MachairWind Offshore Windfarm

Appendix 10.3 Analysis of Hebridean Whale & Dolphin Trust Visual and Passive Acoustic Survey Data

ANALYSIS OF HEBRIDEAN WHALE & DOLPHIN TRUST VISUAL AND PASSIVE ACOUSTIC SURVEY DATA OFF WESTERN SCOTLAND, IN RELATION TO THE MACHAIRWIND OFFSHORE WINDFARM PROJECT

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Acronyms & Abbreviations

AS	Acoustic & Visual Survey Effort
COVID-19	Coronavirus Disease 2019
DPUE	Detection Per Unit Effort
EIA(R)	Environmental Impact Assessment (Report)
GPS	Global Positioning System
GW	Gigawatt
HRA	Habitats Regulations Appraisal
HWDT	Hebridean Whale & Dolphin Trust
JNCC	Joint Nature Conservation Committee
km	Kilometre
MPA	Marine Protected Area
OAA	Option Agreement Area
PAM	Passive Acoustic Monitoring
PCTr / PCEv / PCSi	Porpoise Certain (Train / Event / Single Click)
PLTr / PLEv / PLSi	Porpoise Likely (Train / Event / Single Click)
QGIS	Quantum Geographic Information System
RV	Research Vessel
SAC	Special Area of Conservation
SAMS Enterprise	SAMS Applied Marine Science Enterprise Ltd.
SS	Sea State
WDA	Windfarm Development Area

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Data for this report were provided by Hebridean Whale and Dolphin Trust (HWDT).

1 INTRODUCTION

1.1 Project Background

As one of the primary marine mammal conservation organisations based in western Scotland, Hebridean Whale and Dolphin Trust (HWDT) has been undertaking dedicated surveys for marine mammals and other megafauna species since 2002. These survey data, involving both visual sightings and passive acoustic detections of species vocalisations, have been collected by trained volunteers aboard the HWDT research vessel *Silurian*, and collectively provide an invaluable insight in long-term distribution patterns and species composition of the local cetacean community. Visual sightings data of some cetacean species are also being used to underpin long-term photo-identification catalogues, maintained by HWDT (Hebridean Whale and Dolphin Trust, 2023). The surveys aboard *Silurian* cover the majority of inshore waters along the Scottish west coast, extending into more offshore waters when weather conditions allow (see **Figure 1** below for 2003-2017 survey effort distribution; more recent survey effort distribution has been broadly similar). While these surveys do not necessarily follow a fixed, predetermined route, and spatial distribution of effort varies from year to year, their long history, extensive spatial coverage and high-quality effort-based data collection protocols make them an unparalleled resource when considering presence, distribution, relative abundance and species diversity of (particularly) cetaceans found in inshore waters off western Scotland.

In addition to the dedicated surveys, HWDT runs a long-standing community sightings network, Whale Track, which has provided a means for members of the wider public to record and share observations and photographs of marine mammals and other megafauna species observed in western Scottish waters since 1990. In 2017, the Whale Track programme was relaunched with a smartphone app to allow anyone to submit opportunistic (hereafter 'casual sightings') and effort-based data (hereafter 'excursion') off the west coast of Scotland. In 2022, the programme was expanded to allow users to record land-based watches and enable data collection across Scotland. The programme has continued to grow every year and now has more than 8,000 registered users, who between them submit more than 10,000 sightings records every year. This provides a helpful additional data source through which spatiotemporal variability of occurrence can be studied as well as providing valuable data on both coastal and rarely observed species, which are typically underrepresented in dedicated at-sea survey data.

The MachairWind Offshore Windfarm (hereafter 'the Project') Option Agreement Area (OAA), awarded to ScottishPower Renewables through the ScotWind leasing round in January 2022, covers an area of 754 km^2 which incorporates water depths ranging from 25-112 m. To support the identification of the developable area within the OAA, the Project undertook a preliminary geophysical and environmental site investigation survey campaign in 2023. Analysis of this survey data, other datasets and stakeholder feedback, enabled the identification of a refined and optimised development area referred to as the Windfarm Development Area (WDA). The Project will use fixed-bottom wind turbine foundation technology with an onshore cable connection point near Girvan, South Ayrshire. Once operational, the Project would have a generating capacity of around 2 GW, which is enough electricity to power the equivalent of more than 2 million homes across the United Kingdom. As part of the consenting process, the Project has followed Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA) processes.

Figure 1 Overview of *Silurian* survey effort, 2003-2017 (Hebridean Whale and Dolphin Trust, 2018).

1.2 Document Purpose

The results presented in this report are intended to contribute to the baseline review of marine mammals in the Study Area (see **Chapter 10 Marine Mammals and Leatherback Turtle** of the Environmental Impact Assessment Report (EIAR)), to be published as part of the MachairWind EIA. As such, the marine mammal results included herein will inform the decision of which species are scoped in or out of the assessments in the EIAR.

2 METHODOLOGY

This report aims to provide information on distribution and Detection Per Unit Effort (DPUE) rates for marine mammals (cetaceans and seals) and specific large fish species, observed or collated by HWDT in the vicinity of the WDA as well as the wider Scottish west coast (to provide wider context, due to the highly mobile nature of the species under consideration). Species included in the report are outlined in **Table 1**.

Table 1 Overview of species included in the report.

Species	Scientific name
Harbour porpoise	*Phocoena phocoena*
Short-beaked common dolphin	*Delphinus delphis*
Common bottlenose dolphin	*Tursiops truncatus*
Risso's dolphin	*Grampus griseus*
White-beaked dolphin	*Lagenorhynchus albirostris*
Atlantic white-sided dolphin	*Leucopleurus acutus*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Northern bottlenose whale	*Hyperoodon ampullatus*
Common minke whale	*Balaenoptera acutorostrata*
North Atlantic fin whale	*Balaenoptera physalus*
Sei whale	*Balaenoptera borealis*
Humpback whale	*Megaptera novaeangliae*
Grey seal	*Halichoerus grypus*
Harbour/common seal	*Phoca vitulina*
Basking shark	*Cetorhinus maximus*
Ocean sunfish	*Mola mola*

The report contains a sizeable number of maps, which collectively seek to describe spatiotemporal variability in survey effort, sea state and DPUE rates for all relevant species. The general layout of these maps follows a consistent pattern, which is summarised in **Figure 2** for clarity. All maps were populated by means of a predefined 10x10 km grid covering waters along the west coast of Scotland out to St Kilda in the west, Cape Wrath to the north and Mull of Kintyre to the south (**Figure 2**).

The findings in the report are based on analysis of the following datasets:

- Visual survey data collected from *Silurian* (2018-2024), while also referring to already published data (2003-2017) (Hebridean Whale and Dolphin Trust, 2018) for historical context.
- Passive acoustic survey data collected from *Silurian* using a towed array fitted with two high-frequency elements for the detection of harbour porpoise (2011-2024).
- Citizen science data from HWDT Whale Track (Whale Track — Hebridean Whale & Dolphin Trust) involving marine megafauna observations (2018-2024).

While the focus of the report will be on the WDA, due to these species' wide-ranging movement patterns, and the limited data coverage within the proposed development site, further context across ecologically meaningful spatial scales is required to accurately interpret those observations that exist at the WDA. As such, this report provides analysis of the HWDT visual, acoustic and Whale Track datasets, which cover the entire west coast of Scotland and include the Sea of the Hebrides Marine Protected Area (MPA), set up for conservation of minke whale and basking shark, and the Inner Hebrides and the Minches Special Area of Conservation (SAC), set up for conservation of harbour porpoise. The WDA is adjacent to both these protected sites, highlighting the significance of these waters to different marine megafauna. This analysis will provide crucial context for any patterns in spatiotemporal distribution or DPUE rates that are observed within the WDA.

It is important to note that, due to COVID-19-related restrictions, HWDT data collection efforts in 2020-2021 from *Silurian* focused primarily on acoustic monitoring. Dedicated visual survey effort was conducted wherever possible during this time but was limited and most sightings were recorded opportunistically. Therefore, effort-based visual data were not comparable with other survey years and were not included in the analysis in this report. Effort-based acoustic data collection during this time was also reduced for practical reasons, although overall effort was comparable with earlier years. However, in 2020 the survey season did not begin until August due to restrictions. As one of the aims of this report is to assess seasonality of sightings rates, the 2020 data does not represent the same data collection period as all other years and is not comparable and has therefore been excluded from the analysis. HWDT's standard protocol of dedicated visual and acoustic surveying resumed in March 2022 and has continued to run as normal since then.

Whale Track data continued to be submitted during COVID.

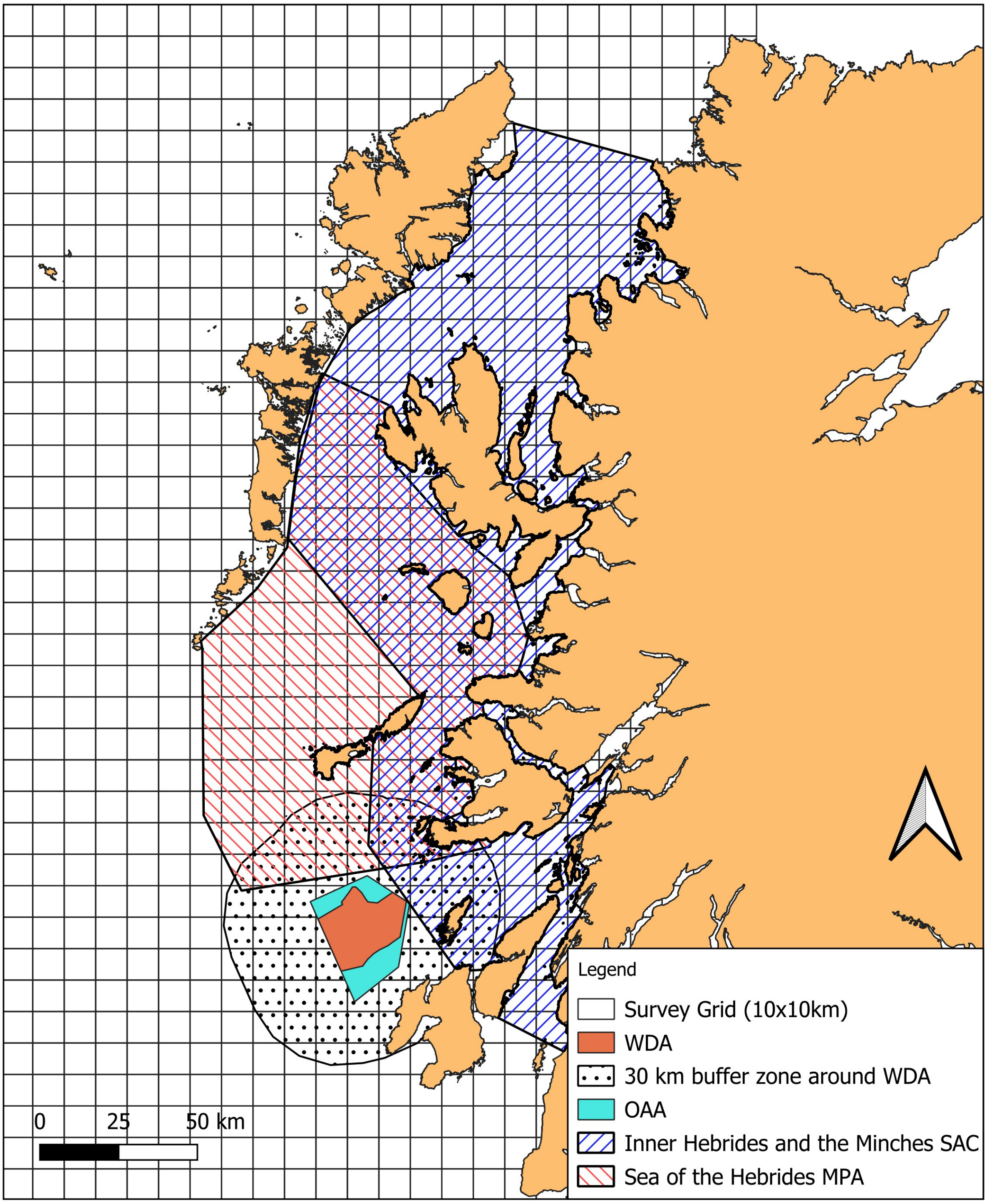


Figure 2 Generic overview of map layouts used throughout this report.

3 VISUAL SURVEY DATA

3.1 Methods

Visual and acoustic data were collected from HWDT's RV *Silurian*, an 18.5m sailing vessel, following standardised data collection protocols (HWDT 2018). All *Silurian* GPS data were checked for potential errors (e.g., points on land) which were removed before proceeding. Similarly, sightings data, based on timestamp data merged with GPS coordinates, were checked for potential errors (duplicates, lack of information on species ID, number of individuals or latitude/longitude data); incomplete records were removed.

GPS tracklines were created based on GPS point data (which had typically been collected at 5-10 second intervals) associated with visual survey effort (either 'S' – for 'Visual effort', or 'AS' – for 'Visual and Acoustic effort' in the raw data), using a bespoke SAMS R script. The following decisions were made at this stage of the analysis:

- Whenever a gap of >15 minutes occurred between consecutive GPS points, a new trackline was created. This greatly reduced the possibility of generating 'phantom transects' (crossing overland between two discrete survey periods, for example).
- Tracklines were subdivided into 5 km segments for higher-resolution analysis. Mean values of sea state were calculated for each segment across all transects; segments without sea state data were removed.

Sighting records were matched to individual tracklines and subsequently exported for analysis. To create maps and explore spatiotemporal distribution of survey effort, sea states and DPUE rates, the data were imported into QGIS (v.3.44.4). Data were aggregated within a 10x10 km grid and Detections per Unit Effort (DPUE) for different species were calculated for each grid cell as number of individuals sighted per kilometre of survey effort. A DPUE value of 1 for a grid cell would mean that on average one individual of a given species was recorded per kilometre surveyed within that cell. This method accounts for variations in survey effort providing a comparable metric to assess relative encounter rates across the study area.

Spatiotemporal distributions and DPUE rates of species were evaluated across a 30 km buffer zone around the WDA, as well as more widely across western Scottish waters to provide regional context. Survey coverage of the 30 km WDA buffer zone was expressed as the proportion of the total number of 10x10 km grid cells that overlapped wholly or in part with the WDA buffer zone (maximum = 73 grid cells). The highest DPUE rates for each species within these grid cells were identified to enable interannual comparisons of species-specific detection rates within the 30 km WDA buffer zone.

3.2 Results

3.2.1 Survey Effort

Based on the data cleaning and analytical pathway described above, a total of 36,117 km of visual survey effort was available for analysis between 2018-2024 (**Figure 3**). This survey effort was distributed fairly evenly across years (7,224 km on average) with the notable exception of 2020 and 2021 due to COVID-19-related restrictions. Due to the impact of these restrictions on survey protocols during these years, these data have therefore been excluded from further analysis.

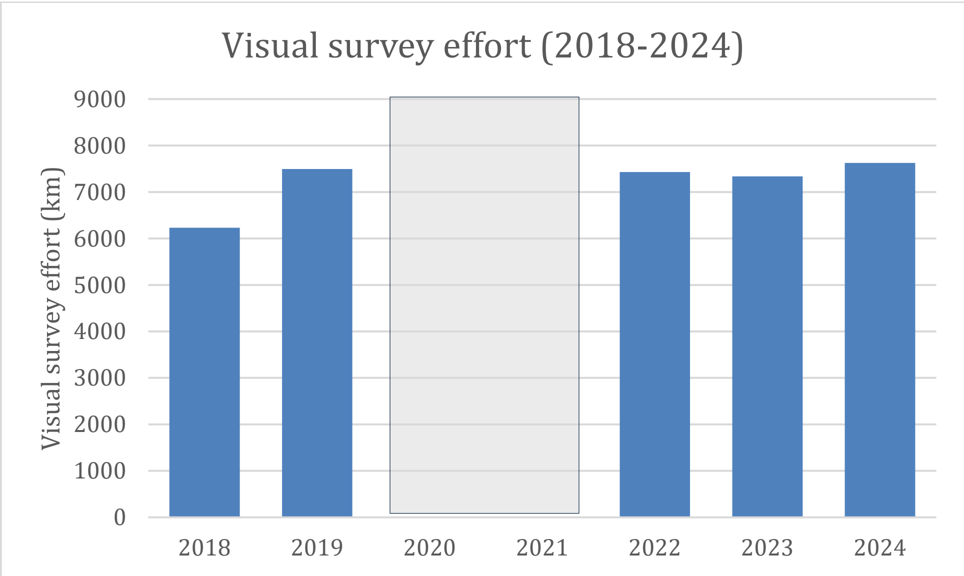


Figure 3 Summary of *Silurian* visual survey effort, 2018-2024. Note that visual survey data from 2020 and 2021 have been excluded (grey box).

Looking at visual survey effort distribution in more detail, it is clear that effort is concentrated in the summer months (May-August; 23,752 km, or 65.7% of total effort) whereas little survey effort is undertaken in winter months, largely due to poor weather and limited daylight hours (November-February; 1,509 km, or 4.2% of total effort; (**Figure 4**). There is limited variability between years in terms of monthly distribution of survey effort (**Figure 5**).

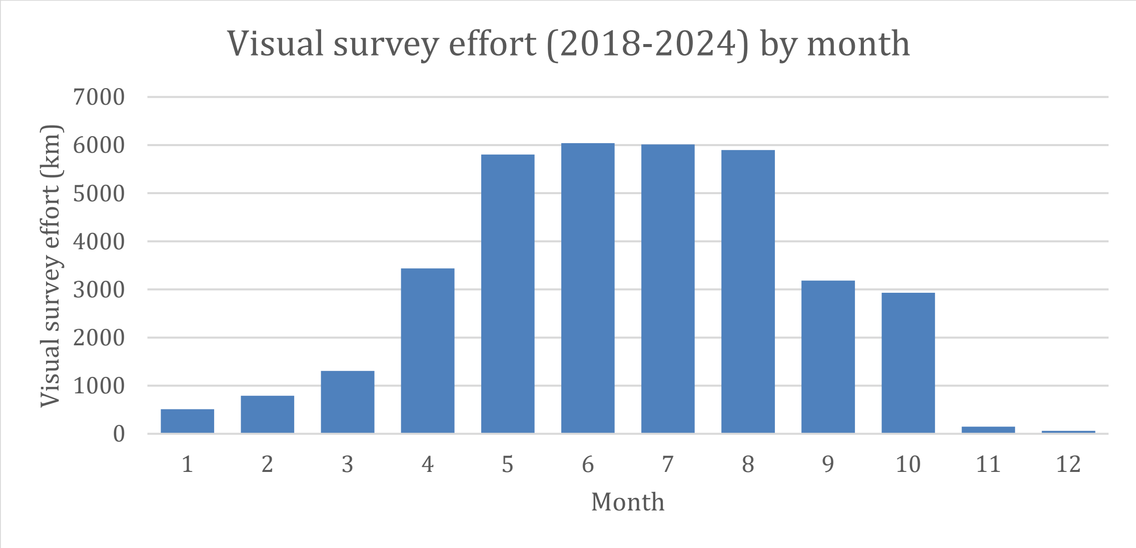


Figure 4 *Silurian* visual survey effort (2018-2024), aggregated by calendar month. Note that visual survey data from 2020 and 2021 have been excluded.

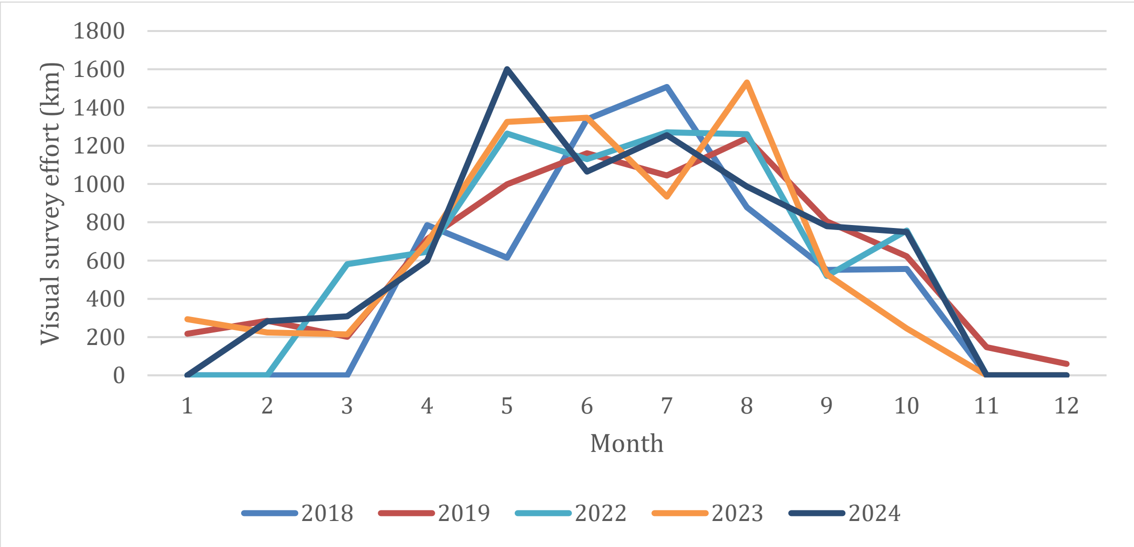
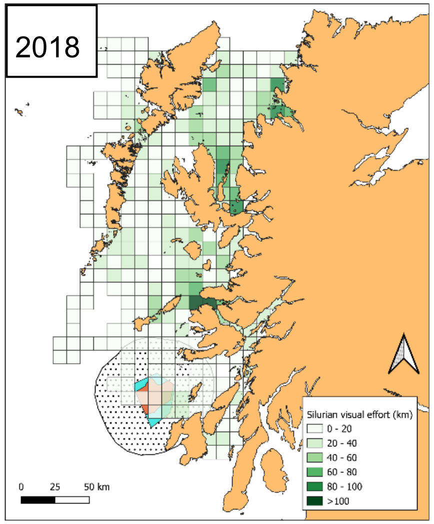
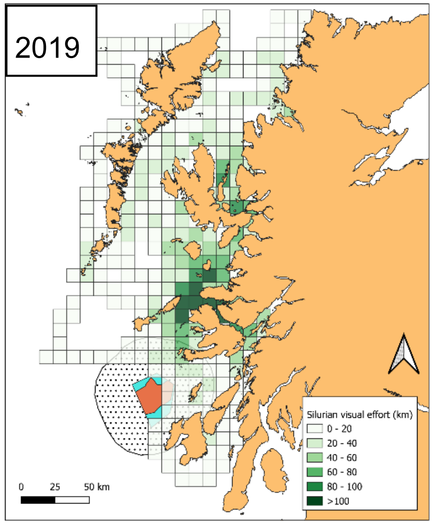
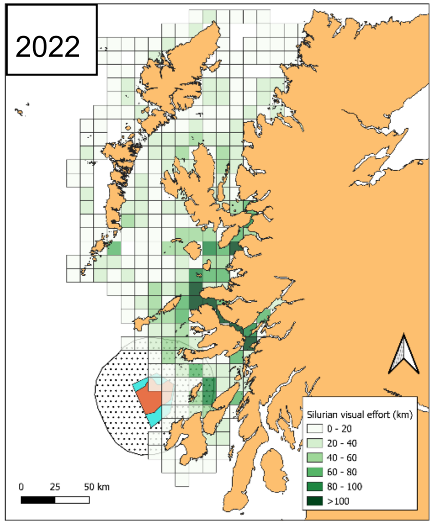


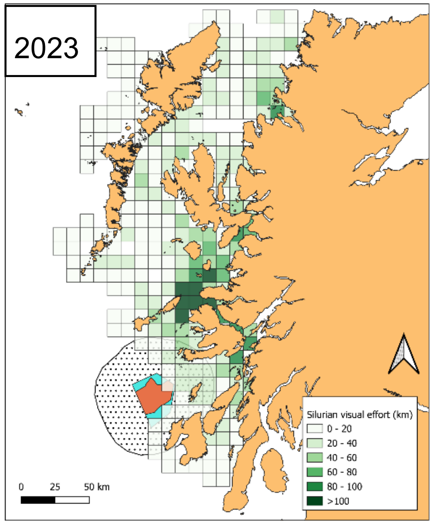
Figure 5 *Silurian* visual survey effort (2018-2019; 2021-2024) by month. Note that visual survey data from 2020 and 2021 have been excluded.

Spatial distribution of survey effort was not uniformly distributed across the survey area and also varied between years (**Figure 6**). Survey coverage was highest throughout the Minch and in areas close to ports used as survey rendezvous locations, most notably Tobermory on the Isle of Mull, where HWDT's headquarters is based, and the harbours of Ullapool and Mallaig. As a result, areas to the north of the Isle of Mull, and up to the Small Isles and Summer Isles, consistently show relatively high levels of survey effort. In contrast, survey effort to the west of the Outer Hebrides was lower due to limited weather windows and suitable sea conditions to survey the area. No survey effort was recorded in this region in 2024 because of persistently poor weather conditions that year.









