of 0.986.

4.11. Killer whale

Demographic parameter estimates for killer whales are more common in the literature than for many other marine mammal species, although there are no estimates for the UK population. The most geographically close population that has estimates available if the northern Norwegian population, for which Kuningas et al. (2014) estimated an adult male survival rate of 0.971, adult female of 0.977 and sub-adult survival rate of 0.768, a calving interval of 3-14 years, and fecundity of 0.197. Other demographic parameter estimates for different killer whale populations are presented in Appendix 2: Vital rates. In general, Taylor et al. (2007) estimated age at first reproduction to be 14 years, interbirth interval of 5.02 years, calf survival of 0.910 and adult survival of 0.990.

4.12. Humpback whale

There are estimates of humpback whale adult survival for the North Atlantic population provided by both Buckland (1990) and Barlow and Clapham (1997), where the former predicts adult survival of 0.951 and the latter estimates adult survival of 0.96. Other demographic parameter estimates for different humpback whale populations are presented in Appendix 2: Vital rates. In general, Taylor et al. (2007) estimated age at first reproduction to be six years, interbirth interval to be 2.36 years, calf survival rate to be 0.76 and adult survival rate to be 0.96.

4.13. Sperm whale

There are no UK or European specific estimate of demographic parameters for sperm whales. At a global scale, calf survival has been estimated to be 0.907 (Chiquet et al. 2013) and 0.828 (Taylor et al. 2007), adult survival rate 0.986 (Taylor et al. 2007) and 0.9777 (Chiquet et al. 2013) age at maturity of nine years (Chiquet et al. 2013) and 12 years (Taylor et al. 2007), interbirth interval of 3-6 years (Chiquet et al. 2013) and 5 years (Taylor et al. 2007) and gestation period of 14-16 months. The natural mortality rate has been estimated at 0.05-0.09 (IWC 1971).

4.14. Fin whale

There are no UK specific estimates of fin whale demographic parameters, though there are some estimates for the Mediterranean and the Gulf of St Lawrence population, as well as general estimates provided by Taylor. For the Mediterranean sub-population, Arrigoni et al. (2011) predicts a calf mortality of 0.774, adult mortality of 0.063-0.022, and a net reproductive rate of 0.73, whereas for the Gulf of St Lawrence sub-population Ramp et al. (2014) predicts an adult survival of 0.955. In general, Taylor et al. (2007) estimated age at first reproduction to be ten years, interbirth interval to be 2.24 years, calf survival to be 0.806 and adult survival to be 0.96.

4.15. Beaked whale spp.

The availability of estimates of demographic parameters of beaked whale species within Scottish waters varies by species, but overall data are sparse.

The best estimates of northern bottlenose whale demographic parameters are provided in relatively old documents based mostly on stranding's or whaling estimates, which estimate gestation duration of 365 days and lactation duration of 365 days (Christensen 1973), minimum age of sexual maturity of 6 years and mean age of sexual maturity of females as 11 years and males 7-11 years, lactation duration of one year and interbirth interval of two years (Benjaminsen and Christensen 1979). In an overall review, Taylor et al. (2007) estimated age at first reproduction as 14 years, an interbirth interval of two years, and calf survival rate to be 0.798 and adult survival rate to be 0.950.

There is a paucity of information on demographic parameters of Sowerby's beaked whale, and so estimates tend to be a 'best estimate' from other species rather than based on evidence from the species itself. In a review, Mead (1984) predicted gestation length as 365 days and lactation duration as 365 days, in agreement with the more recent prediction by New et al. (2013) of a 365 day lactation duration. In an overall review, Taylor et al. (2007) estimated a calf survival rate of 0.798 and an adult survival rate of 0.950.

Of all the beaked whale species covered in this review, Cuvier's beaked whales have the least information on demographic parameter estimates available in the literature, with all estimates based on 'best estimates' rather than evidence-based studies. New et al. (2013) estimated a 365 day lactation duration and 365 day gestation period, whilst Taylor et al. (2007) estimated a calf survival rate of 0.798 and an adult survival rate of 0.950.

5. Discussion

5.1. Data gaps

The review of the abundance and distribution data available on marine mammals presented within this report has highlighted species and areas where there are data gaps or associated uncertainties.