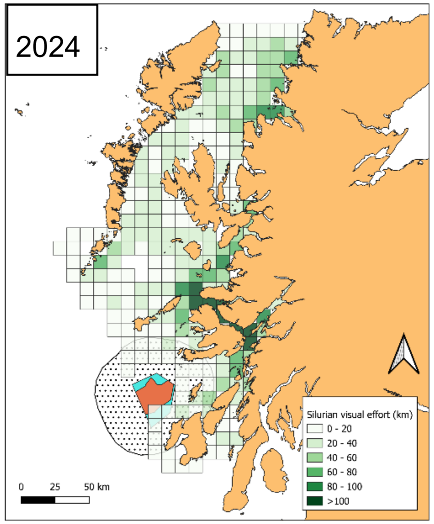


Figure 6 Overview of Silurian visual survey effort distribution (total sum of km surveyed per 10x10 km grid cell) by year (2018-2024), relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited or absent, and results are not included here.

As illustrated in **Figure 2**, the WDA lies at the south-western end of the area typically surveyed visually by HWDT. In any given year, the site might be traversed only once or twice, and some parts of the WDA were not visually surveyed at all during the 2018-2024 period (**Figure 6**). At the same time, many of the species surveyed in this area, and adjacent areas, are highly mobile and are expected to move through or be present in the WDA. With only limited survey effort data available within the 30 km buffer zone around the WDA, and the mobility of the target species, it is therefore important to consider the broader context of marine mammal detections across western Scotland when attempting to make inferences about the potential significance of the WDA to marine mammals and other marine megafauna.

3.2.2 Sea State

Most visual survey effort (32,814 km, or >90%) took place during light or moderate sea states (0-3; **Figure 8**). Ideal surveying conditions (sea state 0, or flat calm seas) were uncommon off the Scottish west coast, with only 1,140 km (3.1%) surveyed under these circumstances during 2018-2024. Sea states >4 were not favoured for surveying for logistical and safety reasons, as well as reducing the likelihood of successful observations in rough seas (316 km, or 0.9% of effort completed during 2018-2024); this is in line with JNCC guidance on visual observations by Marine Mammal Observers, particularly for observing harbour porpoise (JNCC 2023). Unsurprisingly, the best survey conditions generally prevailed during summer months (**Figure 8**).

Excluding 2020-2021, levels of visual monitoring effort across sea states 0-3 were broadly similar across years. A larger amount of visual effort was undertaken in sea state 4 in 2024, compared to 2018, 2019 and 2022. This was primarily due to extensive periods of high winds encountered that year (**Figure 7**).

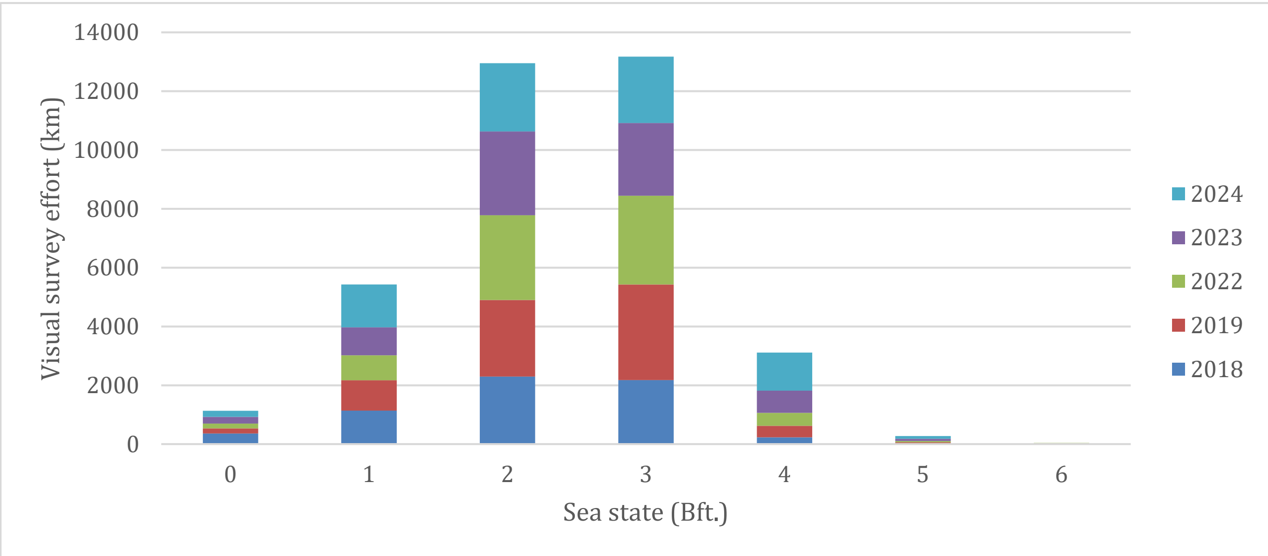


Figure 7 Summary of HWDT visual survey effort, aggregated by year, across sea states 0-6.

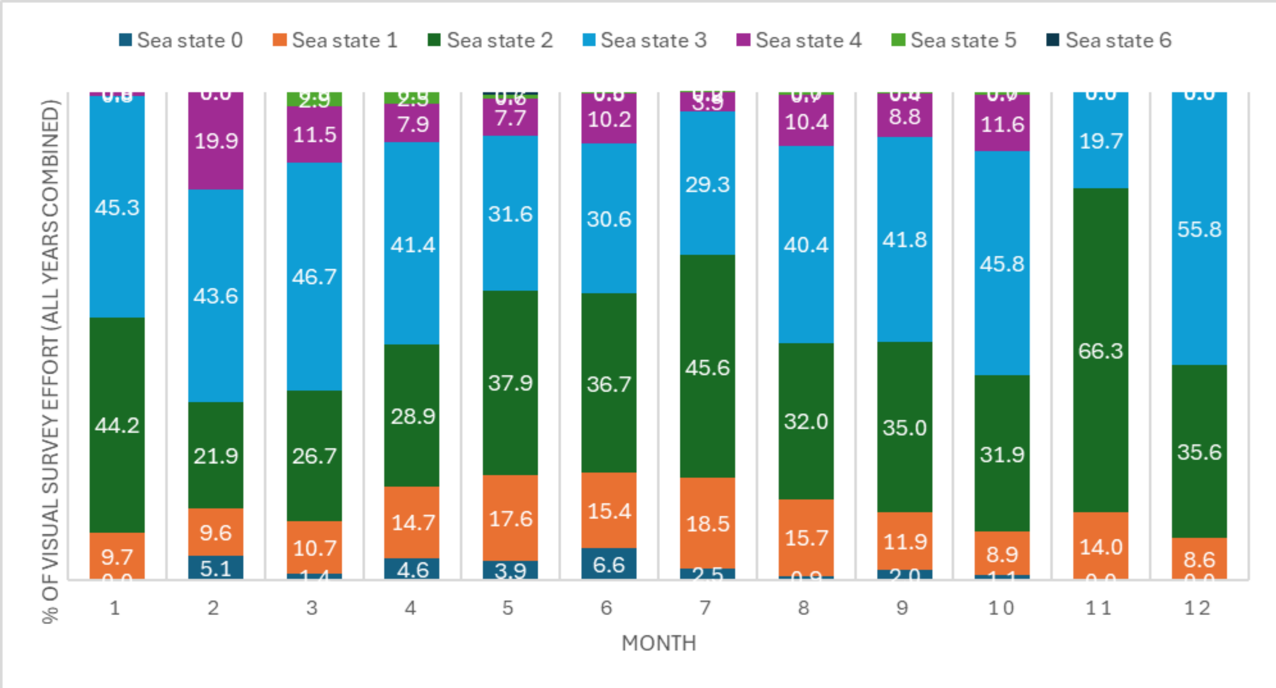
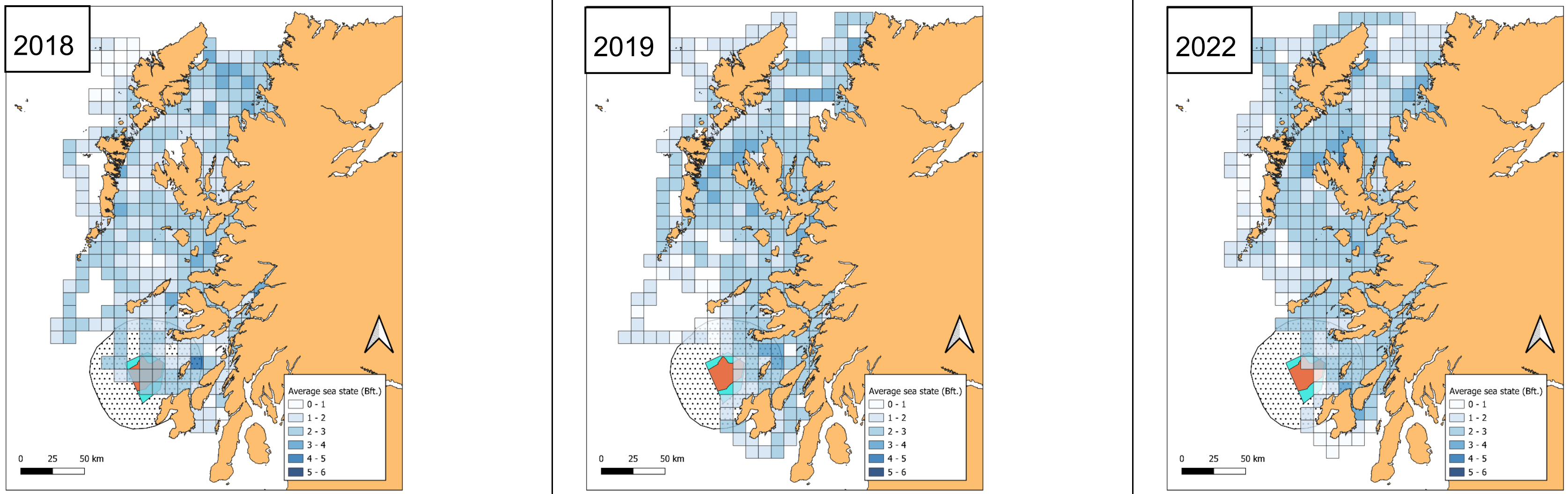


Figure 8 Fraction (%) of visual survey effort by month across different sea states (2018-2024 data combined).

Visual DPUE values, as reported here, are strongly affected by observer bias i.e., the ability of observers to accurately record available animals under prevailing observation conditions. All things being equal, the probability of sighting an individual is highly related to sea state, with detection probability decreasing with increasing sea state. It is therefore important to consider sea state as context for the DPUE values reported here. Annual average sea state conditions throughout the survey area were calculated and combined for each survey year 2018-2024 (**Figure 9**). These data illustrate spatial heterogeneity of annual average sea state conditions, with areas with higher and lower mean sea states varying across years. It is worth noting that some peripheral, exposed areas (e.g., west of the Outer Hebrides, as well as the WDA) tended to only be visited when conditions were favourable, which paradoxically resulted in annual average sea state conditions that were more benign than those calculated for other areas such as the central Minch, which were more frequently surveyed across a wider range of conditions. DPUE rates need to be interpreted in conjunction with interannual effort distribution maps (**Figure 6**) to determine to what degree a reported high (or low) DPUE rate in a given grid cell might be due to genuinely high abundance and/or low effort. Despite this, the use of DPUE rates does account for the variability of effort over the study area to provide a comparable metric for assessing relative density and distribution. However, areas to the edge of the survey area may be subject to boundary and small sample effects.



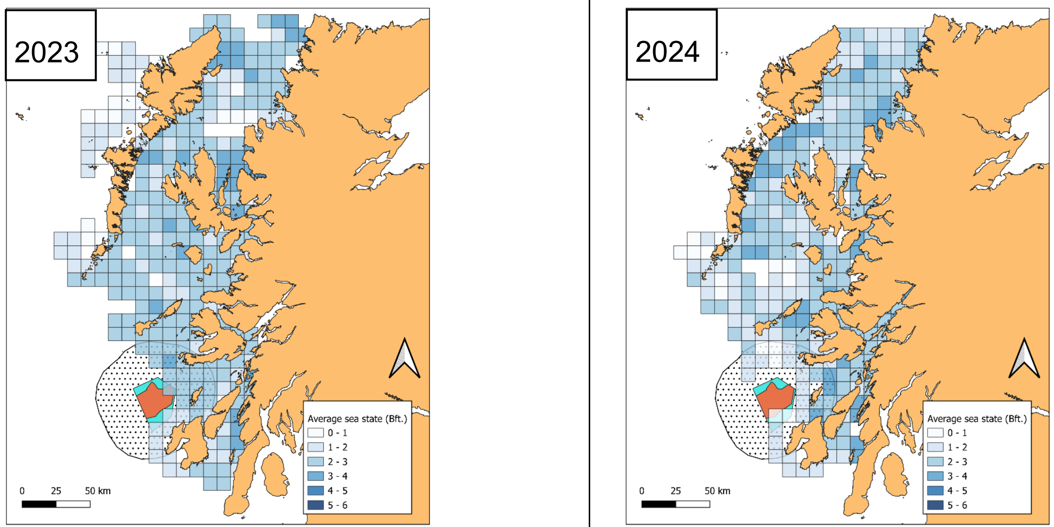


Figure 9 Annual average sea state conditions encountered during HWDT visual surveys, 2018-2024 relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

The effect of changing sea state on visual detection rates was investigated for harbour porpoise only. Harbour porpoise was selected because this species is comparatively small, displays little active surfacing behaviour and is not generally attracted to boats; thus detection rates of this species are therefore likely to be most severely affected by deteriorating conditions.

Across the 2018-2024 period, harbour porpoise DPUE rates declined noticeably as sea state increased (**Table 2**). Even at sea state 1, porpoise DPUE rates (expressed as the number of individuals observed per km of visual survey effort) were only 55% of those estimated at sea state 0; at sea state 4, these had dropped to 6% of DPUE rates at sea state 0. It is assumed that porpoise presence and distribution do not materially change during higher sea states, suggesting that significant numbers of these animals might go undetected during visual survey efforts at sea states 1 and higher, which is where the vast majority of HWDT survey effort occurs. DPUE rate variation across sea states was not assessed for other, larger species but is anticipated to show a similar, albeit potentially less pronounced trend.

Table 2 Summary of harbour porpoise DPUE rates for 2018-2024 across different sea states (SS). For sea states >0, interannual average DPUE rate is also expressed as a proportion of interannual average DPUE rate at sea state 0.

Year	DPUE SS 0	DPUE SS 1	DPUE SS 2	DPUE SS 3	DPUE SS 4
2018	0.426681	0.218837	0.047950	0.051074	0.009977
2019	0.344710	0.219215	0.086671	0.042672	0.027347
Due to the very limited survey effort data available for 2020 and 2021, no DPUE values from these years were used for this analysis.					
2022	0.351315	0.168028	0.052528	0.022082	0.012265
2023	0.279186	0.132295	0.056770	0.023055	0.022809
2024	0.164013	0.134919	0.049631	0.028743	0.021960
Average	**0.313181**	**0.174659**	**0.058710**	**0.033525**	**0.018872**
% of SS 0	**100%**	**55.7%**	**18.7%**	**10.7%**	**6.0%**

3.2.3 Visual Surveys: DPUE Rates near MachairWind Offshore Windfarm Site

Survey coverage and observed DPUE rates for all species were first assessed within a 30 km buffer zone around the WDA (summarised in **Table 3**). For purposes of interannual consistency, DPUE rates were calculated by dividing total numbers of observed individuals by the sum of transect survey lengths across all grid cells that overlapped, or fell within, the 30 km buffer zone. The proportion of coverage varied from year to year between 44% and 55% of grid cells, or approximately half the area overlapping with the 30 km buffer zone. Most of this effort tended to be focused on the northern and eastern side of the buffer zone, with comparatively limited survey effort taking place in the more exposed waters to the south and west. Average DPUE rates across the entire survey area have also been provided for wider context.

Table 3 Summary of annual average/maximum DPUE rates observed within 73 grid cells overlapping with a 30 km buffer zone around the WDA, and annual average DPUE rates across all grid cells surveyed (see also Figure 10), for species that were regularly observed during HWDT surveys. WDA-associated survey effort is also included. Data from 2020 and 2021 have not been included here given COVID-19-related restrictions.

Species	2018	2019	2022	2023	2024
	$DPUE_{avg-buffer}$ / $DPUE_{max-buffer}$ / $DPUE_{avg-Survey}$	$DPUE_{avg-buffer}$ / $DPUE_{max-buffer}$ / $DPUE_{avg-Survey}$	$DPUE_{avg-buffer}$ / $DPUE_{max-buffer}$ / $DPUE_{avg-Survey}$	$DPUE_{avg-buffer}$ / $DPUE_{max-buffer}$ / $DPUE_{avg-Survey}$	$DPUE_{avg-buffer}$ / $DPUE_{max-buffer}$ / $DPUE_{avg-Survey}$
Harbour porpoise	0.009 / 0.261 / 0.102	0.014 / 0.082 / 0.090	0.029 / 0.301 / 0.059	0.011 / 0.084 / 0.056	0.014 / 0.241 / 0.056
Common dolphin	0.017 / 0.792 / 0.160	0.295 / 6.326 / 0.125	0.188 / 1.823 / 0.316	0.155 / 2.538 / 0.334	0.080 / 1.340 / 0.280
Bottlenose dolphin	0.017 / 0.402 / 0.001	0.000 / 0.000 / 0.003	0.002 / 0.082 / 0.004	0.000 / 0.000 / 0.001	0.000 / 0.000 / 0.004
Risso’s dolphin	0.000 / 0.000 / 0.005	0.000 / 0.000 / 0.005	0.000 / 0.000 / 0.002	0.000 / 0.000 / 0.001	0.000 / 0.000 / 0.0003
White-beaked dolphin	0.000 / 0.000 / 0.014	0.000 / 0.000 / 0.011	0.000 / 0.000 / 0.005	0.000 / 0.000 / 0.005	0.000 / 0.000 / 0.001
Minke whale	0.009 / 0.187 / 0.009	0.008 / 0.528 / 0.009	0.016 / 0.177 / 0.011	0.022 / 0.183 / 0.016	0.027 / 0.247 / 0.015
Common seal	0.019 / 0.191 / 0.023	0.006 / 0.206 / 0.022	0.002 / 0.060 / 0.010	0.007 / 0.193 / 0.010	0.030 / 0.484 / 0.022
Grey seal	0.024 / 1.729 / 0.037	0.034 / 0.309 / 0.041	0.049 / 1.325 / 0.047	0.009 / 0.227 / 0.028	0.039 / 0.269 / 0.031
Basking shark	0.000 / 0.000 / 0.0014	0.000 / 0.000 / 0.0029	0.000 / 0.000/ 0.0009	0.004 / 0.068 / 0.0007	0.000 / 0.000 / 0.0001
# Grid cells / % of total in WDA buffer	38 / 52.1%	40 / 54.8%	36 / 49.3%	32 / 43.8%	33 / 45.2%

Several patterns can be observed on the basis of these DPUE rates. Some species (e.g., harbour porpoise, grey seal) are regular visitors of the area, which at least for some individuals (e.g., the grey seals using adjacent haul-out sites) may represent an important habitat. There is evident interannual variability in maximum DPUE rates across all species observed in the vicinity of the WDA, including some cases where maximum DPUE rates changed by approximately an order of magnitude from one year to the next (e.g., common dolphin, common seal). Changes of such magnitude are likely to be not only driven by abundance of animals in the area, but also caused by variability in survey effort distribution, sea state, observer experience etc. For some species (e.g., minke whale), DPUE rates observed within the 30 km WDA buffer zone were of comparable magnitude to those observed across the wider survey area. For other species (e.g., harbour porpoise), DPUE rates within the 30 km WDA buffer zone were considerably lower than those observed across the wider survey area, suggesting this area might be less attractive than others across western Scotland for such species. Extreme fluctuations in DPUE rates for Common dolphin within the 30 km WDA buffer zone can be attributed to this species' propensity for travelling in groups of >100 animals, at least on occasion. If such a large group were encountered within the 30 km WDA buffer zone (as happened in 2019), such a detection would skew the resulting DPUE rate.

Perhaps more important than the absolute values listed in **Table 3** are the recurring observations of several species within the 30 km WDA buffer zone, including harbour porpoise, common dolphin, bottlenose dolphin, minke whale, common seal and grey seal. Given their mobility, these species are likely to also occur regularly within the WDA even if they were not always observed there. Conversely, other species such as Risso's and white-beaked dolphins were never observed in the vicinity of the WDA during the 2018-2024 period, suggesting that these species are genuinely less often found here (although the potential for occasional or even continued presence in low densities cannot be excluded). Detections of basking sharks are likely negatively biased as this species does not need to return to the surface for respiration; the species is likely to occur in the area more frequently than the HWDT sighting data might indicate. Nonetheless, low DPUE rates reported here are in line with previously reported observations of reduced basking shark sighting rates (Hartny-Mills et al. 2024).

3.2.4 Visual Surveys: Average Annual DPUE Estimates

Changes in average annual DPUE rates for several marine megafauna species during the 2018-2024 period are visualised in **Figure 10**. One notable change relates to the increase (effectively almost doubling) of average annual DPUE rates for short-beaked common dolphin (2018: 0.160 individuals/km, 2024: 0.280 individuals/km) during this time, despite broadly comparable survey effort (from 6,231 km in 2018 to 7,625 km in 2024, representing an increase of only 22% during that time; **Figure 3**). In recent years, this species has become the most frequently sighted species in terms of total number of individuals reported, likely in part due to its habit of living in large groups, with records including some “super pods” containing >100 individuals. This is likely in part illustrative of a general increase of the species in waters west of Scotland, assumed to be related to increasing sea temperatures. A similar, albeit less pronounced, increase in average annual DPUE was noted for minke whale (2018: 0.009 individuals/km, 2024: 0.015 individuals/km). Although an uncommon species, there also appears to be an increase in average annual DPUE rates of ocean sunfish, in that they appear in the records from 2022 onwards, although this species has previously been observed in the area and has been recorded in historic HWDT *Silurian* data that were not included in the current analysis.

In contrast, average annual DPUE rates of several other species declined during the 2018-2024 period. Despite remaining the second most-commonly sighted species (by total numbers of individuals reported), harbour porpoise average annual DPUE rates fell by almost half during this time (2018: 0.102 individuals/km; 2024: 0.056 individuals/km). White-beaked dolphin and Risso’s dolphin also illustrated declining average annual DPUE rates over time, with rates particularly low in 2024. These are both relatively uncommon species in the area; it is presently unclear whether the observed declines in DPUE rates might be related to small year-on-year changes in HWDT survey distribution or are indicative of wider distributional shifts for these species. Observations of white-beaked dolphin, in particular, mainly occurred towards the north of the survey area.

Common bottlenose dolphin average annual DPUE rates were low and variable, with no reported sightings in 2018. Likewise, killer whale average annual DPUE rates also remained very low and variable, in line with the small, declining ‘West Coast population’.

Both grey and common seal average annual DPUE rates remained approximately stable, with slightly more recent interannual variability in common seal. Basking shark showed considerable interannual variability, with comparatively high average annual DPUE rates in 2019 compared to years before and after. Finally, several other species (humpback whale, fin whale, Atlantic white-sided dolphin) were occasionally observed in very small numbers (<5 sightings across all years per species).

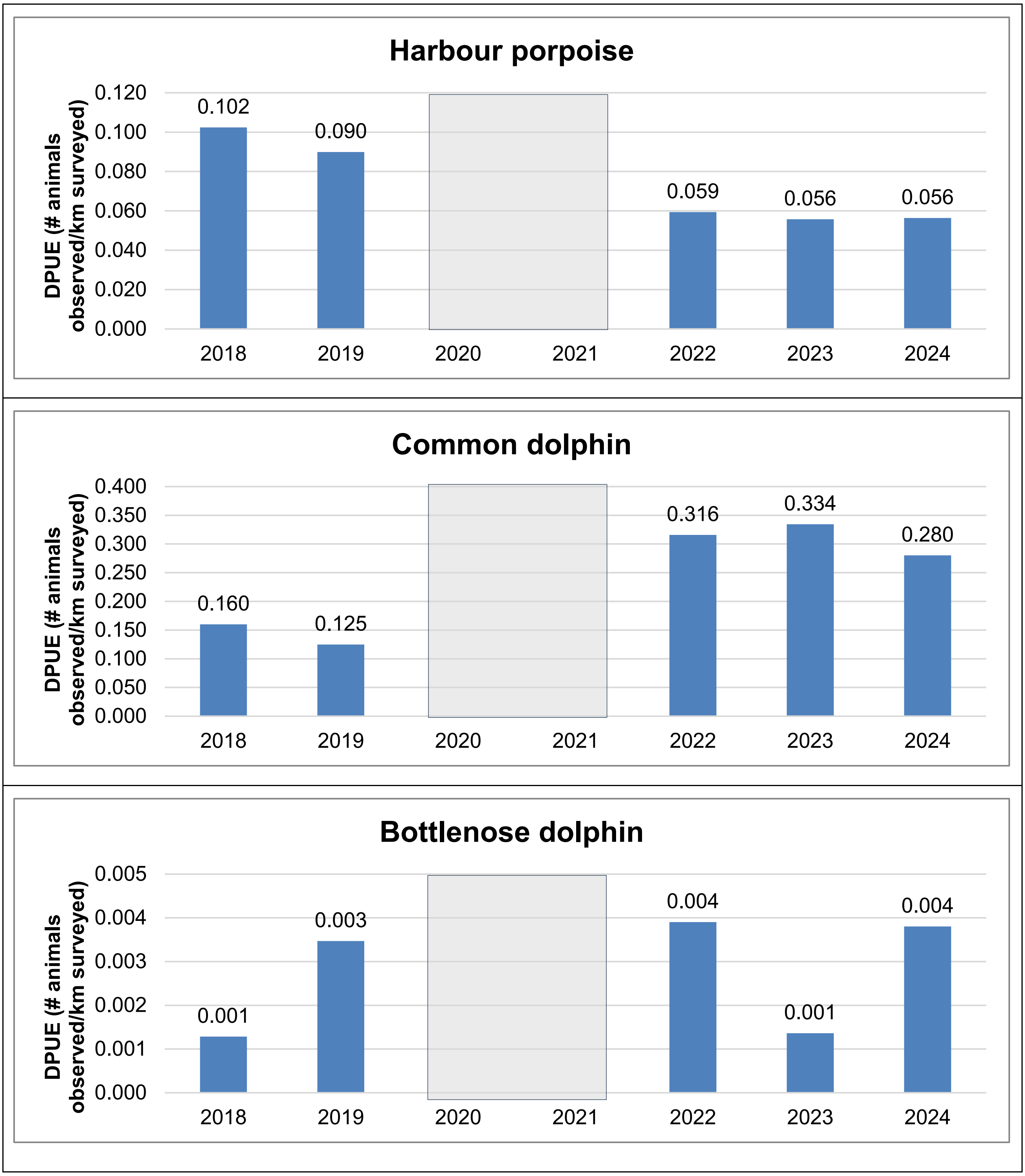


Figure 10 Summary of average annual DPUE rates for relevant megafauna species (2018-2024). DPUE was not calculated for 2020 and 2021 due to impact of COVID-19-related restrictions on visual survey effort.

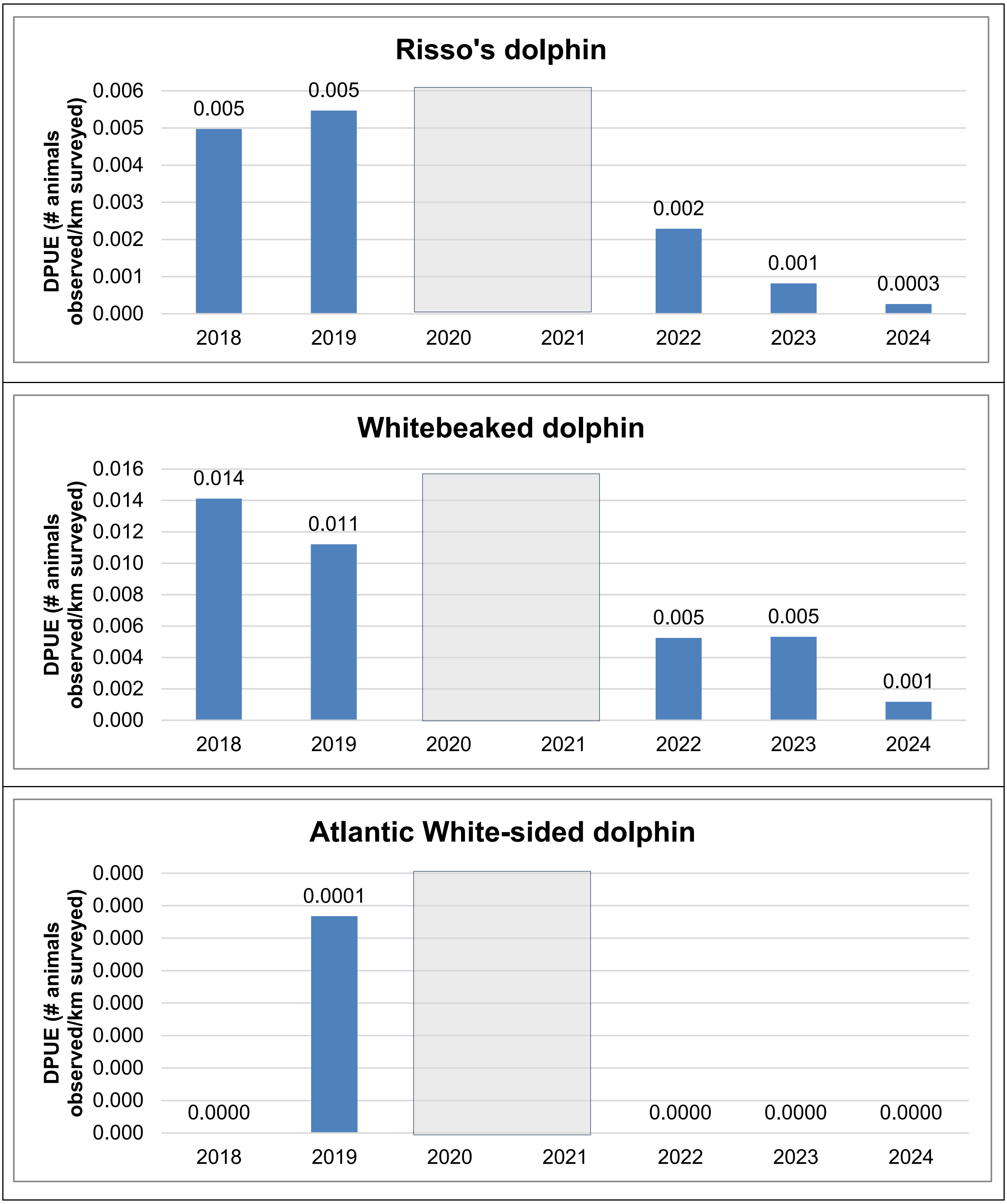


Figure 10 (continued). Summary of average annual DPUE rates for relevant megafauna species (2018-2024). DPUE was not calculated for 2020 and 2021 due to impact of COVID-19-related restrictions on visual survey effort.

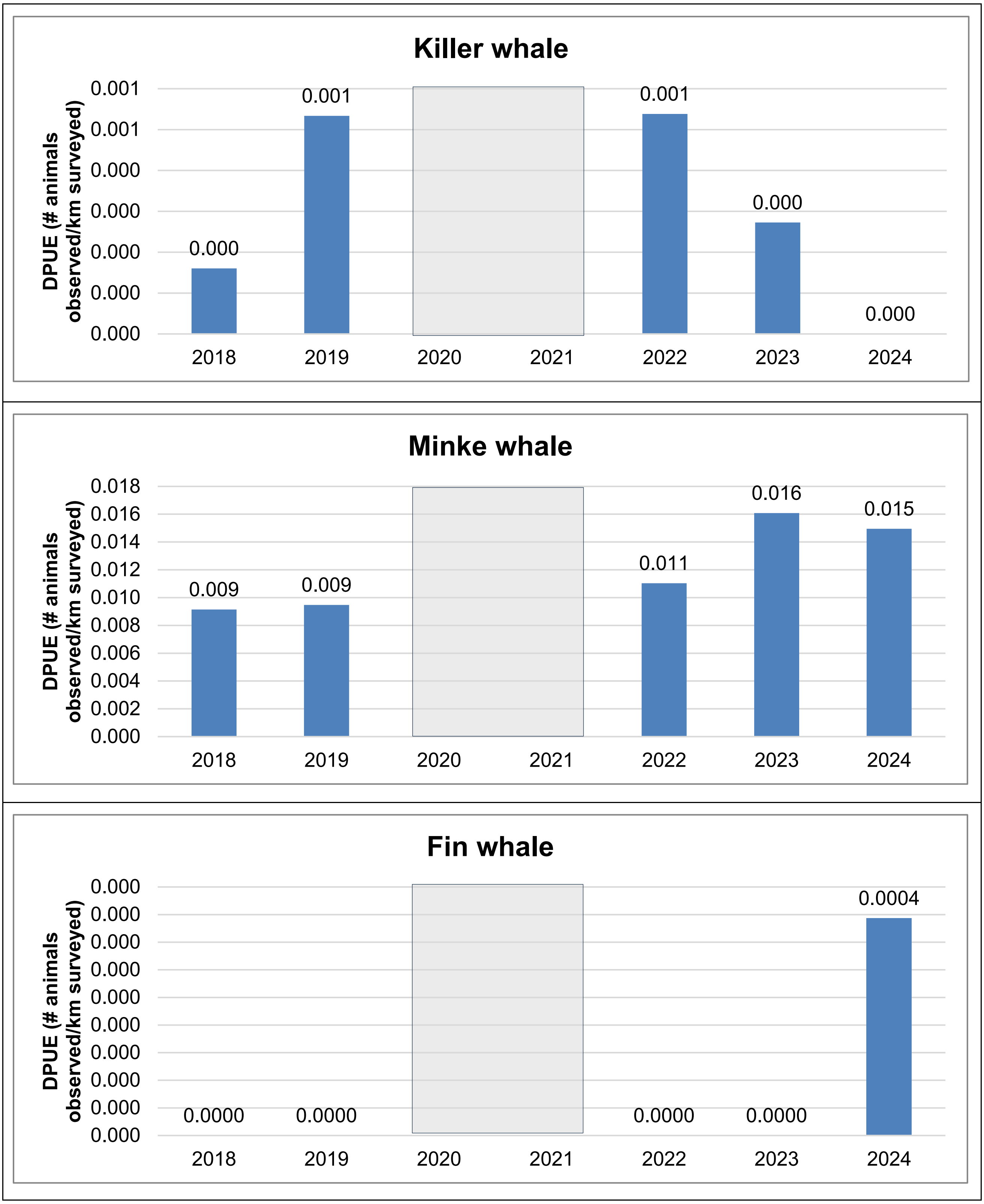


Figure 10 (continued). Summary of average annual DPUE rates for relevant megafauna species (2018-2024). DPUE was not calculated for 2020 and 2021 due to impact of COVID-19-related restrictions on visual survey effort.

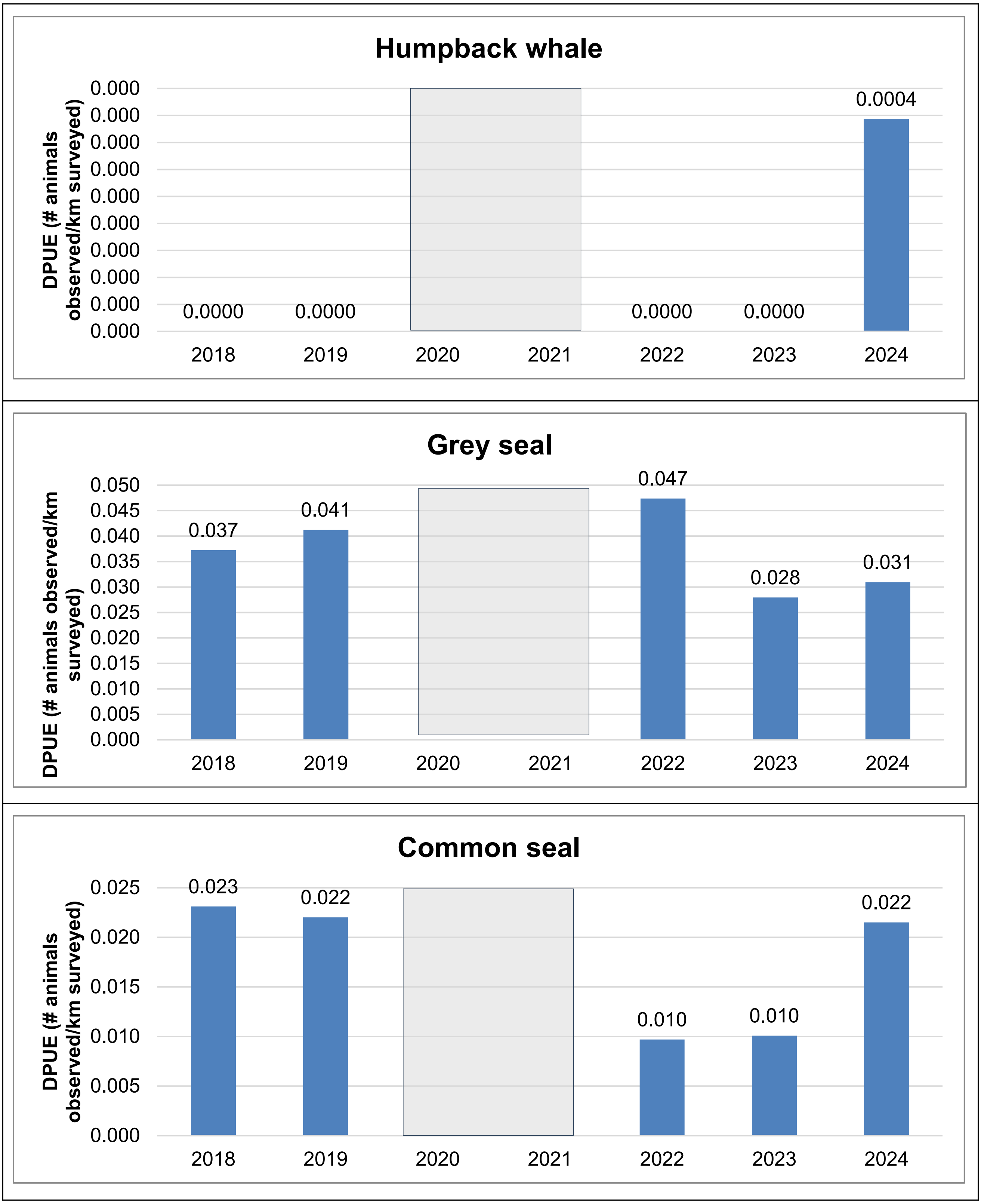
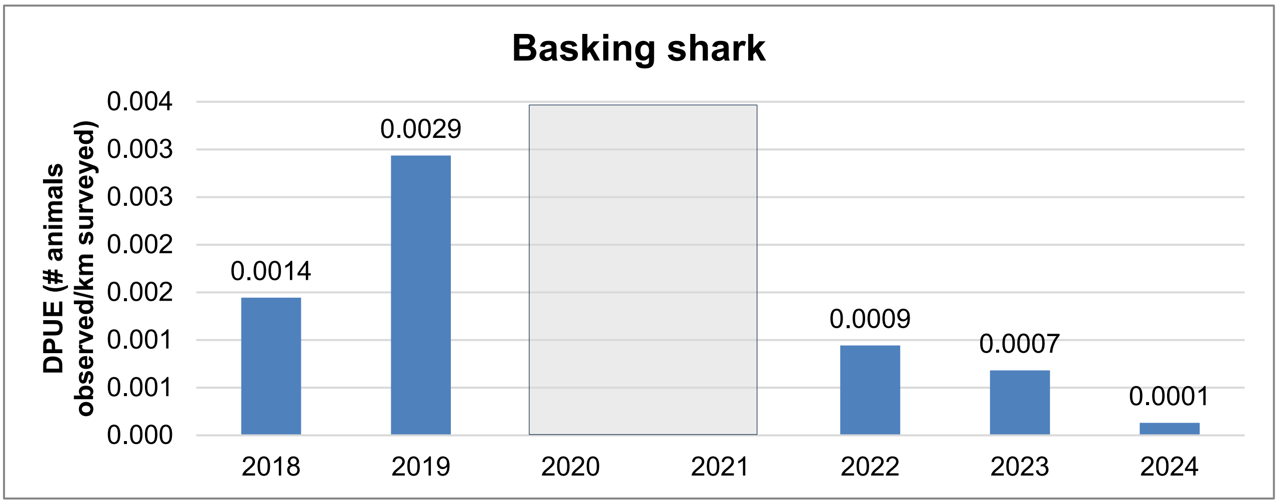


Figure 10 (continued). Summary of average annual DPUE rates for relevant megafauna species (2018-2024). DPUE was not calculated for 2020 and 2021 due to impact of COVID-19-related restrictions on visual survey effort.



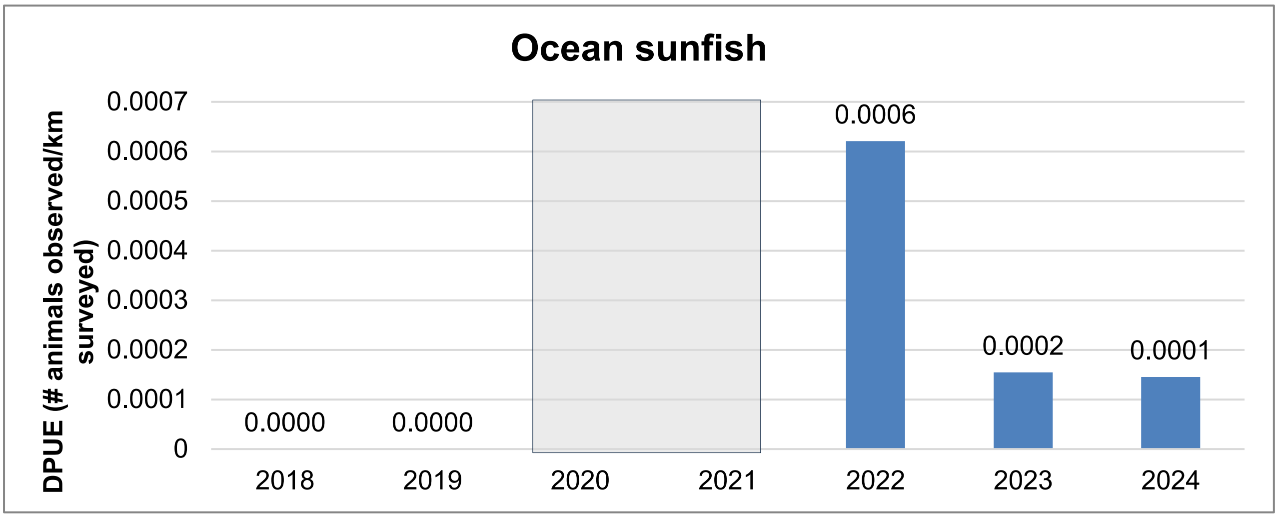
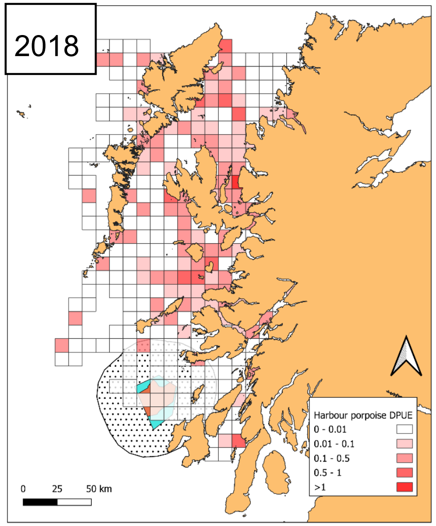
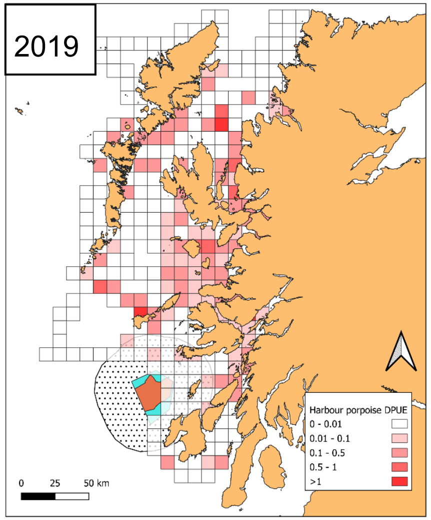


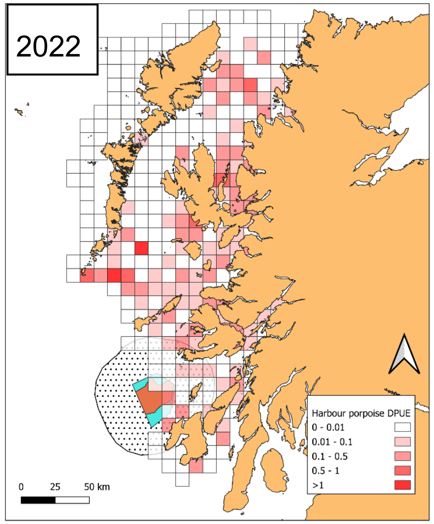
Figure 10 (continued). Summary of average annual DPUE rates for relevant megafauna species (2018-2024). DPUE was not calculated for 2020 and 2021 due to impact of COVID-19-related restrictions on visual survey effort.

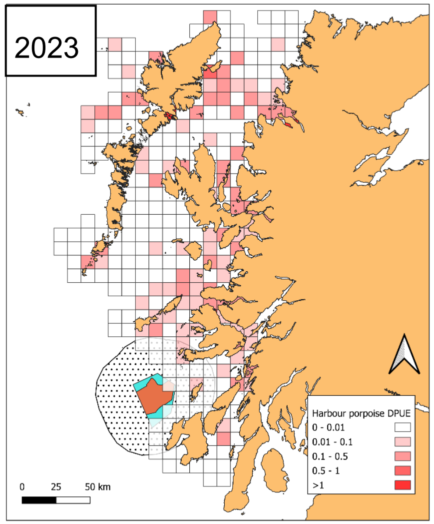
Given the large area over which HWDT surveys are carried out, it is important to consider the spatial heterogeneity in DPUE rates. **Figure 11** to **Figure 19** illustrate annual spatial heterogeneity in DPUE rates for all regularly observed species (based on aggregating sightings and visual survey effort by year, per 10x10 km grid cell).