5.1.1. Seals

There are good data for both seal species that can be used to inform strategic level assessments and future licensing plan iterations. Due to the extensive tagging and haulout count effort for both species of seal in Scottish waters, the at-sea usage maps (and upcoming habitat preference maps) are generally well informed by data. The at-sea usage maps (and potentially the upcoming habitat preference maps) are considered to be suitable for characterising seal presence within DPO areas and for use in quantitative impact assessments. The seal-at usage maps (Russell et al. 2017) and the habitat-based density modeling map for the Moray Firth (Bailey 2017) have been used in the quantitative impact assessment for various offshore windfarms in Scottish waters (including Moray West, Seagreen, Neart na Gaoithe and Inch Cape) and as such, are considered to be the best currently available datasets on estimated seal at-sea densities.

One data gap for seals is that the period in which they can be tagged is limited by both the breeding and the moult period. However, there is extensive data collection outwith these periods and therefore this is unlikely to be an issue for characterisation purposes for any of the DPOs or regions of interest.

Appendix 4: Seal Abundance and Distribution highlights DPO areas where there is more uncertainty in the at-sea usage or habitat model estimates. This includes the DPOs N3 (for harbour seals), NE1 (for both species) and SW1 (for harbour seals) due to the smaller levels of telemetry data available in these areas. For quantitative impact assessment in these areas, there may be significant uncertainty and confidence in predictions of usage in these areas may potentially benefit from additional tagging studies focused in these areas (e.g. harbour seal tagging in Shetland or NW Scotland).

5.1.2. Cetaceans

5.1.2.1. Seasonal coverage

One key data gap that is evident in most datasets, is the lack of year-round coverage and therefore a lack of information on seasonal patterns in sightings or density. For example, there is reasonably good coverage of W1 and N4 in the Hebrides by HWDT, however these data are restricted to the summer months (Apr – Oct). Likewise, the SCANS surveys, while providing broad scale data for all DPO regions, is summer only data and is only collected every 11 years.

Many of the datasets that do have good temporal coverage year-round (e.g. ECOMMAS, COMPASS, MarPAMM) are restricted to coastal sites and so do not overlap with DPOs (with the exception of W1).

5.1.2.2. Coastal coverage

Many of the datasets presented in this report do not extend far enough beyond the coastal areas to contain data within the DPO areas (e.g. WDC land-based counts, Aberdeen University and the University of St Andrews coastal bottlenose dolphin surveys, PAM projects such as ECOMMAS, COMPASS and MarPAMM and seal haulout counts). While these datasets may be useful in informing the assessment of potential impacts in coastal waters, such as landfall and vessel activity, they are unsuitable for use in characterising marine mammal presence within the broader offshore region or the DPO areas.

5.1.2.3. Density estimates within DPO areas

Very few of the datasets provide confident, year-round density estimates for the DPOs. Many of the datasets are able to provide insight into the likely species present within each DPO region, however, they are not able to provide the temporal and spatial fine scale density estimates that are the preference for characterisation and for use in impact assessments. Where there are density estimates available for cetaceans within DPOs, these are primarily based on JCP or SCANS data.

JCP dataset

The JCP dataset has been included in several analyses for different objectives such as general distribution maps, persistence maps, to identify potential conservation areas and to identify densities in commercially important areas (e.g. Paxton and Thomas 2010, Paxton et al. 2011, Paxton et al. 2012, Paxton et al. 2014, Heinänen and Skov 2015, Paxton et al. 2016, Waggitt et al. 2020). An in-depth analysis of the JCP dataset has been conducted for minke whales, Risso's dolphins and white-beaked dolphins (Paxton et al. 2014) in order to help inform the designation of MPAs in Scottish waters, however this level of analysis and identification of persistent density estimates has not been conducted for any other species using the JCP dataset.

Paxton et al. (2016) provides density estimates for commercially important areas that at least partially overlap with some of the DPO areas (SW1, W1, N4, N1, NE4 and NE5), however, the density estimates provided are estimates for 2010 and are therefore not necessarily representative of current marine mammal abundance and distribution in each area. Likewise, the associated JCP Phase III Analysis Tool provides estimates only for the summer averaged across 2007-2010, which again, doesn't provide any seasonal information and is now considered to be old data. It may be potentially useful to repeat this type of analysis using future, updated versions of the JCP dataset to provide more up-to-date density estimates for the current DPOs. However, it is difficult to envisage an analysis that would not suffer from the same limitations. For example, the authors of the JCP Phase III density estimates explicitly stated that they should be considered indicative and should not be used for fine scale estimates due to issues relating to standardising the data (such as corrections for undetected animals and potential biases) from so many different platforms/methodologies and the strong assumptions that had to be made when calculating detection probability.