3.2.4.1 Harbour porpoise









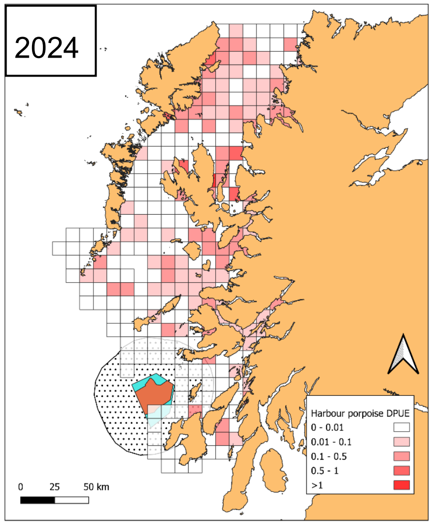
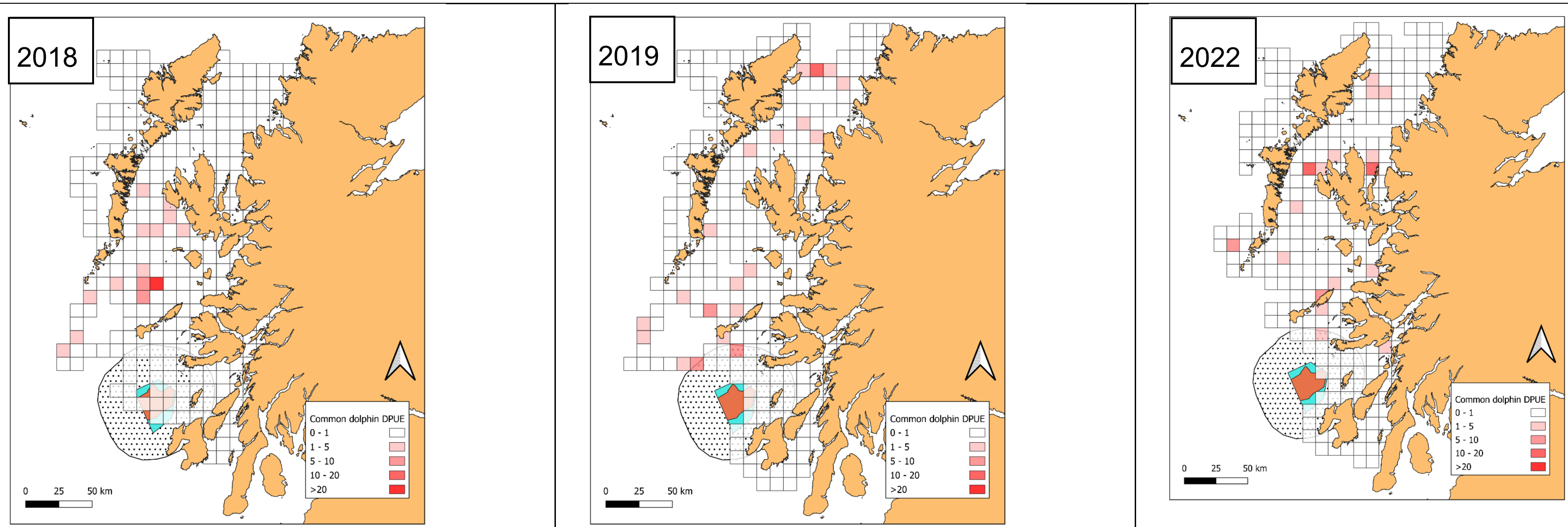


Figure 11 Overview of average annual visual DPUE rates (# individuals/km surveyed) for harbour porpoise (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.2 Common dolphin



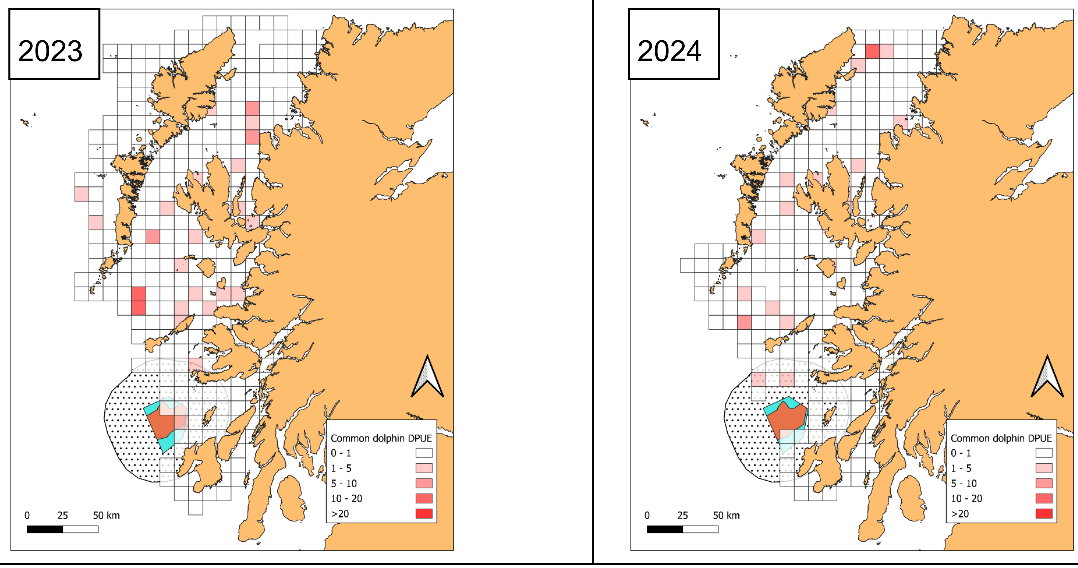


Figure 12 Overview of average annual visual DPUE rates (# individuals/km surveyed) for common dolphin (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.3 Minke whale

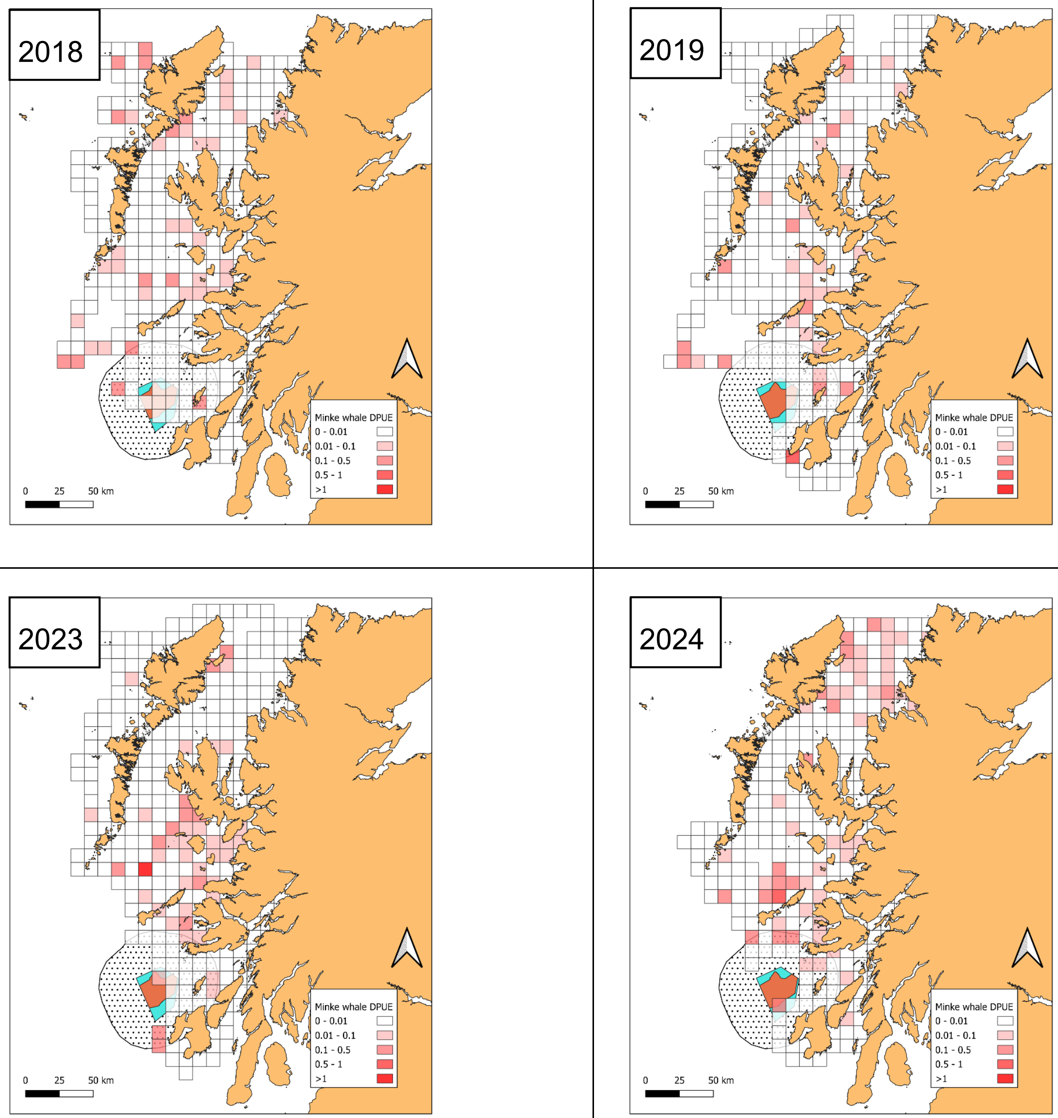


Figure 13 Overview of average annual visual DPUE rates (# individuals/km surveyed) for minke whale (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.4 Bottlenose dolphin

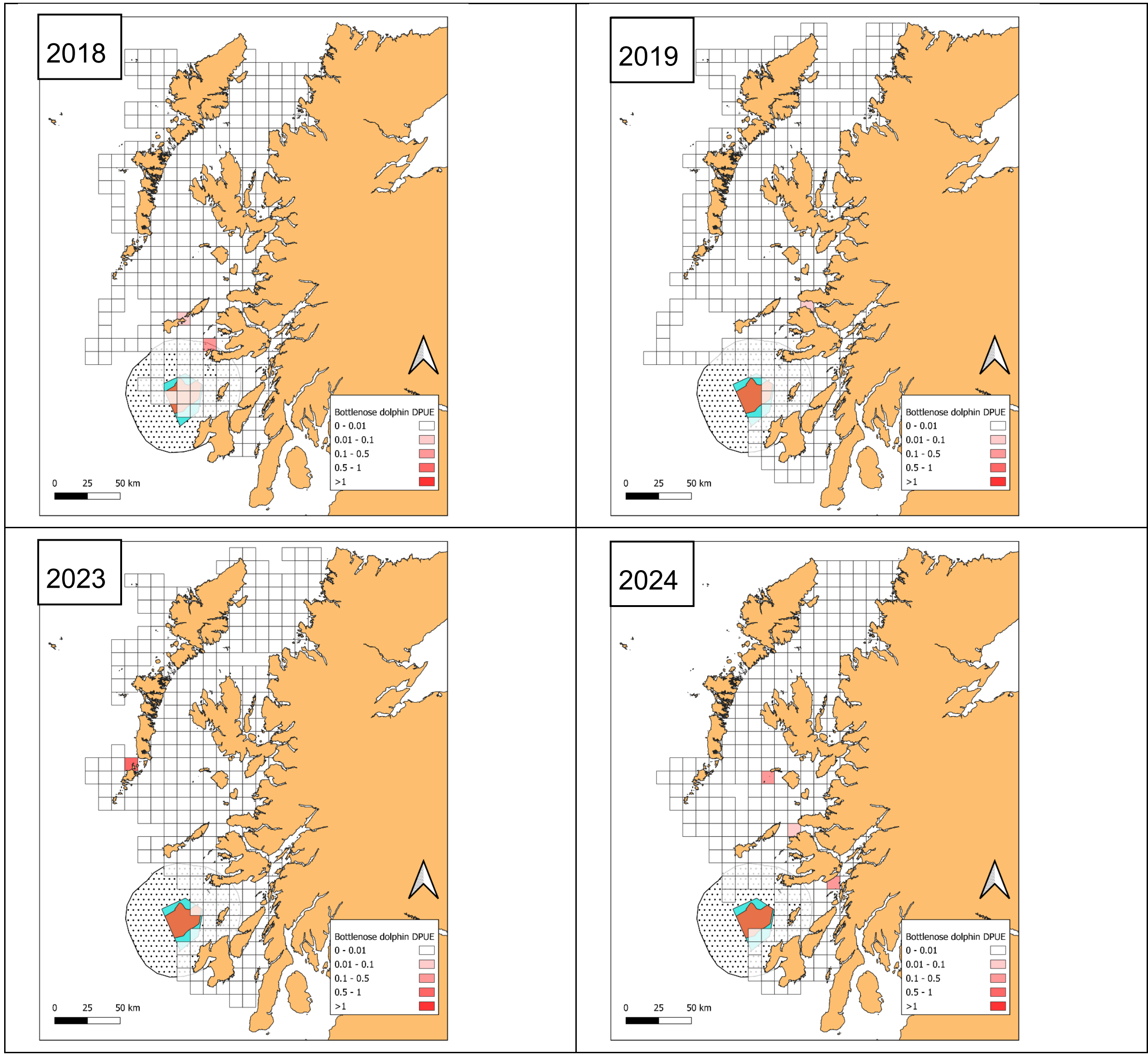
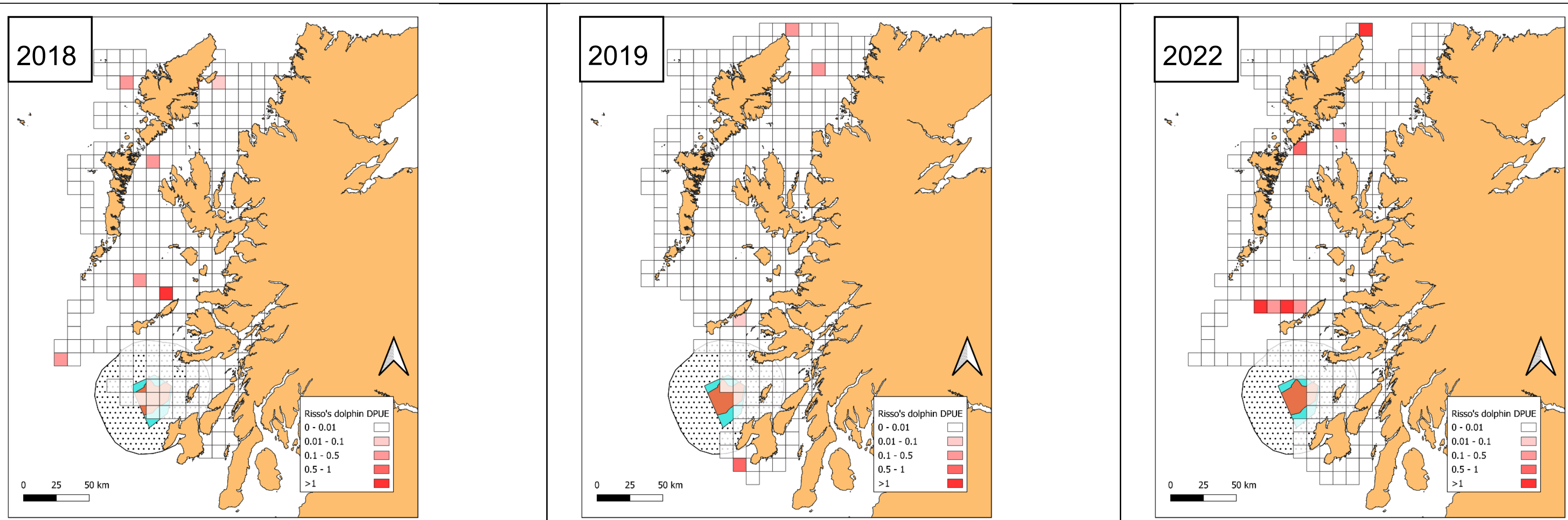


Figure 14 Overview of average annual visual DPUE rates (# individuals/km surveyed) for bottlenose dolphin (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.5 Risso's dolphin



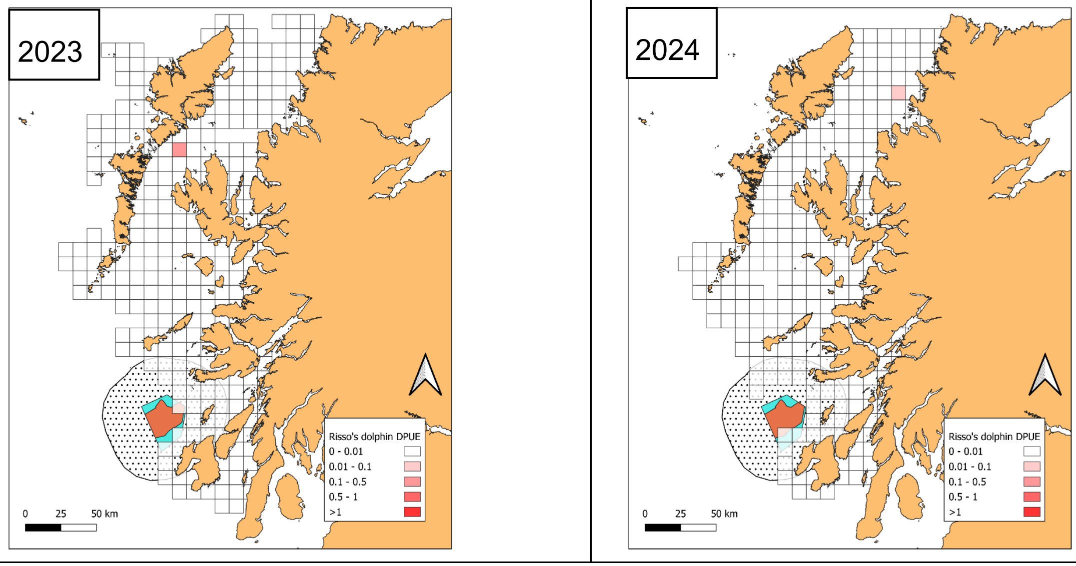
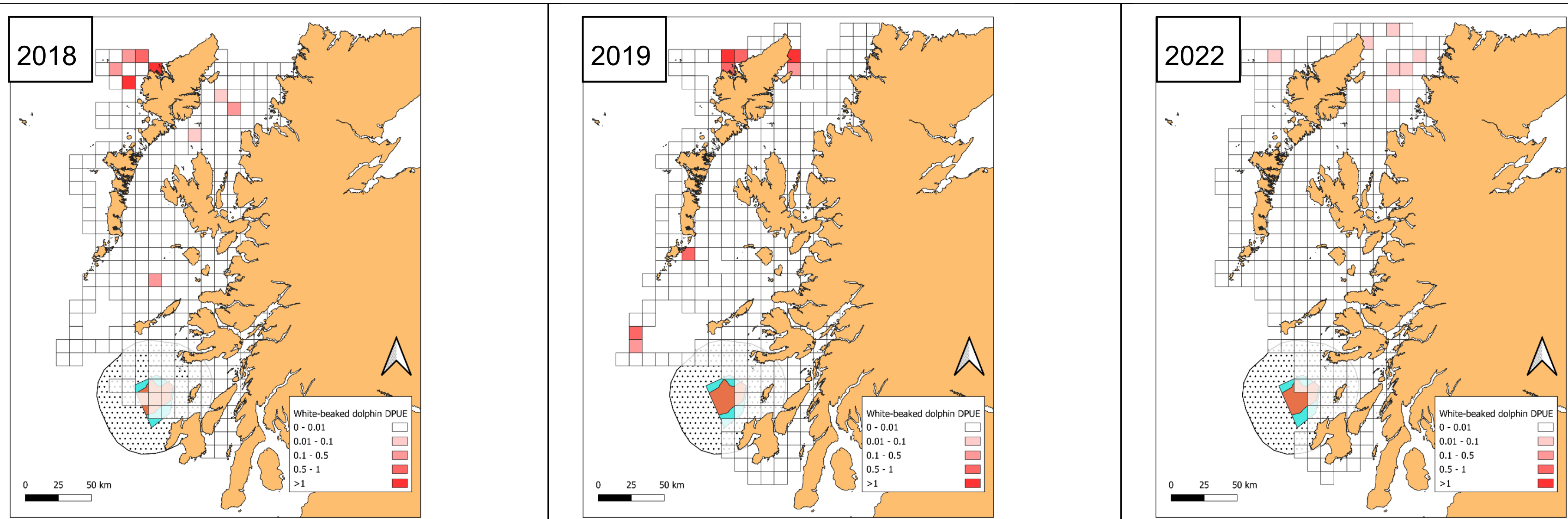


Figure 15 Overview of average annual visual DPUE rates (# individuals/km surveyed) for Risso's dolphin (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.6 White-beaked dolphin



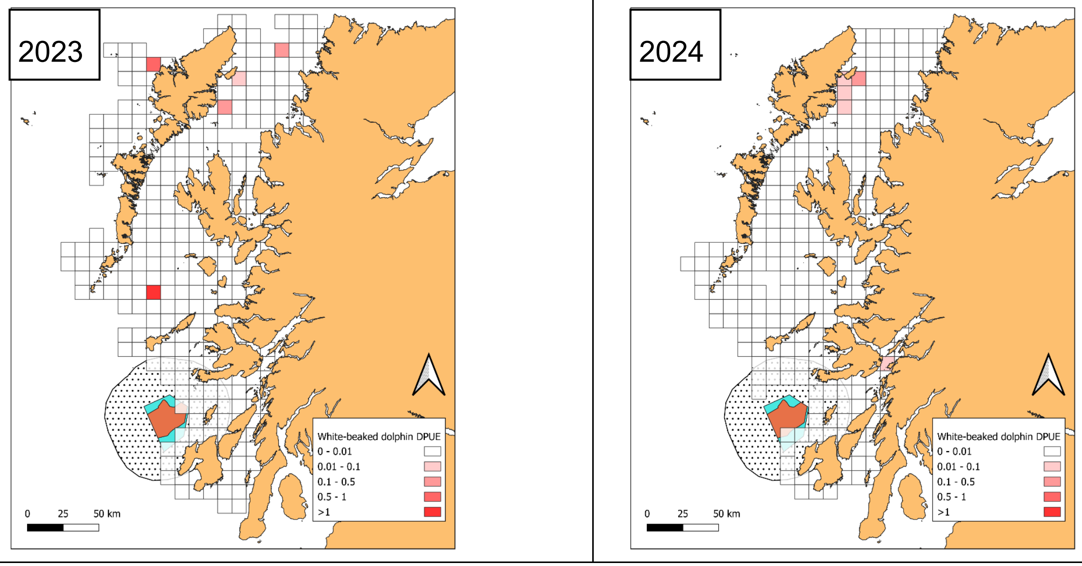
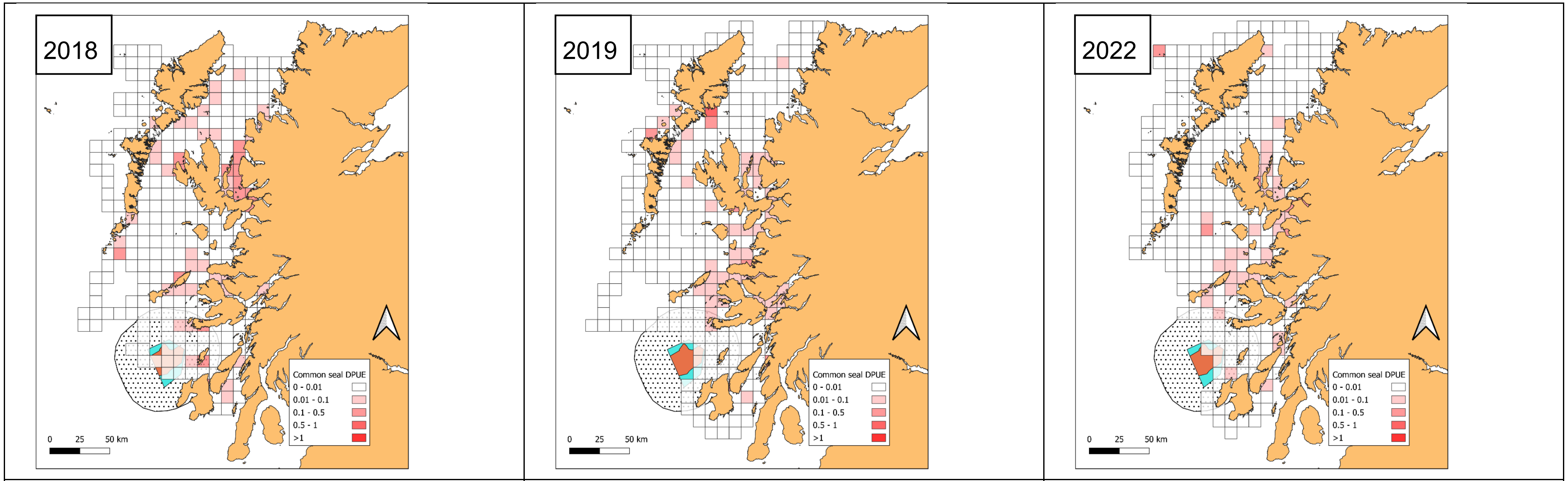


Figure 16 Overview of average annual visual DPUE rates (# individuals/km surveyed) for white-beaked dolphin (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.7 Common seal



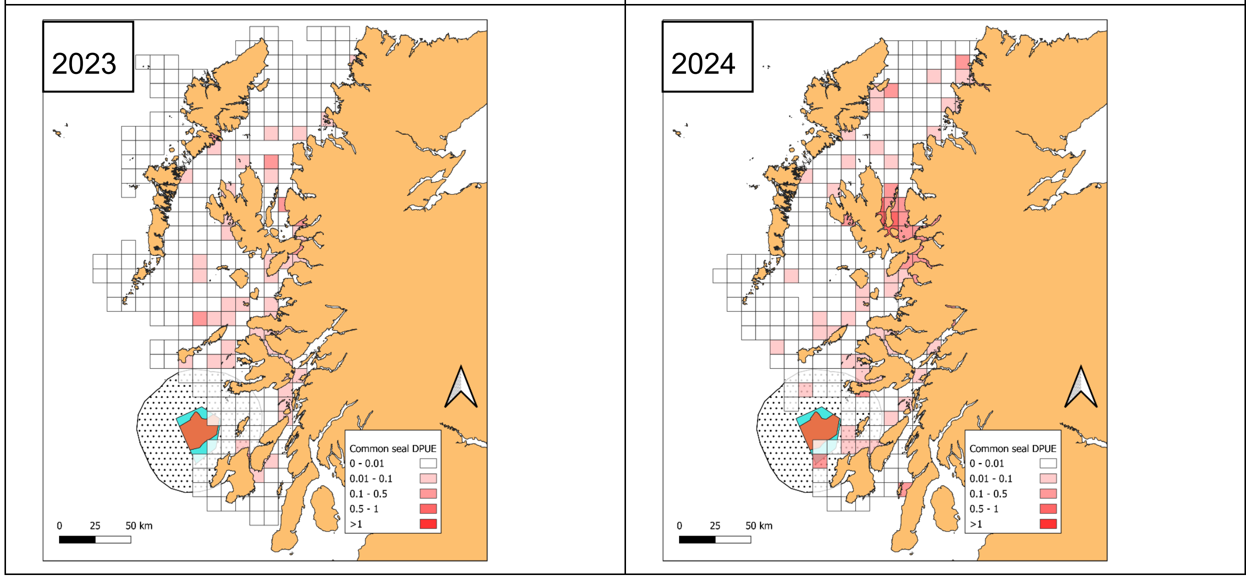
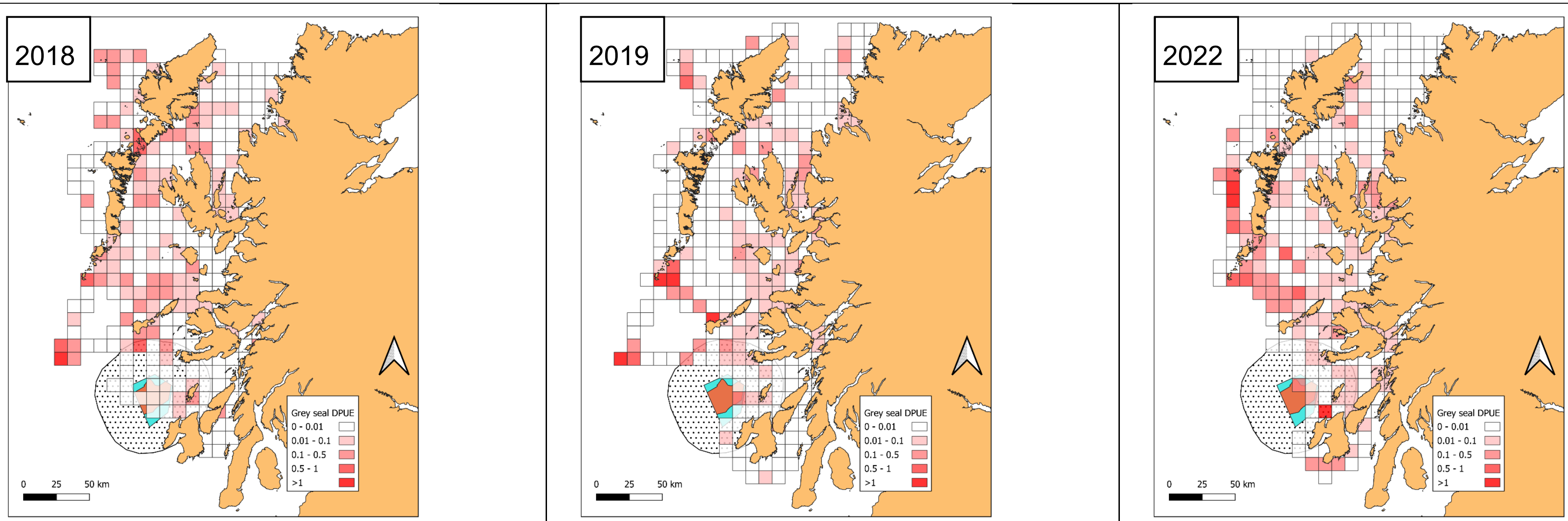


Figure 17 Overview of average annual visual DPUE rates (# individuals/km surveyed) for common seal (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.8 Grey seal



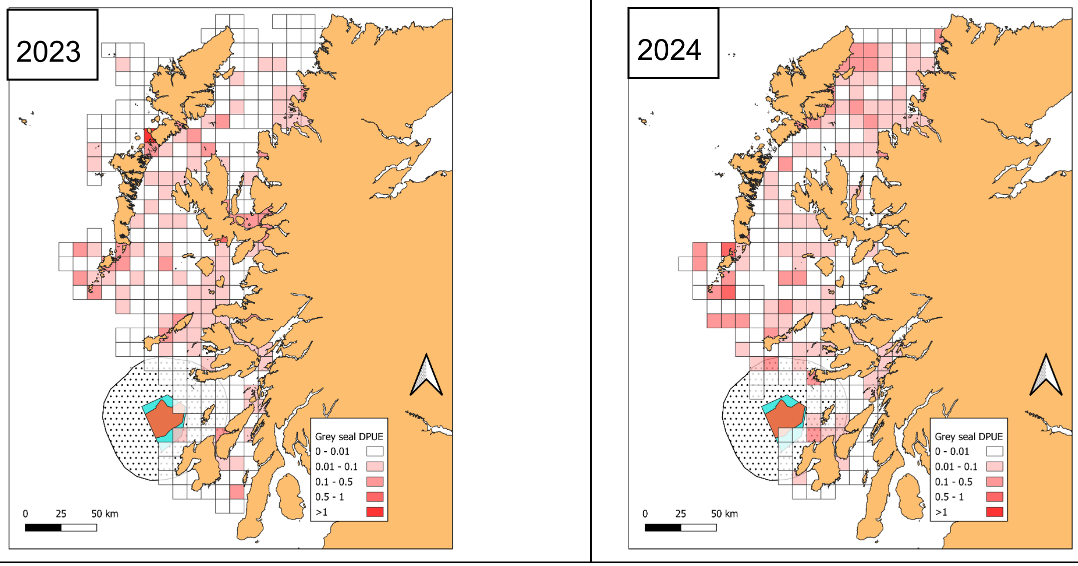


Figure 18 Overview of average annual visual DPUE rates (# individuals/km surveyed) for grey seal (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

3.2.4.9 Basking shark

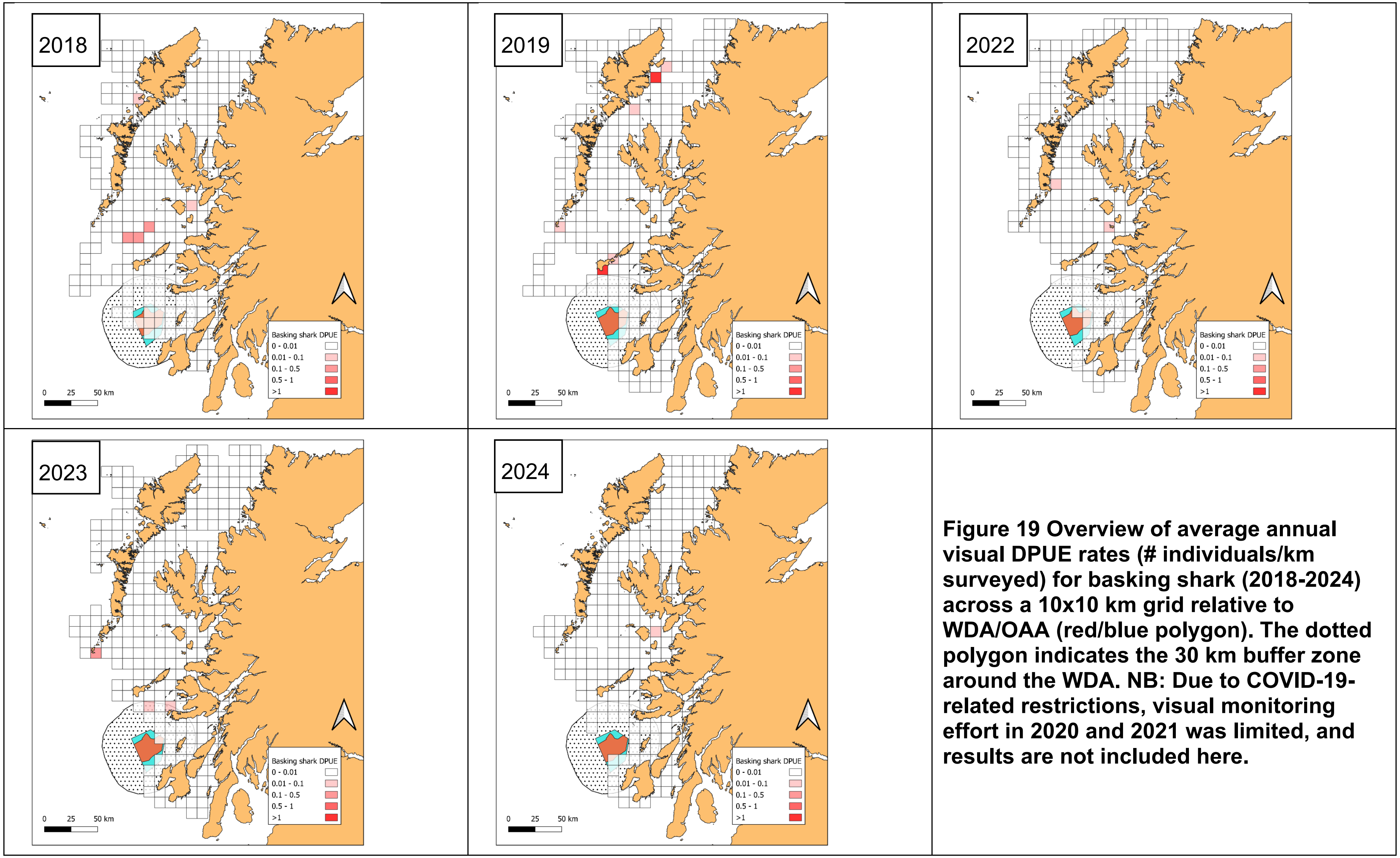


Figure 19 Overview of average annual visual DPUE rates (# individuals/km surveyed) for basking shark (2018-2024) across a 10x10 km grid relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA. NB: Due to COVID-19-related restrictions, visual monitoring effort in 2020 and 2021 was limited, and results are not included here.

4 PASSIVE ACOUSTIC SURVEY DATA

4.1 Methods

This analysis focussed on harbour porpoise as detected in the passive acoustic data collected using HWDT's hydrophone array deployed from RV *Silurian*. Although the focus was on data collected during 2018-2024, a separate analysis of older data (2011-2017) was performed for additional context.

As before, GPS data were checked for potential errors (e.g., points on land) which were removed before proceeding. The acoustic data had been processed by HWDT using the PAMGuard click detector (Gillespie et al. 2026). Porpoise detections were manually annotated and classified according to pre-defined criteria (**Table 4**) and merged with GPS coordinates based on the timestamp data.

DPUE rates were calculated based on the numbers of detection events per km surveyed. A DPUE value of 1 would mean that on average one detection was recorded per kilometre surveyed within that cell. This method provides a comparable metric to assess relative encounter rates accounting for variations in survey effort across the study area. No spatiotemporal segregation was applied between consecutive acoustic detections. Only detection events of 'likely' and 'certain' confidence in their identity as 'porpoise-derived' were included in the analysis (**Table 4**). These detections were checked for potential errors (inadvertent duplication, lack of information on event definition, or lack of latitude/longitude data), and incomplete records were removed. No attempt was made to assess whether successive acoustic porpoise detections along the same trackline were generated by the same individual. Conversely, standard caveats around passive acoustic porpoise detections (only vocalising animals detected; inability to distinguish individuals; lack of information on group sizes, directionality of echolocation beams emitted, etc.) also apply to this dataset. In addition, the high-frequency echolocation calls (>125 kHz) produced by porpoises tend to result in limited detection ranges (<500 m). For these reasons, DPUE rates reported here are therefore likely underestimated.

As with the visual survey data, GPS tracklines were created on the basis of GPS point data associated with passive acoustic survey effort (either 'A' – for 'Acoustic effort' or 'AS' – for 'Visual and Acoustic effort' in the raw data), where:

- Whenever a gap of >15 minutes occurred between consecutive GPS points, a new trackline was created.
- Tracklines were subdivided into 5 km segments for higher-resolution analysis. Mean values of sea state were calculated for each segment across all transects, and segments without sea state data were removed.

Acoustic detection events were subsequently matched to individual tracklines and exported for subsequent analysis. Average survey speeds were calculated for each 5 km segment.

Table 4 List of harbour porpoise detection event categories which were carried forward in the analysis. Event types and descriptions based on PAMTech (2015).

Detection event	Description
Porpoise Certain Event (PCEv)	Those events where there are many good clicks, but they are in a cluster with no directionality.
Porpoise Certain Click train (PCTr)	This event should contain about 10 good clicks with clear directionality (ideally with a bearing going through 90 degrees).
Porpoise Certain Single click (PCSi)	One or two clicks by themselves, which are clearly porpoise, but have no other clicks associated with them.
Porpoise Likely Event (PLEv)	Those events where there are fewer clicks, of poorer quality, in a cluster with no directionality.
Porpoise Likely Click train (PLTr)	This event should have directionality, but not as clear as PCTr, either because there are not enough clicks, or because the direction is not so straight.
Porpoise Likely Single click (PLSi)	One or two clicks by themselves, which are of poorer quality, and have no other clicks associated with them.

4.2 Results

4.2.1 Survey Effort

From 2011 to 2024, HWDT undertook a total of 81,437 km of passive acoustic survey effort across waters off western Scotland. This was split approximately evenly across the two broad periods used in this report (42,437 km in 2011-2017 and 39,002 km in 2018-2024; Figure *20*). Average survey effort per year was 6,069 km in 2011-2017, and 5,571 km in 2018-2024, with the difference mainly driven by COVID-19-related restrictions on survey activity in the 2020-2021 period. Accordingly, no PAM survey data from 2020 have been included in this analysis. By 2021, acoustic monitoring effort comparable to historic (2012-2013) levels could once again be realised, despite limited crew onboard the research vessel; for this reason, 2021 data have been included here.

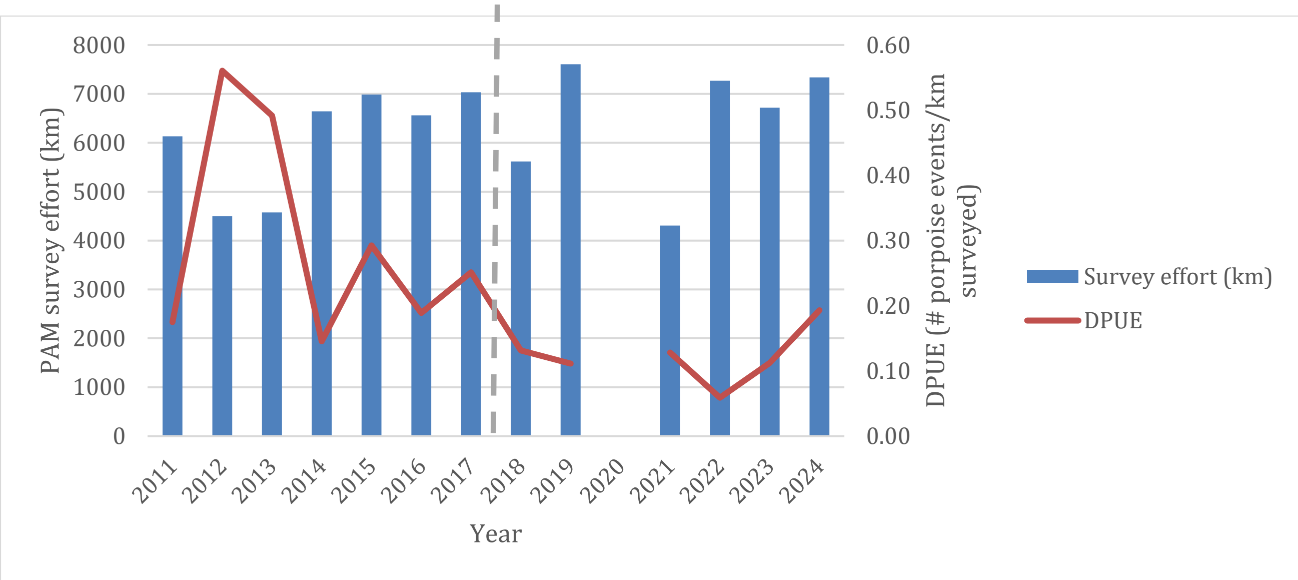


Figure 20 Summary of *Silurian* passive acoustic survey effort and porpoise vocalisation DPUE, 2011-2024. The two broad periods (2011-2017 and 2018-2024) are separated by the vertical dashed line. Data from 2020 have been excluded.

When considering seasonality of acoustic survey effort, there was a clear focus on summer months (**Figure 21**) in line with concurrent visual survey effort (**Figure 4**). While acoustic monitoring efforts during the winter months (November-March) increased in 2018-2024 with the start of the winter surveys, these surveys still amounted to only 7.7% of total effort over these years.

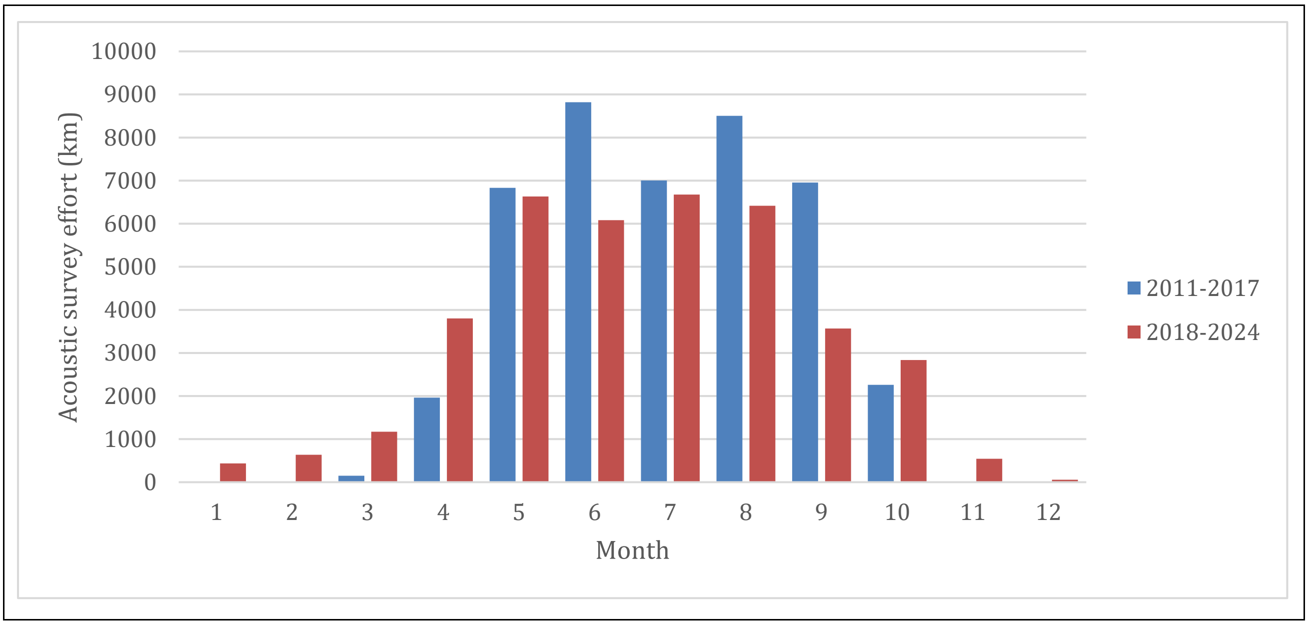


Figure 21 Seasonal distribution of passive acoustic survey effort for 2011-2017 (blue), and 2018-2024 (red), excluding 2020. Data have been aggregated across the two time periods.

As expected, monthly distribution of acoustic survey effort varied somewhat between years (**Figure *22***), although effort was always highest during summer months (May-August); a pattern replicated across all years.

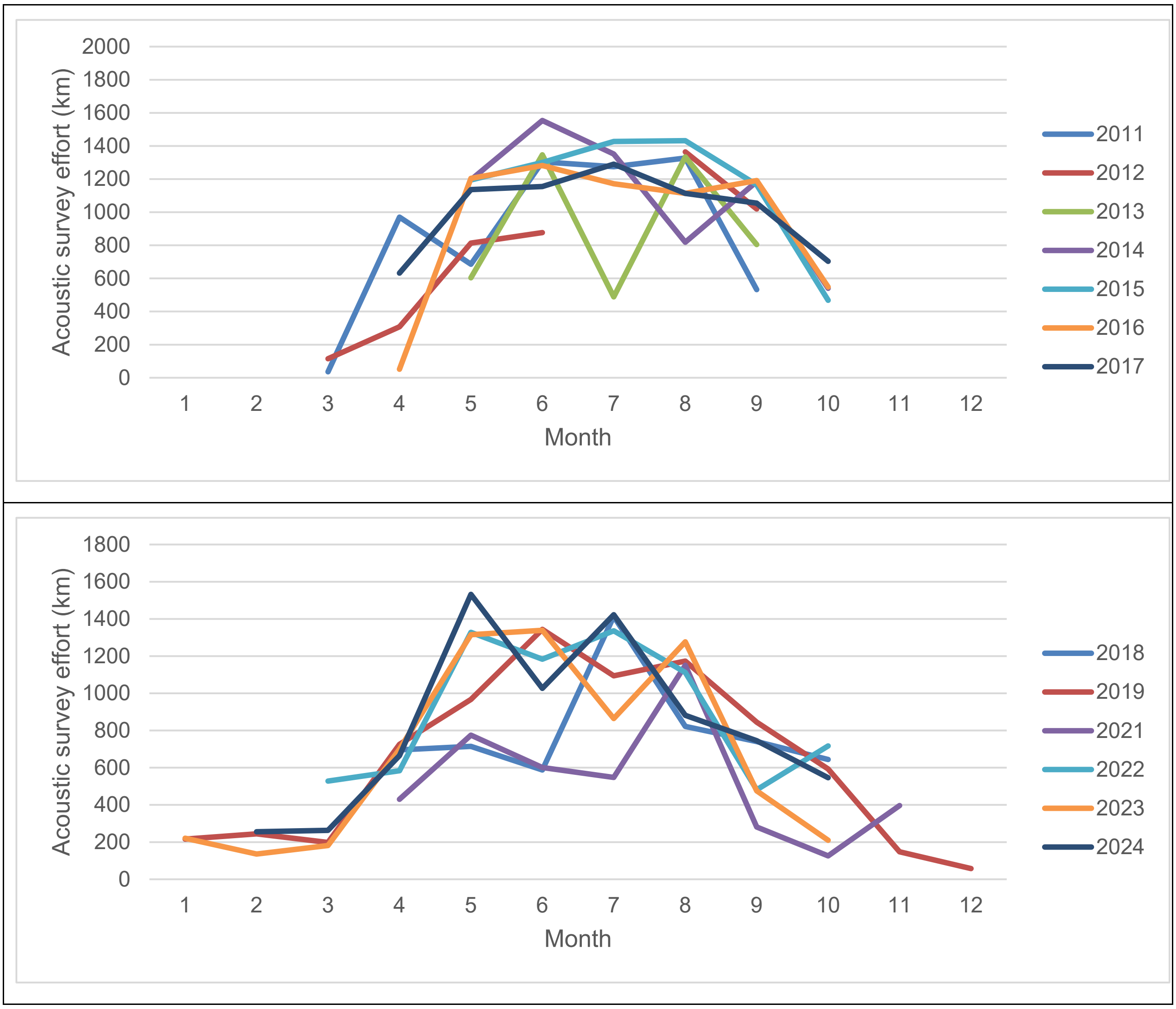


Figure 22 Summary of passive acoustic survey effort, by year, by month, for 2011-2017 (top) and 2018-2024 (bottom), excluding 2020.

As for visual survey effort, spatial distribution of acoustic effort generally encompassed the entire Minch but varied between years (**Figure 23** and **Figure 24**). For years presenting both visual and acoustic monitoring effort, the areas receiving increased monitoring effort were very similar for visual and acoustic effort. Similar caveats previously highlighted for the visual survey effort (**Section 4.2**) apply regarding the acoustic survey effort presented here, with the consideration that acoustic surveys were less affected by inclement weather, as well as COVID-19-related restrictions in 2020/2021. In some years, acoustic monitoring efforts covered a notable part of the WDA (particularly 2018 and 2021).