There is a more recent analysis of data including the JCP dataset by Waggitt et al. (2020), however, there are limitations to the analysis approach used that make the resulting density surfaces unsuitable for characterising marine mammal presence or for use in quantitative impact assessments. For example, the model used summarised and averaged distribution over a very large timeframe (1980-2018) and therefore does not account for any change in species distribution within that period. This means that the density surfaces are not likely to be representative of current conditions for certain species. For example, there is evidence from the SCANS surveys that harbour porpoise distribution in the North Sea changed significantly between 1994 and 2005 with a southwards shift in distribution which has not been taken into consideration in the outputs of Waggitt et al. (2020).

SCANS dataset

The SCANS surveys are large-scale surveys that are specifically designed to provide comprehensive estimate of abundance for marine mammals in European Atlantic waters. They are specifically designed to provide equal coverage probability within survey blocks such that each point within a block has the same probability of being surveyed. This allows for an unbiased abundance estimation when extrapolating sample density to block-wide density estimates (Hammond et al. 2017). The main limitation of the SCANS dataset is that the surveys are conducted in the summer only and therefore, while they provide good and reliable density estimates for the summer, they are not representative for other times of the year. Some species, such as minke whales, are only seasonally present in Scottish waters and, therefore, there is the potential to overestimate their average presence levels if only summer densities are used. It should be noted that the authors of the SCANS density surfaces have maintained the position that the modelled density surfaces are not appropriate for use in quantitative impact assessment over small scales, and that they consider the block-wide design based estimates to be the most appropriate representations of animal densities for use in impact assessment.

Areas with high levels of data

The DPO areas with some of the best data are NE4 and NE5 in the Moray Firth where there are good quality, recent fine scale density surfaces available for four of the five key species: harbour seals, grey seals, harbour porpoise and bottlenose dolphins (but not minke whale). This is due to the extensive survey effort that has been conducted in the Moray Firth over many years.

Another area that has received extensive survey effort is the east coast of Scotland due to the survey effort that has been conducted for the Forth and Tay offshore windfarm developments. There are fine scale temporal and spatial sightings data for marine mammals in the development areas, however, none of the existing data extends offshore enough to cover the DPO areas. While it is likely that the marine mammal composition would not change significantly between the current development sites and the DPOs, the specific density estimates and fine scale patterns in distribution will likely differ for the more offshore sites.

There has also been extensive coverage of the Hebrides by the HWDT, however, the effort level within DPO sites W1 and N4 low compared (mostly <50 km survey effort per cell) to the Inner Hebrides and areas such as the areas around the Isles of Mull, Skye, Rum, and Coll (where survey effort is mainly >250 km per cell).

5.1.2.4. Effort data

The raw JCP effort data are not publicly available, and as such the level of effort within each DPO included within this dataset is unknown.

Unfortunately at the time of writing, the Crown Estate Scotland data sharing site was not available, and, therefore, this review may not have included all datasets associated with offshore developments that would otherwise have been available through this site. Where possible, we have included data from the larger offshore development projects that we were aware of and where data were available in associated Environmental Impact Assessments (EIAs). For example, there was a lack of recent data available online for the EMEC surveys, however in this instance this will not have impacted greatly on the review, given that none of the DPOs are located in close proximity to the EMEC sites.

5.1.1. DPO data gaps

Table 12

Summary table of data gaps associated with marine mammal abundance and distribution data coverage within DPOs areas in Scottish waters

DPO Region	Data Gaps
South West	Overall this region and site are not well characterised. The data within this DPO and the surrounding areas are predominantly summer density estimates for cetaceans (e.g. SCANS).
West	In general, there are good data for the Hebrides as a region, but a low proportion of the effort is within DPO site W1. Site W1 is on the boundary of the harbour porpoise SAC and pMPA for minke whales, indicating this could be very close to an important area for both species. However, the aerial data used to explore minke whale abundance and distribution within the pMPA gained little sightings data and highlighted that aerial surveys are not an effective technique for minke whale data collection (Webb et al. 2018).