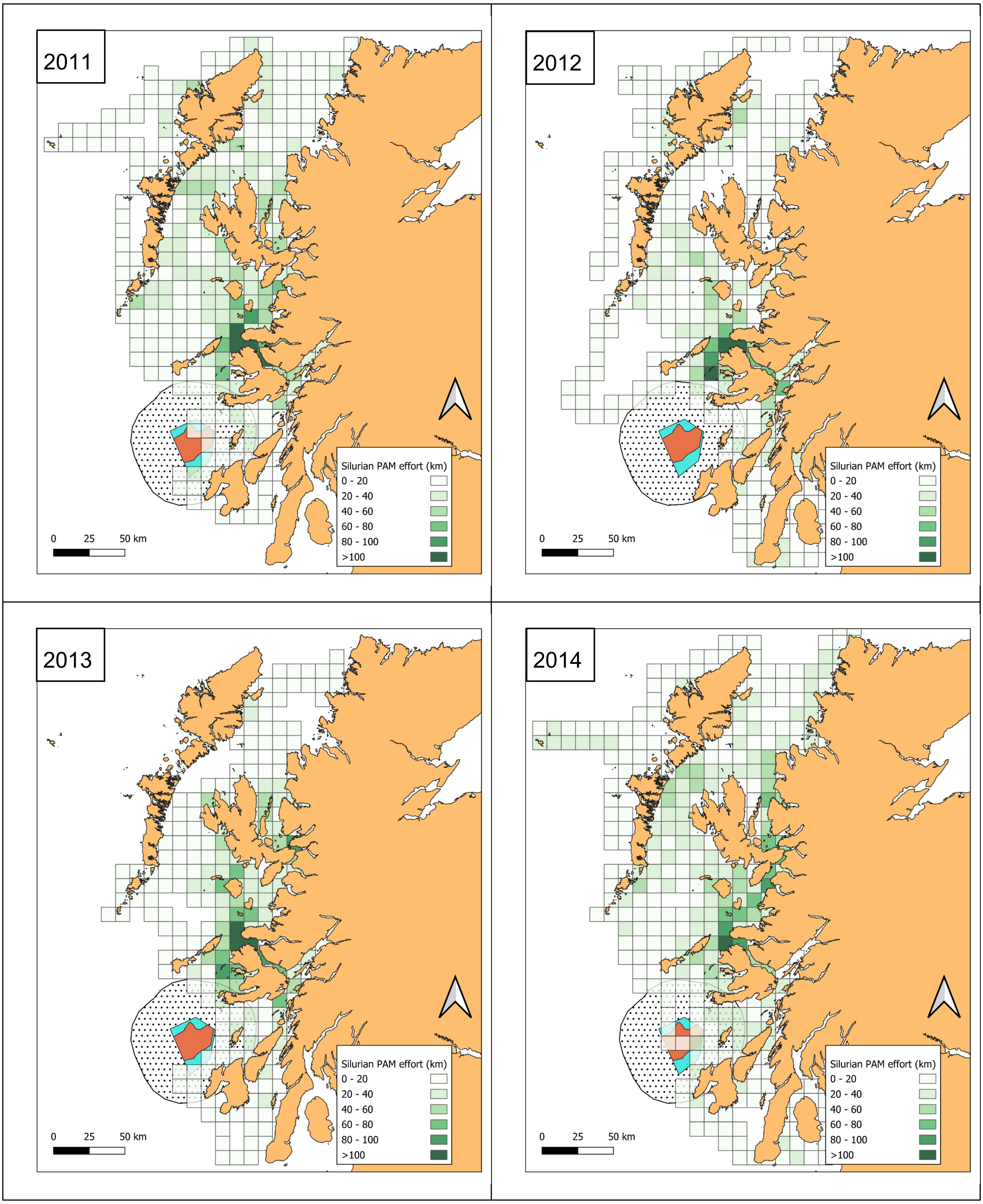


Figure 23 Overview of *Silurian* acoustic survey effort distribution (total sum of km surveyed per 10x10 km grid cell) by year (2011-2017), relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

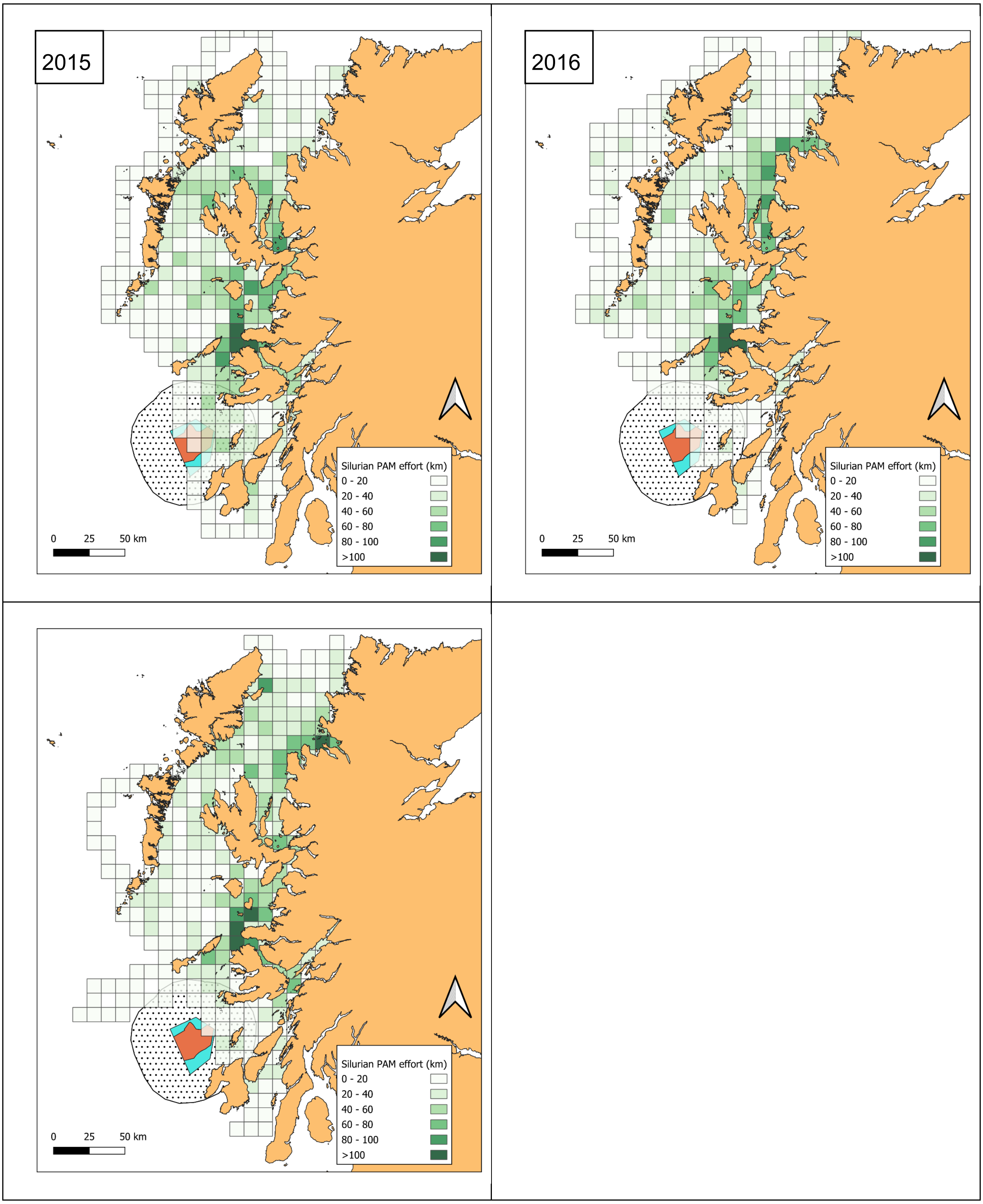
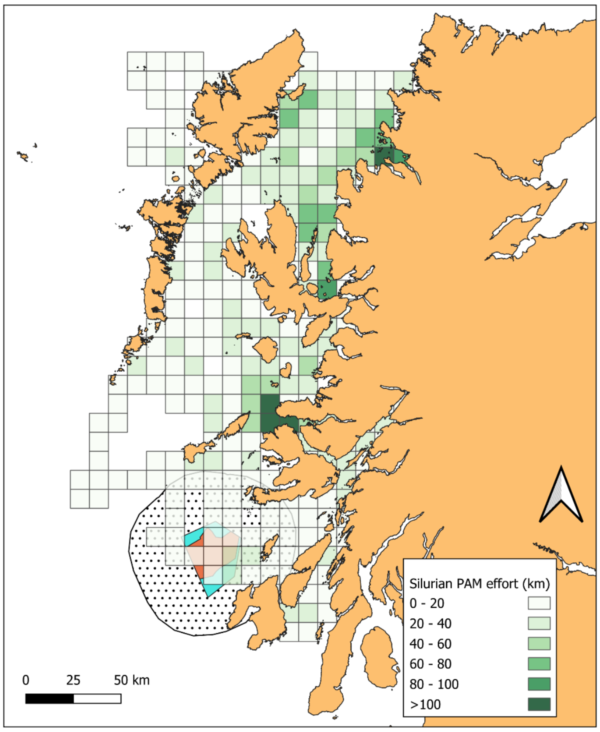
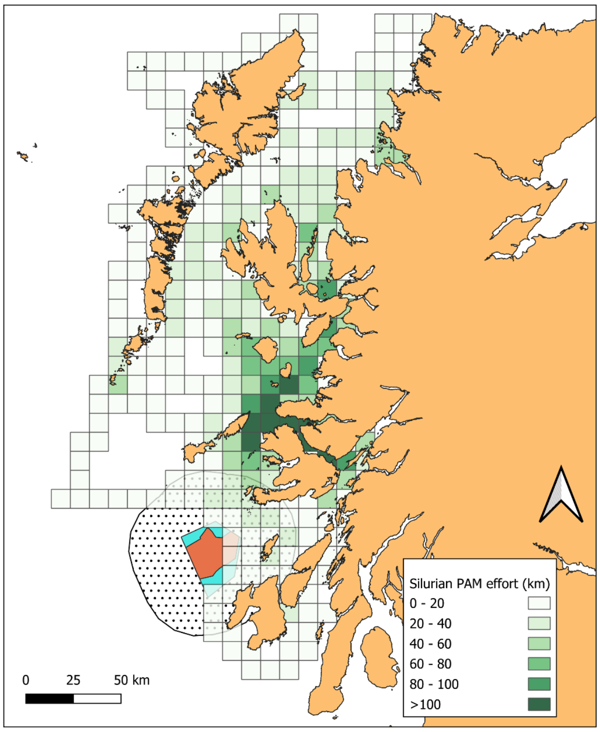


Figure 23 (continued). Overview of *Silurian* acoustic survey effort distribution (total sum of km surveyed per 10x10 km grid cell) by year (2011-2017), relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.





2020

2020 data not included due to impact of COVID restrictions.

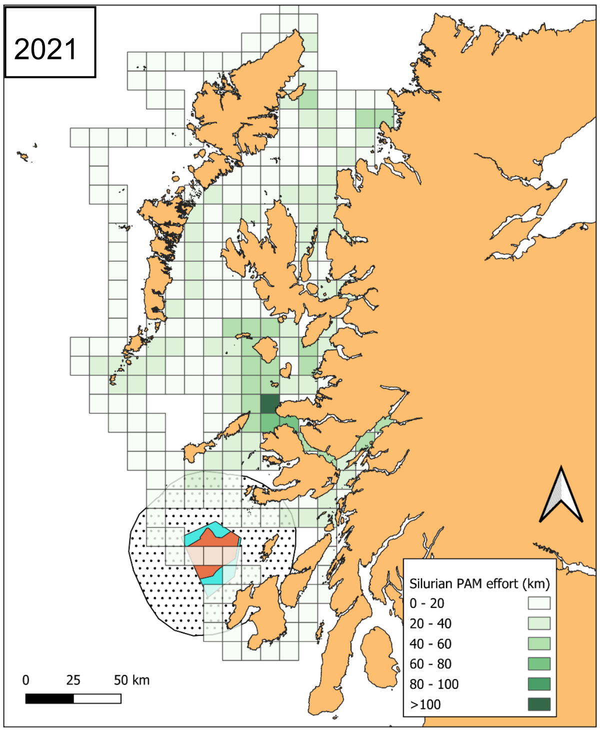


Figure 24 Overview of *Silurian* acoustic survey effort distribution (total sum of km surveyed per 10x10 km grid cell) by year (2018-2024), relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

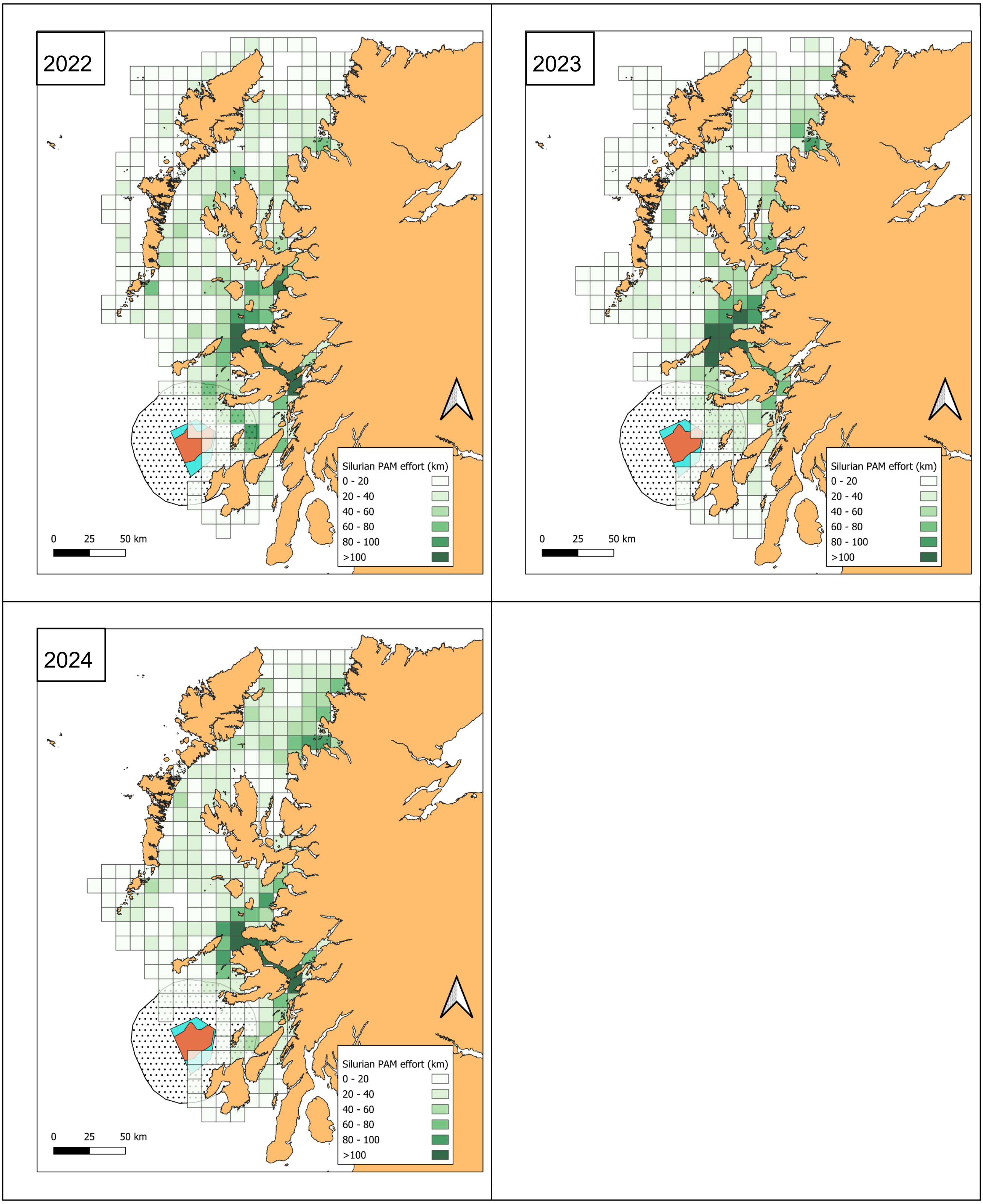


Figure 24 (continued). Overview of *Silurian* acoustic survey effort distribution (total sum of km surveyed per 10x10 km grid cell) by year (2018-2024), relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

4.2.2 Sea State

Passive acoustic monitoring is less affected by sea state and can continue under conditions where visual surveys become compromised. However, since *Silurian* typically undertook combined visual and passive acoustic surveys, the majority (>70%) of passive acoustic survey effort occurred at sea states 2-3 as a result. Only 2,402 km (2011-2017) and 1,623 km (2018-2024), respectively, were surveyed under conditions of sea state 0; these generally occurred during summer months. A summary of sea states encountered during HWDT surveys is presented in **Section 3.2.2**, this report.

4.2.3 Harbour Porpoise Average Annual Acoustic DPUE Estimates

Passive acoustic survey data revealed changes in average harbour porpoise DPUE rates over time (**Table 5**). Overall DPUE rates were particularly high during 2012 (with a particular peak in April) and 2013, which was followed by a gradual decline in average DPUE rates until at least 2022, although the most recent data suggest DPUE rates are once again increasing. Long-term declines in porpoise acoustic DPUE rates have in recent years been reported from various areas in northwestern Europe (e.g., Paradell et al., 2024; Todd et al., 2025) potentially suggesting wider-scale responses to changing environmental conditions (e.g., driven by climate change). DPUE rates also varied considerably within years (**Figure 25**).

Porpoise acoustic DPUE rates varied spatially within and across the 2011-2024 period (**Figure 26** and **Figure 27**). This spatiotemporal heterogeneity was likely driven by a range of factors, with some areas seeing significantly more effort than others (**Figure 26**). This was in part driven by logistical and safety considerations, in part by unavoidable fluctuations in weather conditions in time and space. Acoustic detection probability of porpoise echolocation depends on a range of factors, including, for example, ambient sound levels, numbers of animals within acoustic detection range, orientation of the vocalising animals relative to the hydrophone receivers, vocalisation rates across different behavioural states. Such biases are a standard feature of this type of survey and are not peculiar to the HWDT survey programme. The complexity of the interplay between all these (and various other) factors, also in relation to spatiotemporal variability in survey effort, means that the underlaying reason(s) for the fluctuating DPUE rates are not known at present. In any case, porpoises were regularly detected acoustically across the area, including in open water within the central and northern Minch, during the entire period (**Table 5**). Porpoises also continued to be detected in the vicinity of the WDA throughout this period. Average annual PAM DPUE rates within the 30 km WDA buffer zone were typically lower than the average annual PAM DPUE rates recorded across the whole PAM survey. This suggests that this buffer zone (and potentially the WDA itself) are less heavily frequented by harbour porpoise than other areas including the central and northern Minch (**Figure 26** and **Figure 27**).

Table 5 Summary of annual average/maximum porpoise PAM DPUE rates observed within 73 grid cells overlapping with a 30 km buffer zone around the WDA, and annual average PAM DPUE rates across all grid cells surveyed (see also Figure 20 (2018-2024). WDA-associated survey effort is also included. Data from 2020 have not been included here given COVID-19-related restrictions.

Year	$DPUE_{avg\text{-}buffer}$	$DPUE_{max\text{-}buffer}$	$DPUE_{avg\text{-}Survey}$	# Grid cells / % of total overlapping with 30 km WDA buffer
2018	0.132	0.882	0.131	38 / 52.1%
2019	0.063	0.378	0.111	40 / 54.8%
2021	0.039	0.366	0.128	30 / 41.1%
2022	0.044	0.248	0.059	35 / 47.9%
2023	0.060	0.297	0.112	29 / 39.7%
2024	0.141	0.639	0.193	31 / 42.5%

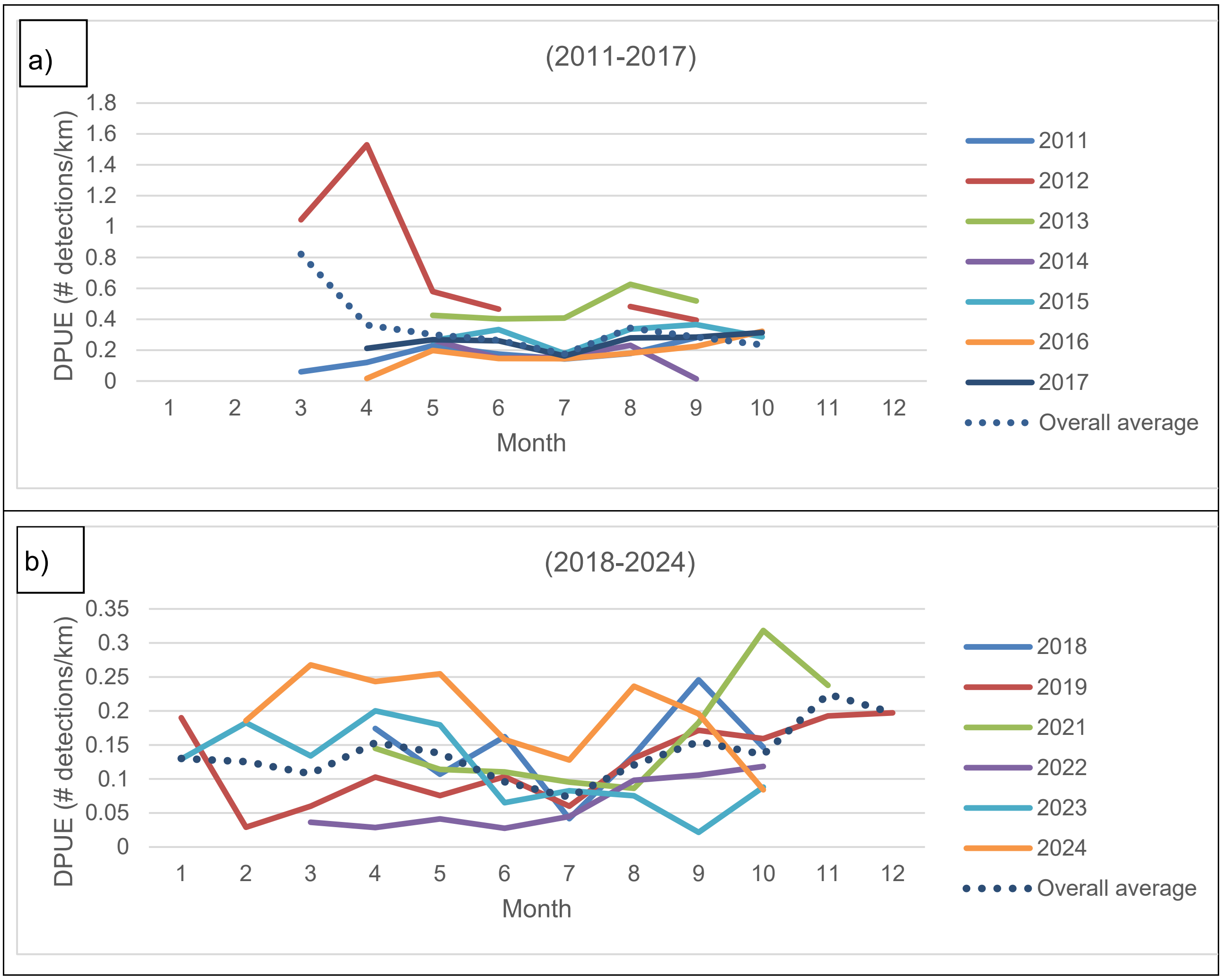


Figure 25 Summary of average porpoise acoustic DPUE rates by year, by month across a) 2011-2017 and b) 2018-2024. Average DPUE rates across both periods are also included.