North	In general, not well characterised. These sites have only been covered by large-scale strategic surveys which only occur in the summer months (e.g. SCANS).
North East	Moray Firth (NE4 and NE5): There are good density surfaces available for harbour porpoise, bottlenose dolphins, harbour seal and grey seal. However a density surface for minke whales is lacking – there is a density surface for "observed adjusted densities" for minke whales in Paxton et al. (2014), however this is averaged across seasons and since minke whales are primarily present in the summer months, this is not necessarily appropriate. NE1: The DPO site NE1, to the east of Shetland, does not have the same density surfaces available as other sites within the North East region. In comparison, it is less well characterised. There is little tag data on harbour seal at-sea usage around Shetland, so it is uncertain the overlap of use with this DPO site.
East	There are good data for the region from Firth and Tay offshore windfarm surveys which provide good and consistent information on the key species present: harbour porpoise, minke whale, white-beaked dolphin, grey seal and harbour seal. However these surveys do not extend far enough offshore to provide reliable density estimates for the specific DPOs.

5.1.4. Marine mammal species data summary and gaps

Table 13

Summary table of data gaps associated with the abundance and distribution of marine mammals in Scottish waters

Species	Data Summary and Gaps
Harbour seal	• Lack telemetry data during the moult period as tags are shed. • No agreed MUs provided by the IAMMWG.
Grey seal	• Lack telemetry data during the moult period as tags are shed. • No agreed MUs provided by the IAMMWG.
Harbour porpoise	• There are good data from various sources confirming year-round presence in Scottish waters. • There is a lack of understanding of porpoise movement and range and as such it is unknown if there are vulnerable sub-populations that need to be considered in impact assessments. This would benefit from tagging studies conducted in Scottish waters, similar to those conducted by Aarhus University and in studies such as Johnston et al. (2005), Sveegaard et al. (2011), Teilmann et al. (2013) and Nielsen et al. (2018) etc.
Bottlenose dolphin	• There are almost no data available on the offshore ecotype, other than what is presented in the Waggitt et al. (2020) maps using the JCP data and sightings from the SCANS surveys. • The data available for bottlenose dolphins is almost exclusively from land-based and coastal surveys of the SAC population.
Risso's dolphin	• Monthly and relative abundance estimates are available (Reid et al. 2003) however the data used is now very old (1979-1997). • JCP database analyses predict the density and persistence in specific areas and have been used to inform designation of protected areas. • IAMMWG provide a MU boundary but no population estimate. • Lack vital rate data or information on population trends.
White-beaked dolphin	• Monthly and relative abundance estimates are available (Reid et al. 2003) however the data used is now old (1979-1997).

	• The SCANS III survey (Hammond et al. 2017) identified relatively high densities in the North and East regions, however this is summer only data. The East region benefits from additional data from the Forth and Tay developments which have found that while white-beaked dolphins are recorded year-round, they are present in higher numbers in the summer months. Additional seasonal surveys in the North region may enhance the data for the North DPOs. • There are ongoing discussions regarding the suitability of the current MU size for white-beaked dolphins (the Celtic and Greater North Sea). • Lack of vital rate data or information on population trends.
Minke whale	• Monthly and relative abundance estimates are available (May-Nov) (Reid et al. 2003) however the data used is now very old (1979-1997). • JCP based analyses predicting density and persistence in specific areas to inform designation of protected areas. • There are ongoing discussions regarding the suitability of the current MU size for minke whales (the Celtic and Greater North Sea).
Short-beaked common dolphin	• There are ongoing discussions regarding the suitability of the current MU size for short-beaked common dolphins (the Celtic and Greater North Sea). • Lack of vital rate data or information on population trends.
Atlantic white-sided dolphin	• There are ongoing discussions regarding the suitability of the current MU size for Atlantic white-sided dolphins (the Celtic and Greater North Sea). • Lack of vital rate data or information on population trends.
Long-finned pilot whale	• No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.
Killer whale	• No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.
Humpback whale	• No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.
Sperm whale	• Several data sources confirm that sperm whales are primarily encountered in deeper waters further offshore, and as such are not considered to be an important species within the DPO areas and regions. • No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.
Fin whale	• Data sources confirm that fin whales are primarily encountered in deeper waters further offshore, that are not relevant to the DPO areas or regions of interest. While they have been sighted within the Moray Firth, given the survey effort in the region and the low number of sightings they are considered rare in this area. • No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.
Beaked whale species	• Several data sources confirm that beaked whales are primarily encountered in deeper waters further offshore, and as such are not considered to be an important species within the DPO areas and regions. • No defined MU provided by the IAMMWG against which to assess impacts. • Lack of vital rate data or information on population trends.

5.2. Summary of review findings

This review has demonstrated that overall there is a reasonable amount of survey and data coverage across all of the Scottish Northern North Sea region and Scottish Atlantic waters, with parts of the North Sea and the west coast (around the outer and Inner Hebrides) relatively well covered by survey effort and existing data sources. Regionally, the biggest gaps in survey coverage are in the North West and South West parts of the region. Although patchy in both space and time, the level of coverage across the whole region is deemed largely sufficient to be able to identify the likely species in each region/DPO, but there may be a number of gaps (discussed in detail in the previous section) in our ability to determine the likely spatial and temporal variation in abundance of many species. As expected, the more common species are better covered than rarer species in this respect. Harbour porpoise, both species of seal and coastal bottlenose dolphins are probably the species with the most reliable information across their ranges. Our understanding of minke whales and Risso's dolphins has benefited from bespoke analyses to assist in the identification of potential protected areas, but the data these are based on are now well over ten years old. Many of the other cetacean species are not as well characterised but this is because they are rarer and would require significant species-specific tailored effort to generate a greater understanding of their occurrence and distribution.

In terms of temporal coverage, as Section 5.2 illustrates, the major limitations are the age of some of the key data sources, the low frequency at which large-scale systematic surveys are repeated (e.g. SCANS every ~11 years) and the limited amount of coverage outside of the summer period for cetacean surveys and at specific times for seals. This provides obvious limitations in terms of our ability to understand the abundance and distribution of marine mammals during particular times of year. The age of data is an important factor and although it is difficult to apply a threshold to determine what is 'too old' to be useful, clearly confidence in the ability of a dataset to characterise an area declines with the age of a dataset. Given the uncertain timeline for the award of leases, the time required to development consent applications and the length of the determination period, by the time project construction is underway many of the datasets considered recent here will be several years older. As detailed in Appendix 4: Seal Abundance and Distribution, assumptions of temporal stability in distribution are unlikely to hold over long periods of time for seals, especially given marked trends in abundance regionally. Large-scale shifts in distribution have been observed in harbour porpoise regional density as a result of the regular SCANS surveys and therefore reliance on older data will bring increased uncertainty.

5.2.1. Availability of data

Not all surveys that cover the abundance and distribution of marine mammals in Scottish waters are readily available through literature searches. This may be due to their small scale, small sample size, lack of financial resources to publish or make data available, or the challenge of making data publicly available (Kaschner et al. 2012). Also, not all survey data are available to be used commercially. For example, charities and NGOs may commit significant resources into collecting data, and they subsequently may limit the types of projects for which their data can be used.

5.2.2. Interpretation of data

Care must be taken not to use the outputs of this report to over-estimate the amount of data available for specific areas or species, as the same sightings datasets are included into multiple reports, overviews or analyses (e.g. JCP and MERP), though we have attempted to highlight sources that present the same data sources. However, lack of clarity on the temporal, spatial and geographical of each dataset used in data collation has limited our understanding of overlap.

The data and any associated shapefiles presented in this report and the appendices are not directly comparable, for several reasons. Some surveys are skewed with a taxonomic focus or may have been limited financially, by methodological scope or by the training level of observers which may affect species identification and group size estimate accuracy. For example, acoustic detection and visual sightings are not directly comparable. Surveys may also differ by their intra-annual and inter-annual temporal coverage. Nevertheless, the collation of all available data presented in this report provides a good overview of the existing knowledge on the species present, and their distribution, within Scottish waters.

5.2.3. Other potential sources of data on abundance and distribution in marine mammals

This report presents information collated from a literature review of available data and information on abundance and distribution of marine mammals in Scottish waters. It is not an exhaustive list. Other potential data sources include the Marine Conservation Society, National Biodiversity Network, casual ferry sightings e.g. John O'Groats Ferry, North Ronaldsay Bird Observatory records, Shetland Amenity Trust, Orkney Biodiversity Records database, Scottish Power Argyll Array Survey (off Islay in 2009 and 2010), Fair Isle Bird Observatory records, Cetacean Strandings Investigation Programme (CSIP), Marine Mammal Observer (MMO) records from any offshore surveillance activities, and observations made by contractors for Renewable Energy Developers not presented above at renewables test sites. Some sources either declined or did not respond to our requests to share data for the purposes of this project (CRRU, Sea Watch Foundation, Clyde Porpoise).