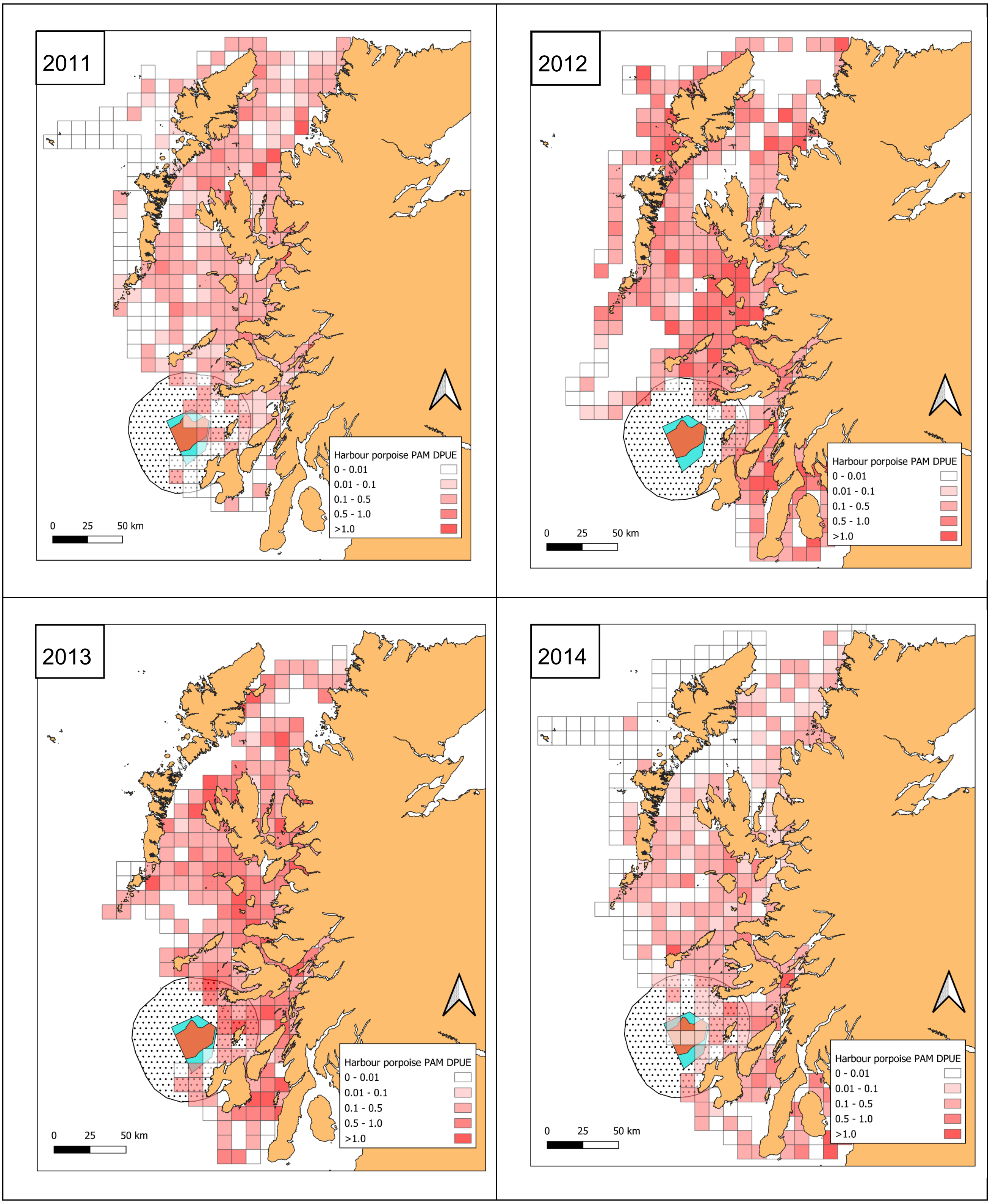


Figure 26 Overview of average annual acoustic DPUE for harbour porpoise (2011-2017) across a 10x10 km grid, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

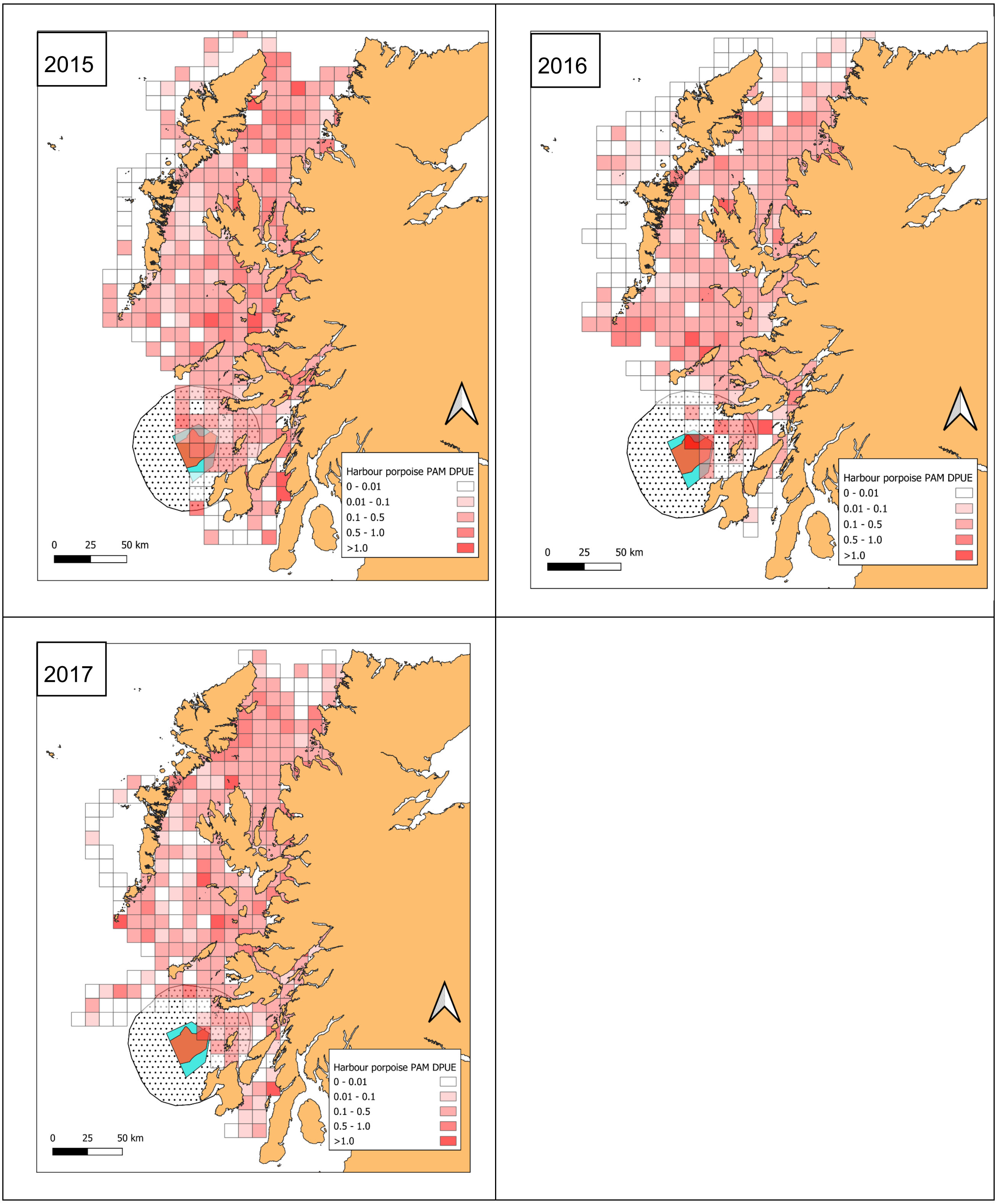
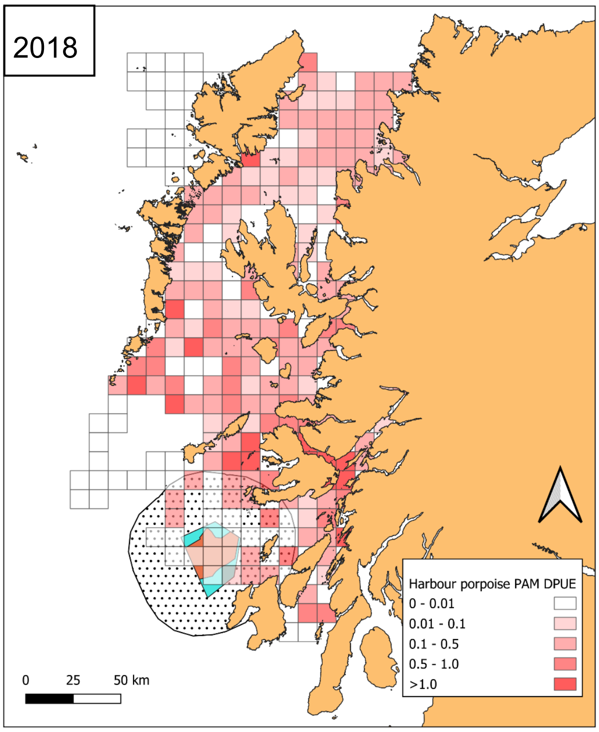
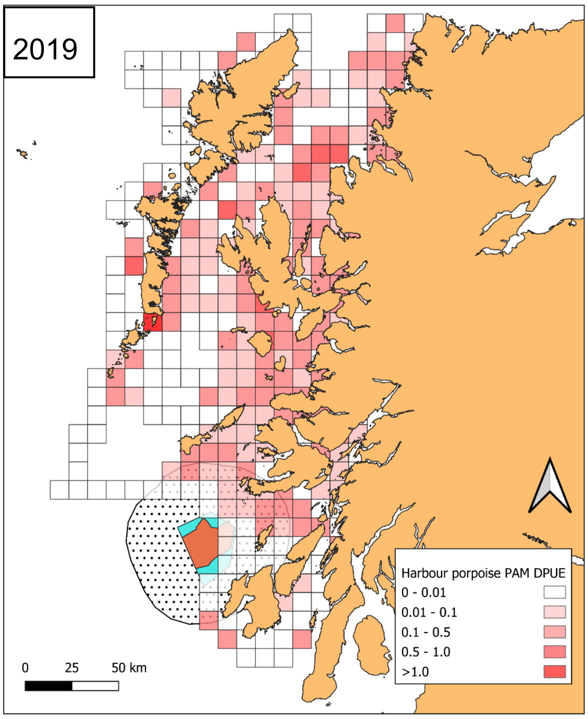


Figure 26 (continued). Overview of average annual acoustic DPUE for harbour porpoise (2011-2017) across a 10x10 km grid, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.





2020

2020 data not included due to impact from COVID restrictions.

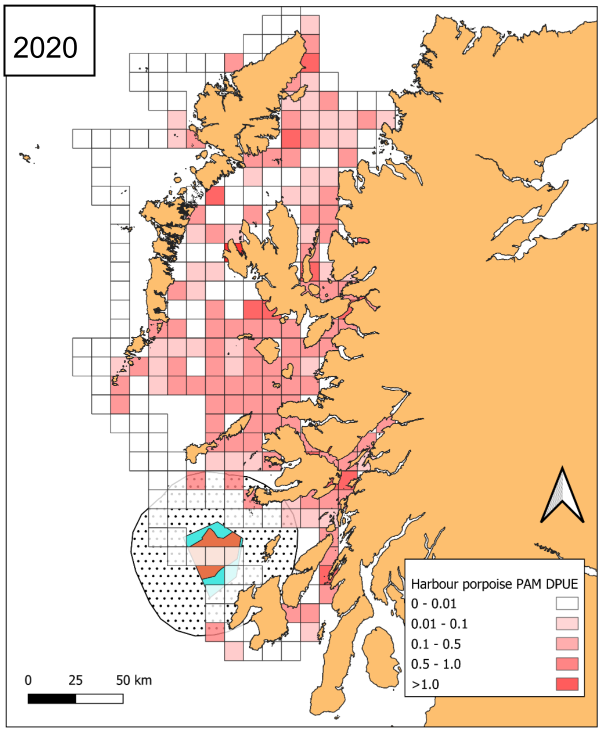


Figure 27 Overview of average annual acoustic DPUE for harbour porpoise (2018-2024) across a 10x10 km grid, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

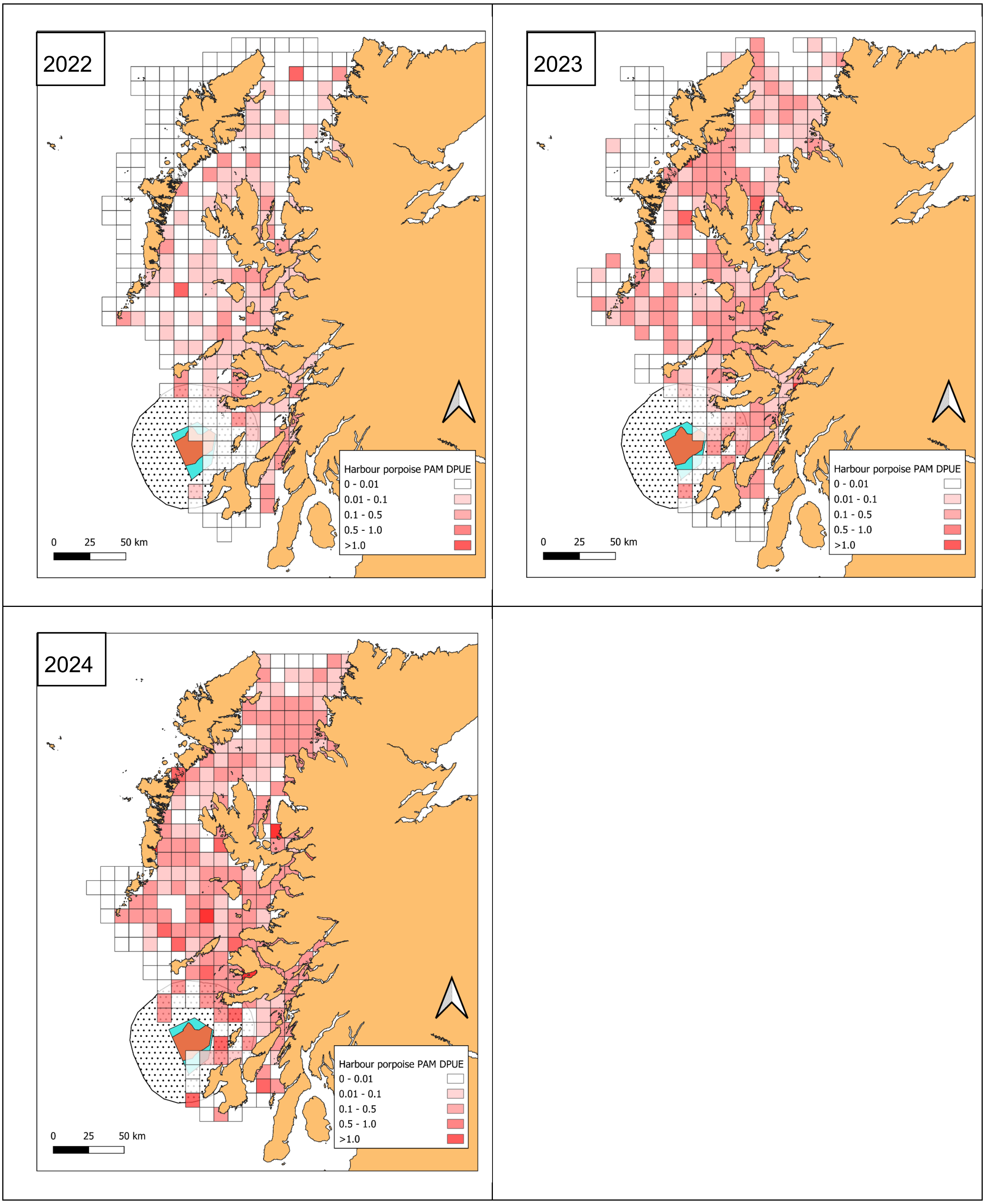


Figure 27 (continued). Overview of average annual acoustic DPUE for harbour porpoise (2018-2024) across a 10x10 km grid, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

4.2.4 Harbour Porpoise: Comparison Between Visual and Acoustic Surveys

The vast majority of survey effort conducted between 2018-2024 involved both visual and acoustic monitoring modalities, although COVID-19-related restrictions resulted in primarily acoustic survey effort in 2020-2021 (**Table 6**). Please note that these results do not enable evaluation, on an event-by-event basis, of whether specific visual observations corresponded to acoustic detections and *vice versa*.

Table 6 Overview of completed HWDT survey effort during 2018-2024, expressed as number of grid cells in which survey effort was undertaken using visual and/or acoustic survey modalities.

Year	Only visual survey effort	Only acoustic survey effort	Visual & acoustic survey effort	Total number of grid cells
2018	28	3	276	307
2019	3	4	309	316
2020	No data			
2021	0	328	0	328
2022	6	5	323	334
2023	12	6	295	313
2024	10	1	282	293

In cases where both visual and passive acoustic survey effort occurred in the same grid cell, the numbers of grid cells where porpoises were detected through only one or the other modality were compared (**Table 7**). During all years, more passive acoustic detections occurred in cases where porpoises were not visually observed, than there were visual observations that did not coincide with passive acoustic detections. While not addressing specific observations, this crude metric reinforces the importance of using passive acoustic monitoring alongside visual surveys as part of a comprehensive survey effort for an otherwise elusive species like the harbour porpoise. **It is important to note that the associated DPUE rates for visual sightings and acoustic detections are not directly equivalent – i.e., no direct, numerical relationship between visual and passive acoustic DPUE rates for harbour porpoise is implied within a given grid cell.**

Table 7 Summary of the number of grid cells in which harbour porpoise presence was identified, having been surveyed by visual and/or passive acoustic modalities. *Based on PAM data only.

Year	Visual and/or acoustic survey effort	No porpoise sightings or detections	Only visual sightings	Only acoustic detections	Both visual sightings and acoustic detections
2018	276	74	31	89	82
2019	309	124	21	80	84
2020	No data				
2021*	278	132	0	146	0
2022	323	160	40	52	66
2023	295	111	24	90	70
2024	282	71	12	97	102

When comparing general presence and distribution patterns, aggregated by grid cell, across survey modalities and years, broadly similar patterns were observed, although acoustic detections were more widespread than visual sightings (**Figure 28**). It is important to reiterate that sightings are on an observation encounter basis, whilst acoustic detections can be based on a single click, single click train, or single click event. Nonetheless, in many areas, including the area around the WDA, acoustic DPUE rates are relatively high while concurrent visual DPUE rates are relatively low (when compared across the HWDT survey area), suggesting that porpoises were more often detected acoustically than spotted visually. This can relate to elevated sea state levels observed in these areas (**Figure 10**), although numerous other factors (e.g., vocalisation rates) come into play.

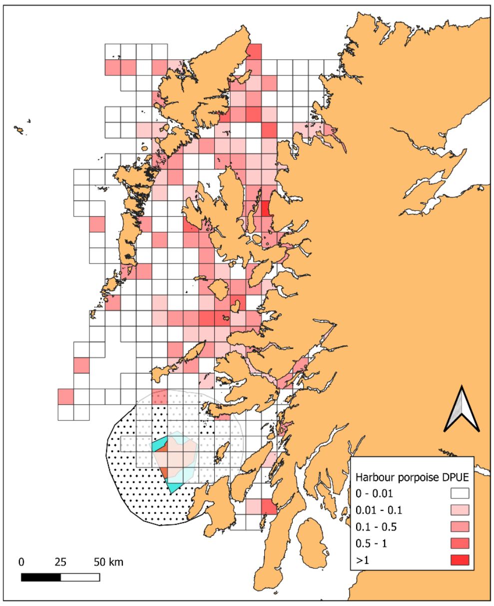
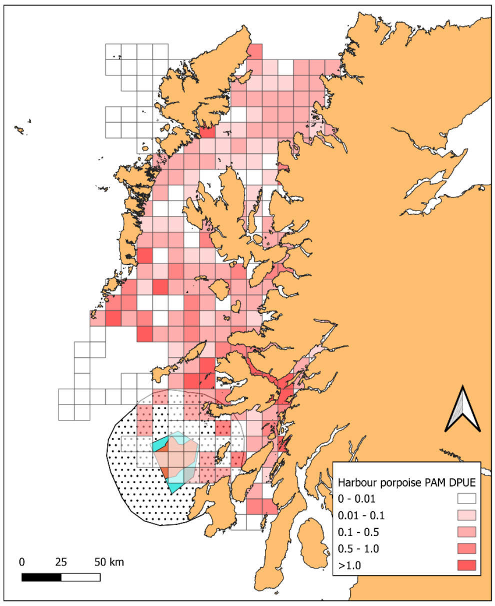
<table>
<tr><th>Year</th><th>Visual</th><th>Acoustic</th></tr>
<tr><td>2018</td><td>
</td><td>
</td></tr>
</table>

Figure 28 Comparison between annual average visual and passive acoustic DPUE rates, aggregated in 10x10 km grid cells, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

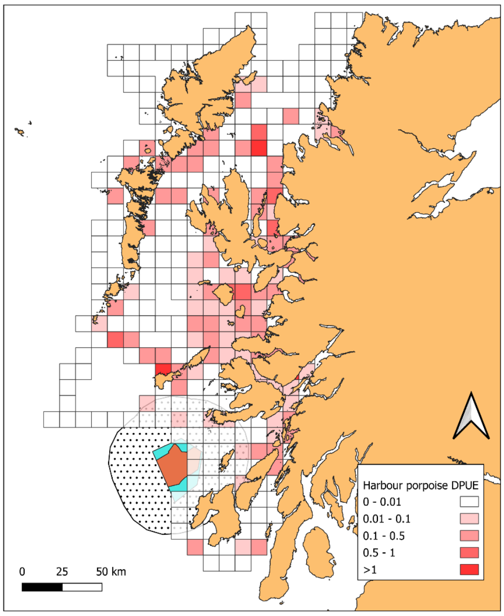
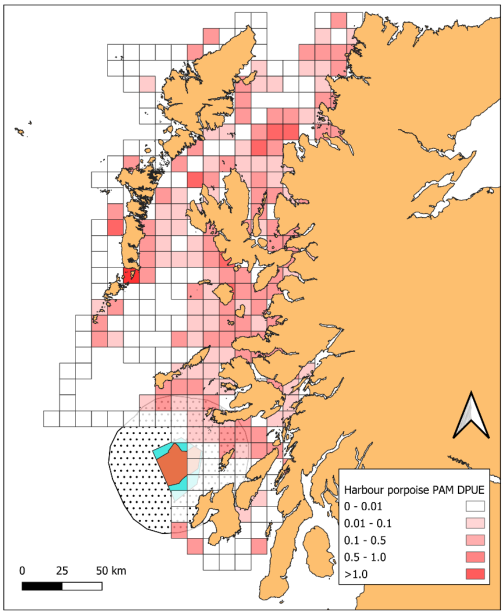
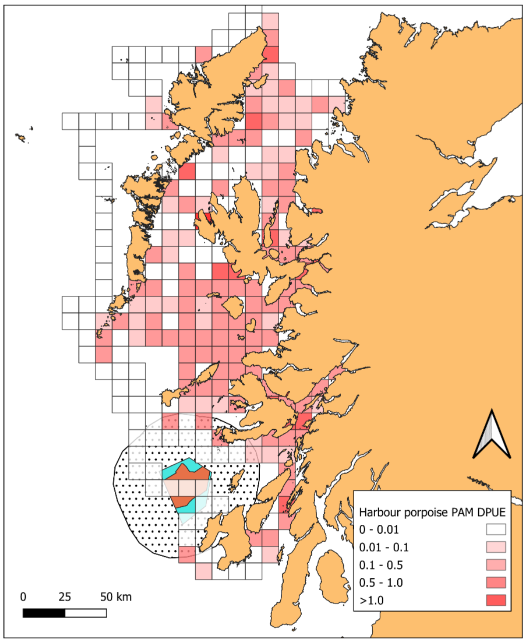
2019		
2020	Visual data not included due to impact of COVID restrictions.	Acoustic data not included due to impact of COVID restrictions.
2021	Visual data not included due to impact of COVID restrictions.	

Figure 28 (continued). Comparison between annual average visual and passive acoustic DPUE rates, aggregated in 10x10 km grid cells, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

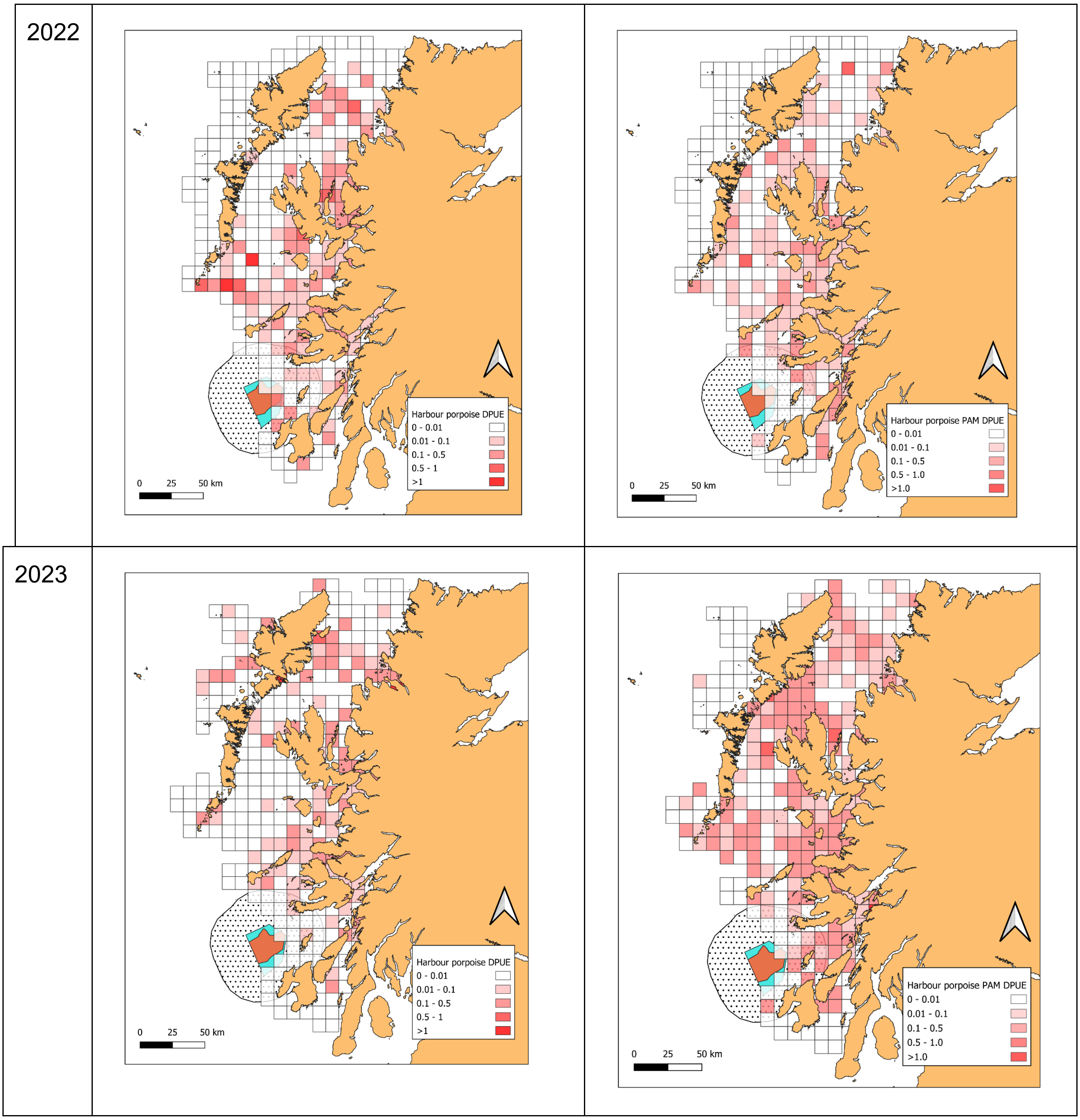


Figure 28 (continued). Comparison between annual average visual and passive acoustic DPUE rates, aggregated in 10x10 km grid cells, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

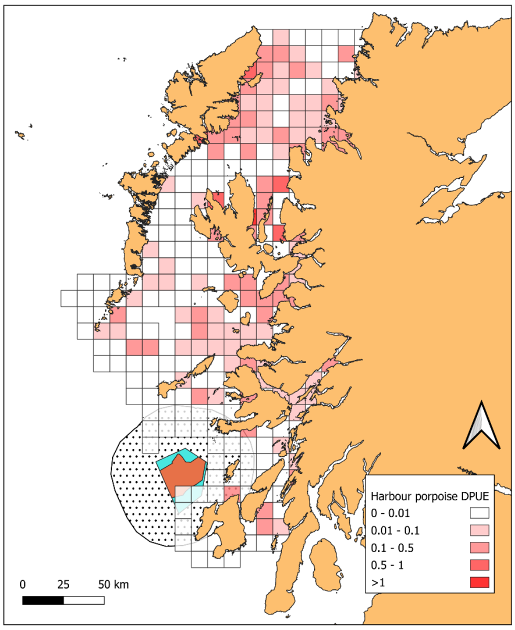
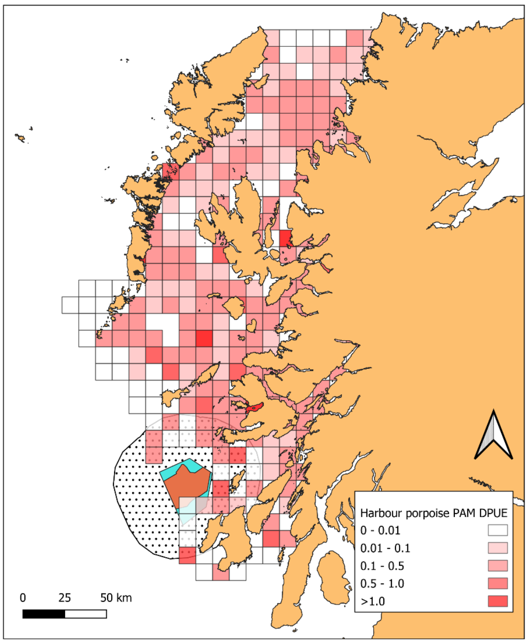
2024		

Figure 28 (continued). Comparison between annual average visual and passive acoustic DPUE rates, aggregated in 10x10 km grid cells, relative to WDA/OAA (red/blue polygon). The dotted polygon indicates the 30 km buffer zone around the WDA.