5.3. Recommendations

5.3.1. Recommendations for seals

For harbour seals, there are clear gaps in the telemetry data that have led to low or very low levels of certainty in the at-sea usage and habitat preference maps in certain areas. The low confidence areas include NE1 off Shetland, N3 in Northwest Scotland and SW1 in Southwest Scotland. Therefore, it is recommended that additional tagging work is considered for these targeted areas to better characterise the at-sea usage estimates for these specific DPOs. Given their current conservation status assessment as 'Unfavourable – Inadequate', it is likely that harbour seal tagging would be prioritised over any grey seal tagging studies.

The telemetry data for seals is limited by when the seals can be tagged. For grey seals, telemetry data are available between May and August and for harbour seals are available between December and May. The breeding and moult periods limit the ability to tag each species out with these periods. The feasibility of increasing the coverage out with these times is currently unknown, therefore, one option would be to instigate discussions with SMRU to investigate the potential feasibility to tag seals during periods that are not currently covered.

The habitat preference maps for seals are not yet available, and as such have not been used before for the purposes of impact assessment. Once the upcoming seal habitat preference maps are available, there will need to be an assessment of how best to extract, interpret and use the data for the purposes of quantitative impact assessment. In addition, a process to update the seal at-sea usage/habitat preference maps as and when new telemetry and count data become available is required.

5.3.2. Recommendations for cetaceans

Aerial Surveys

Given the paucity of year-round data available, large-scale strategic surveys outside the summer months would be beneficial. Surveys such as the SCANS surveys in each season would provide the level of data required to properly characterise seasonal patterns in marine mammal distribution at the scale required for strategic level planning. That said, there are significant logistical considerations for such surveys. In non-summer months the daylight hours are limited, and weather conditions including sea state could severely limit the length of each survey day and the quality of data collected, especially for cryptic species such as harbour porpoise. Thus, similar coverage in non-summer months would require a larger number of survey days and could therefore drastically increase surveys costs relative to the summer surveys.

Developers have commonly been required to conduct two years of baseline characterisation surveys. However, at the DPO scale this may not be the case and instead the length and frequency of baseline characterisation required should be discussed once development details are known. Baseline characterisation should be tailored to the activity, site and relative risk, and depending on this there may be an additional or reduced requirement for both the type and the scale of baseline surveys. Whilst it is not recommended that significant investment is required to better characterise each DPO site at this stage at a strategic level, there are some DPO regions that may benefit from more regular systematic surveys. Data is lacking for the South West region, much of the North region outside of the Inner Hebrides, as well as the Shetland part of the North East region. Therefore, these specific regions may benefit from a series of systematic surveys that would allow more confidence in our characterisation of these areas. Given the large areas within these regions, aerial surveys would likely be a suitable method.

While there is significant benefit to aerial surveys, there are limitations that need to be considered, especially for digital aerial surveys. One key assumption of distance analysis (to estimate animal density) is violated in aerial surveys: availability bias, where animals are present in the area but are underwater and not available for detection. Manned aerial surveys such as the SCANS surveys can use the ‘circle-back’ or ‘racetrack’ method described in Hiby (1999) where the aircraft circles back after a detection is made in order to re-survey a segment of the transect to correct for animals missed on the transect line. However, this is not current practice in digital aerial surveys, primarily because ornithological considerations have largely driven digital aerial survey design. In order to account for the availability bias in digital aerial surveys, correction factors can be used to scale sighting rates by the proportion of time spent below the surface by each species in order to account for animals underwater at the time of the survey. Unfortunately, there is a lack of regionally appropriate data on the amount of time spent at the surface for most species. Given that this proportion is essentially a scalar on abundance, corrections are very sensitive to the value used. We would recommend that aerial survey-derived estimates include consideration of this sensitivity and present a range of estimates where appropriate. Focused work could be carried out to characterise and define appropriate correction factors for different species.

In addition, digital aerial surveys may not be equally suitable for all marine mammal species. A recent study by HiDef Aerial Surveying Limited (Webb et al. 2018) has highlighted that digital aerial surveys were ineffective for minke whales. The survey was conducted in the Sea of the Hebrides pMPA area in summer months (Aug-Sep) which is an area known to support high numbers of minke whales in the summer season. However, over 3 surveys days that covered a total of 719 km^2, there were only two sightings of minke whales. The authors concluded that the unexpectedly low number of minke whale sightings was likely because minke whales conduct long, deep dives, and so spend little time at the surface, and so are only available for detection at the surface for very short periods in relation to the short detection window available during aerial surveys (due to the speed the surveys are flown at). Therefore, the authors concluded that other survey methods may be more appropriate for minke whales. These results may call into question any density estimate for minke whales (and other larger cetacean species that have similar dive patterns) that has previously been obtained during digital aerial surveys.

PAM surveys

A wider PAM network (beyond that covered by ECOMMAS, COMPASS and MarPAMM) may be beneficial in obtaining fine temporal scale data on vocalising marine mammal species. For example, the DPO site N4 off North Lewis is a coastal site that has received very little effort. This site in particular would benefit considerably from PAM data to enhance understanding of not only the species likely to be present but also the temporal variability in presence.

In addition, a network of PAM devices located further offshore could be extremely beneficial towards better characterising some of the more offshore regions and DPOs, however there are logistical considerations that need to be taken into account. PAM networks in deeper waters may require different mooring systems and increased vessel time to deploy and maintain.

Monitoring devices such as C-PODs are useful to discriminate between porpoise and dolphin detections, but are unable to identify dolphin detections to species level. Palmer et al. (2017) developed a method to categorise dolphin clicks in C-POD data into broadband and frequency banded clicks, which allows for discrimination between groups of species. Broadband recording devices (such as SM2Ms and SoundTraps) are able to provide the raw acoustic data that can be further processed to discriminate between dolphin groups and can support the development of categorisation models for C-POD data, such as those published by Palmer et al. (2017). Likewise, these broadband recorders are able to detect and identify minke whales, as demonstrated by Risch et al. (2019b). Therefore, it is recommended that any additional PAM surveys and wider PAM networks are equipped with broadband recorders so as to obtain better species-level data. However, the additional time and effort required to process and analyse the noise recordings from broadband detectors should not be underestimated.

5.3.3. Recommendations for vital rates

There is a lack of vital rate data for many marine mammal populations. For those that we have good data for (e.g. bottlenose dolphin and harbour seal), this is as a result of long-term photo-ID and individual tracking studies. This is not feasible for many marine mammal species and/or populations, due to their ecology or behaviour of the species (e.g. transient nature, cryptic behaviour), or due to logistical considerations (e.g. difficulties in conducting surveys in high seas). Where long-term individual level studies are not feasible, data can be obtained from other sources. For example, much of our knowledge of harbour porpoise vital rates (age at first maturity, pregnancy rate) are obtained from studies of stranded and bycaught animals. For example, Murphy et al. (2015) used stranded female porpoise necropsy data to examine reproductive status. Such an approach could potentially be implemented for other species, for example, common dolphins and pilot whales, both of which have reasonably high strandings rates in UK waters (860 and 213 reported between January 2011 and December 2017, respectively) (CSIP 2018). In addition, the dataset used in Murphy et al. (2015) is now reasonably old and an updated analysis incorporating more contemporary data could be beneficial. Other data that could be obtained from stranded animals includes estimates of age from growth layers in teeth (e.g. Hohn and Fernandez 1999, Blundell and Pendleton 2008) or earplugs (e.g. Trumble et al. 2013), or from fatty acid concentrations in blubber (e.g. Koopman et al. 2003, Herman et al. 2008).

In addition, there is the possibility of obtaining vital rate information (such as reproductive hormone levels) from remote tissue sampling methods including biopsy darts, or blow and faecal sampling. Such methods have applications for a wide range of marine mammal species as they do not require live capture. There is also the potential to obtain data such as population stage structure (e.g. adult, juvenile) and body condition from photogrammetry studies, however, the images required need to be of high quality. A recent pilot study on the use of porpoise images obtained from baseline digital aerial survey studies found that the image quality and the likelihood of capturing the animal at the correct orientation severely limited this application (Sinclair and Booth 2019). However, surveys that are specifically designed to obtain such images, such as targeted drone surveys (e.g. Christiansen et al. 2016, Christiansen et al. 2019) can potentially be beneficial for various species that are otherwise relatively inaccessible. This could be feasible for species such as minke whale in Scottish waters.

Ongoing research as part of the Scottish Government funded harbour seal decline project (part of the Marine Mammal Scientific Support research programme at SMRU) will continue to update and refine our estimates of harbour seal vital rates, and as such it is not recommended that additional work is required for this species. Likewise, bottlenose dolphin surveys are expected to continue as part of the required SAC site condition monitoring, and thus will continually update and improve our estimates of vital rates for this species.

Individual-based studies of grey seals are not currently being conducted, and thus the contemporary knowledge of vital rates is limited. However, given the results of the annual pupping surveys and August haulout surveys that show the population of grey seals in UK waters is expanding rapidly, this species is not considered a priority.

5.3.4. Recommendations for MUs

While the IAMMWG (2015a) provided MU boundaries for some species (harbour porpoise, bottlenose dolphin, Risso’s dolphin, minke whale, white-beaked dolphin, short-beaked common dolphin and Atlantic white-sided dolphin) there is still no statutory nature conservation body (SNCB) guidance on recommended MUs for other species, including both harbour and grey seals, and various other cetacean species such as pilot whales and killer whales. Even where MUs have been defined, MU-level abundance estimates are either lacking or are out-of-date and thus need revising. JNCC are expected to publish revised abundance estimates for some species later in 2020 (J. Sutherland, personal communications). However, another issue that has been raised in impact assessment work is the fact that some of the MU boundaries are too large to effectively manage potential impacts on populations. For example, the agreed MU for white-beaked dolphins is the entire Celtic and Greater North Sea, and regulators have highlighted that assessing development-specific impacts against such a large population may be inappropriate. However the issue of MU boundaries is still in discussion and any revision of species MU boundaries are not likely to be available until later this year (J Sutherland, personal communications).

Of particular importance is the lack of agreed MUs for grey seals. Given the far-ranging behaviour of grey seals, it is widely acknowledged that the current seal MUs presented in SCOS are too small for grey seals. Thus, for the purposes of assessing impacts on a population, there is a need to address the grey seal MUs. This would ideally involve the use of telemetry data to define units at the appropriate scale to take into account the scale of both breeding and foraging areas and movements between the two. In a recent review of demographic data, Sinclair et al. (2020) suggested that one potential option would be to define grey seal MUs at the scale at which regional pup production models are developed for SCOS (North Sea, Inner Hebrides, Outer Hebrides and Orkney).

5.3.5. Recommendations at a DPO site level

To better characterise DPOs at finer spatial and temporal scales to inform detailed project level assessment, additional survey work is likely to be required in most areas. It is expected that the requirement for baseline surveys and the type and duration of such surveys will depend on the type of development. Recommendations regarding the nature and extent of this work is beyond the scope of this report and will be addressed via the licensing and consenting process.

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If you would like to use any of the datasets presented within this report, please contact the relevant authors for specific permission for your individual purposes.

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JNCC. 2019f. European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1365 - Common seal (*Phoca vitulina*) UNITED KINGDOM.

JNCC. 2019g. European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2029 - Long-finned pilot whale (*Globicephala melas*) UNITED KINGDOM.

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8. Appendix 1: Data Sources

Please see attached document entitled:
19.12.13.MSS - Regional Baseline - Appendix 1 Data Sources.doc

9. Appendix 2: Vital Rates

Please see attached document entitled:
19.12.13.MSS - Regional Baseline - Appendix 2 Vital rates.doc

10. Appendix 3: SCANS surveys

Please see attached document entitled:
19.12.13.MSS - Regional Baseline - Appendix 3 SCANS Surveys.doc

11. Appendix 4: Seal Abundance and Distribution

Please see attached document entitled:
19.12.13.MSS - Regional Baseline - Appendix 4 Seal Abundance and Distribution.doc

12. Appendix 5: Supplementary Material – Density Estimates

Please see attached document entitled:
19.12.13.MSS - Regional Baseline - Appendix 5 Supplementary Material – Density Estimates.doc

Marine Scotland Science
Marine Laboratory
375 Victoria Road
Aberdeen
AB11 9DB

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