5 WHALE TRACK DATA

5.1 Whale Track casual sightings

5.1.1 Methods

Whale Track casual sightings refer to opportunistic observations, from either a vessel or the shore, where there is no search effort associated with the sightings data. Data are submitted through the Whale Track smartphone app or website, which captures the time and observers' location along with required information on the species, number of animals, reporter confidence, sea state and visibility. Records are verified following a set protocol designed to ensure accuracy and consistency across the dataset. Verification is undertaken by trained volunteers following a standardised protocol that assess records against predefined criteria, including spatial and temporal plausibility, species identification, group size and behaviour. Where available, supporting photographic or video evidence is used to confirm species identification. Each record is assigned a verification status (i.e. correct, likely, plausible, pending, unlikely, incorrect). Records classified as incorrect or unlikely were removed prior to analysis. Records classified as pending have undergone initial screening to remove any incorrect sightings. Data from recent years are close to fully verified, and verification is ongoing for earlier years.

The Whale Track data were assessed on an encounter basis as presence-only sightings. Whale Track casual sightings data were provided by HWDT in Excel format and imported into QGIS where any data points that were more than 1 km inland from the coastline or outside the preset grid were removed (3,443 records), leaving 25,120 records available for analysis. Entries without species designation (12) and/or lacking a reporter confidence assessment on species identification (20) were also removed, resulting in a total of 25,088 records which were analysed in more detail. Data were analysed to assess species presence and distribution, and to identify any monthly and interannual trends within the data range (2018-2024). Species-specific distributions of observations were visualised by mapping the number of sightings per 10x10 km grid cell relative to WDA. Seals are not recorded on Whale Track to avoid potential inclusion of sightings of seals on shore into the database (HWDT, pers.comm., October 2025).

5.1.2 Results

Analysis of the remaining 25,088 records suggested that reporting rates have increased over time, with 2023 being the best year to date in terms of number of individual reports received (6112, or 24.4% of all reports; **Figure 29c**).

Reports were highly seasonal, with most reports across 2018-2024 falling within the May-September period (21,512, or 85.8% of total; **Figure 29a-b**). A particular high number of sighting reports were received in August 2023 (1,523; **Figure 29a**). Winter observations (December-February) were relatively limited (649, or 2.6% of total). This is most likely related to temporal distribution of observer effort, with more people on or near the water during the May-September period, overall better weather and sea state conditions of spotting sightings, as well as longer daylight hours and the seasonal presence of migratory species increasing both species diversity and number of sightings.

Spatial coverage of Whale Track casual records includes most of the inshore waters off the Scottish west coast, with large numbers of reports from around the Inner Hebrides (especially between Skye and Mull). Other areas with comparatively high rates of reports include the Clyde and Arran, the Firth of Lorn, and the central and northern Minch (particularly on the Ullapool-Stornoway ferry route). The number of reported sightings per grid cell varied across the area of study, with highest concentrations of sighting records around the Isle of Mull. Although reporting rates were relatively low, some casual observations were reported from within and surrounding the WDA (**Figure 30**).

Perhaps unsurprisingly, the lowest number of reports were received in 2020 (2,243), presumably due to various COVID-19-related restrictions. This is also apparent from the increase in reporting rates during the 2nd half of the year when the strictest limitations were lifted.

The majority (88.4%) of casual sighting reports involved a small number of species, with harbour porpoise, common dolphin and minke whale each making up >20% of all reports (**Figure 29b-c**; **Table 8**). Other noteworthy species reported regularly, albeit in comparatively lower numbers, include bottlenose dolphin, basking shark, Risso's dolphin, killer whale, humpback whale and fin whale. Additionally, the casual sighting reports include rare observations of multiple additional species, including those typically found in deep offshore waters (e.g., Northern bottlenose whale, Cuvier's beaked whale, sperm whale) or in warmer waters (striped dolphin; **Figure 29b-c**). Many of these species are sufficiently rare in inshore Scottish waters so as to be difficult to pick up even through HWDT's comparatively intense survey efforts, and therefore these casual sightings offer a unique perspective on these rarer elements of the Scottish marine mammal community.

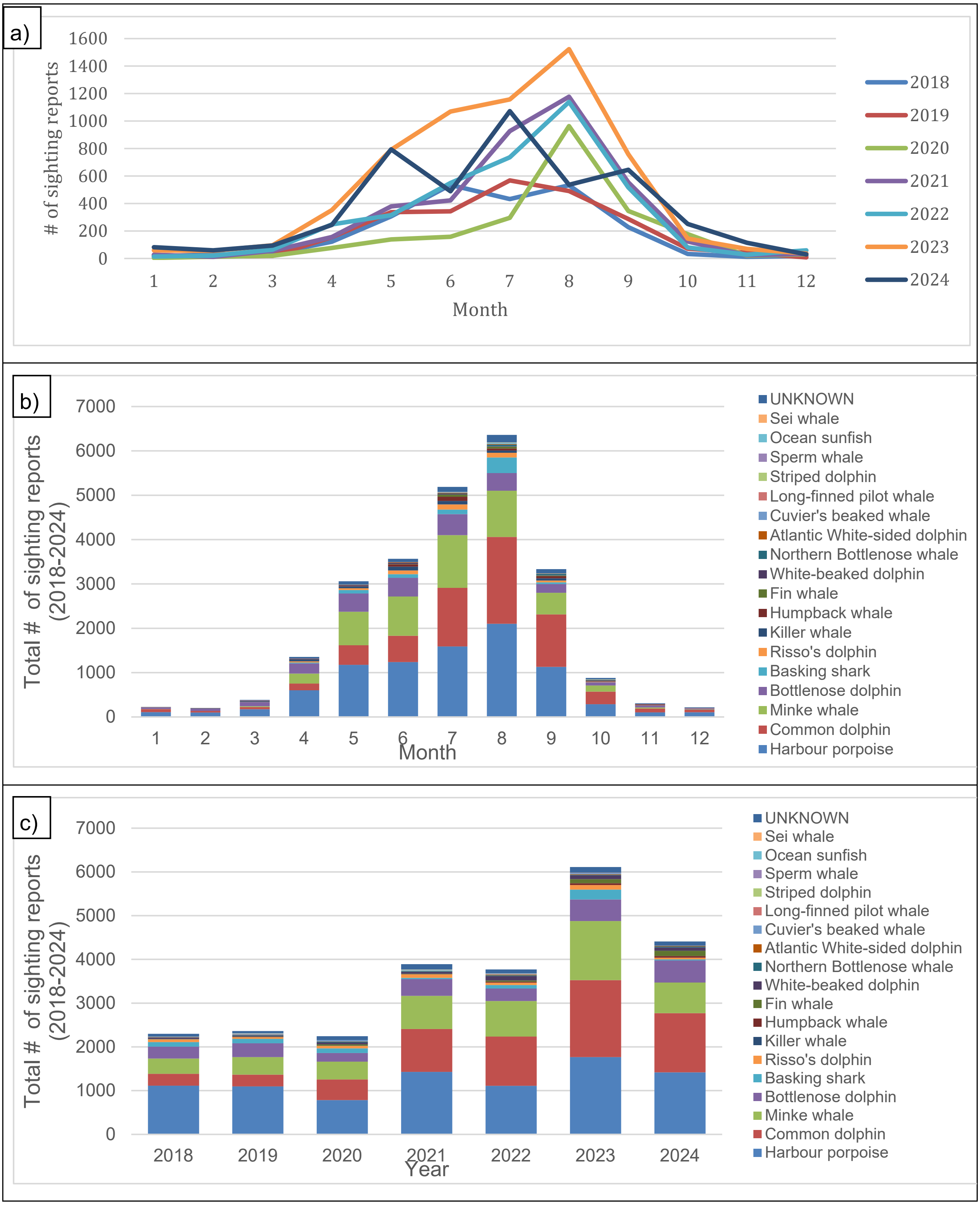


Figure 29 Summary of Whale Track Casual sightings data (2018 – 2024). a) Number of sighting reports per month for all species combined; b) Number of sighting reports per month showing all species (2018-2024 data combined); c) Number of sighting reports per year showing all species (2018-2024 data combined).

Table 8 Summary of Whale Track casual sighting reports of all reported species (2018-2024).

Species	Number of reports	Percentage of total
Harbour porpoise	8717	34.8%
Common dolphin	6231	24.8%
Minke whale	4777	19.0%
Bottlenose dolphin	2452	9.8%
Basking shark	672	2.7%
Risso's dolphin	435	1.7%
Unidentified dolphin	416	1.7%
Killer whale	396	1.6%
Humpback whale	299	1.2%
Fin whale	112	0.5%
White-beaked dolphin	111	0.4%
Unidentified whale	93	0.4%
Northern bottlenose whale	85	0.3%
Atlantic white-sided dolphin	63	0.3%
Unidentified cetacean	54	0.2%
Other	45	0.2%
Ocean Sunfish	45	0.2%
Unknown	30	0.1%
Long-finned pilot whale	26	0.1%
Sei whale	10	<0.1%
Striped dolphin	8	<0.1%
Sperm whale	7	<0.1%
Cuvier's beaked whale	4	<0.1%

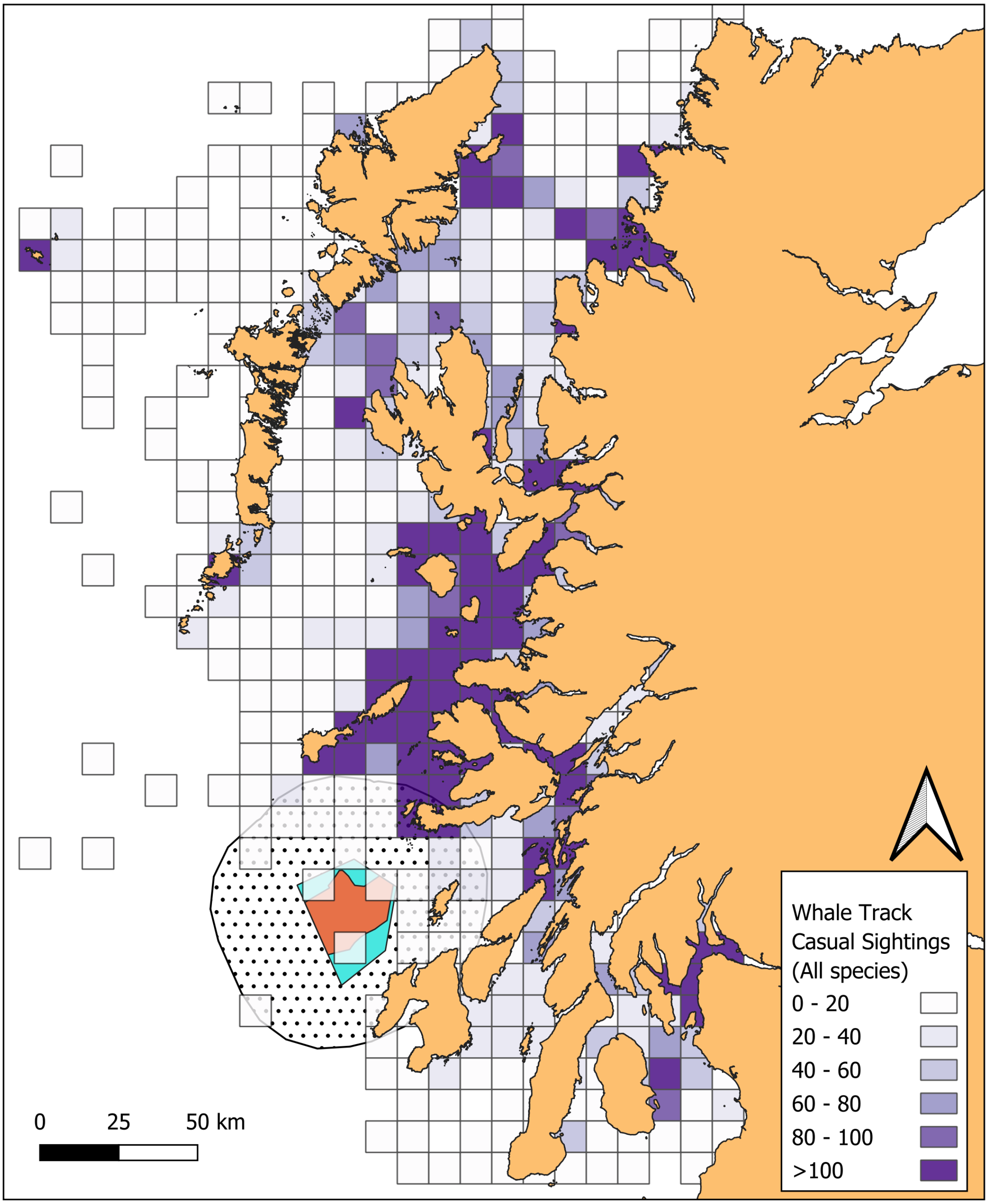


Figure 30 Overview of Whale Track casual sightings data 2018-2024 (number of sightings per 10x10 km grid cell) by year (2018-2024), relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.1.2.1 Harbour porpoise

From 2018 to 2024, harbour porpoise was reported 8,717 times, most commonly in the month of August in absolute terms (**Figure 31a**). However, it was proportionally commonly reported in winter months, which is not unexpected for what is thought to be a largely resident species in coastal waters off western Scotland (**Figure 31b**). When aggregated by year, as a % of total number of reports, a declining trend can be noted (**Figure 31c**) in apparent agreement with HWDT survey outcomes (**Figure 10**). The species was most commonly reported from coastal areas (**Figure 32**).

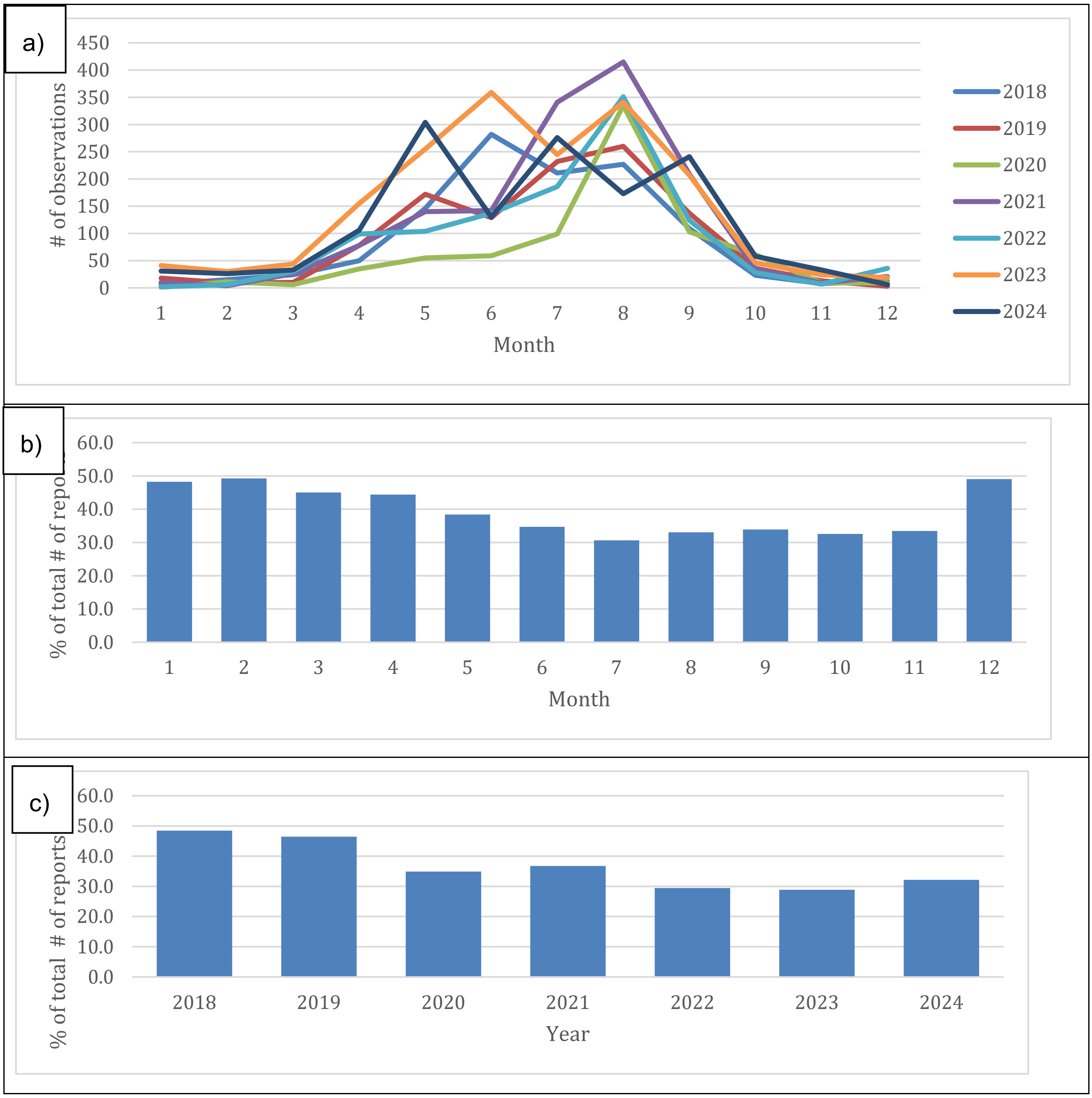


Figure 31 Whale Track Casual sightings reports of Harbour porpoise (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

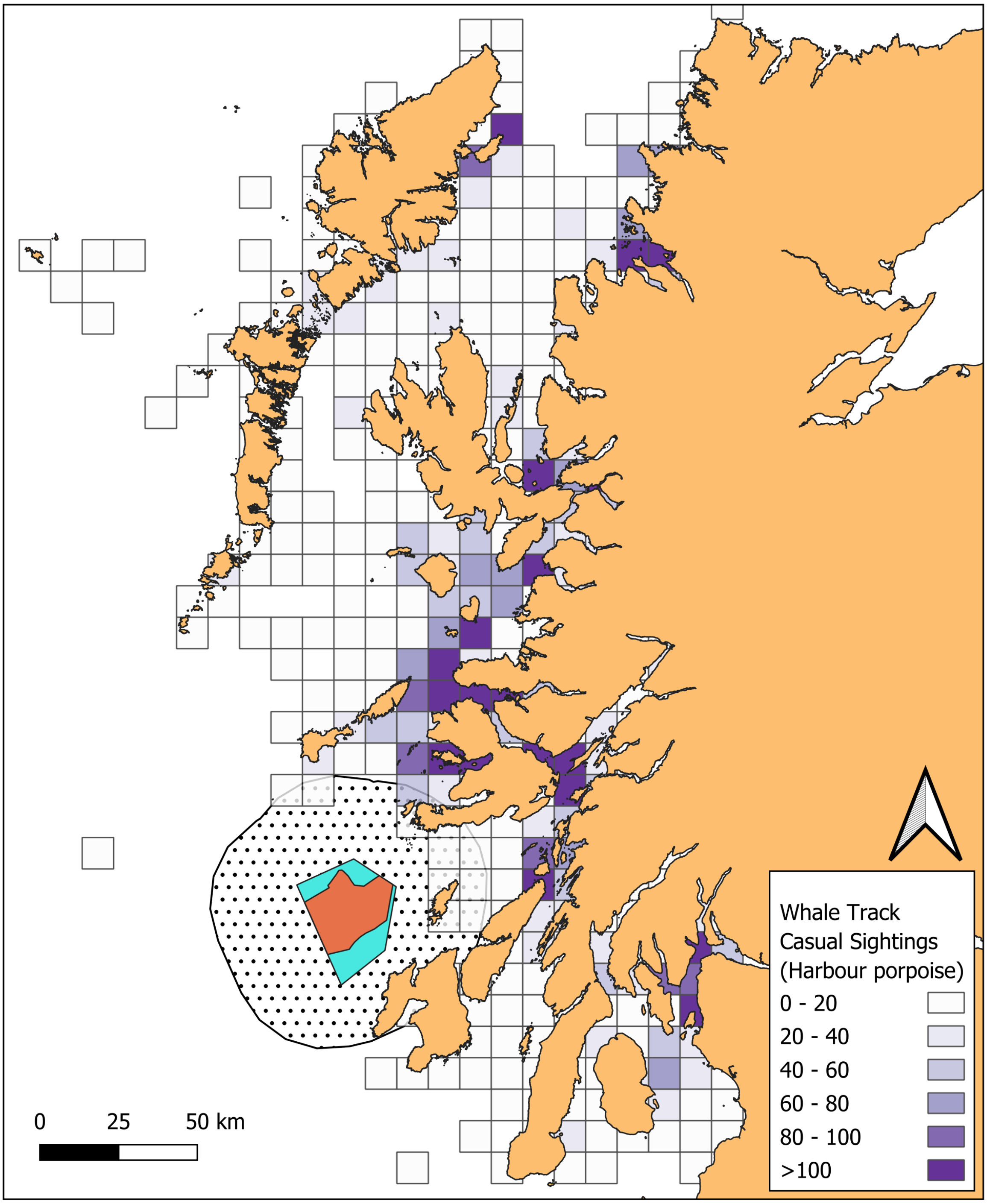


Figure 32 Distribution of harbour porpoise observations from Whale Track casual sightings data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.1.2.2 Common dolphin

From 2018 to 2024, common dolphin was reported 6,231 times, in absolute terms most commonly in the month of August (**Figure 33a**). Proportionally, detection rates of this species peaked in late summer/early autumn, with a pronounced reduction in proportional sighting rates in Spring (when waters are likely to be at their coldest; **Figure 33b**). A pronounced increase in % of all observations involving this species is notable over time (**Figure 33c**). Detections were particularly frequent to the north and west of Mull, immediately to the north of the WDA (**Figure 34**).

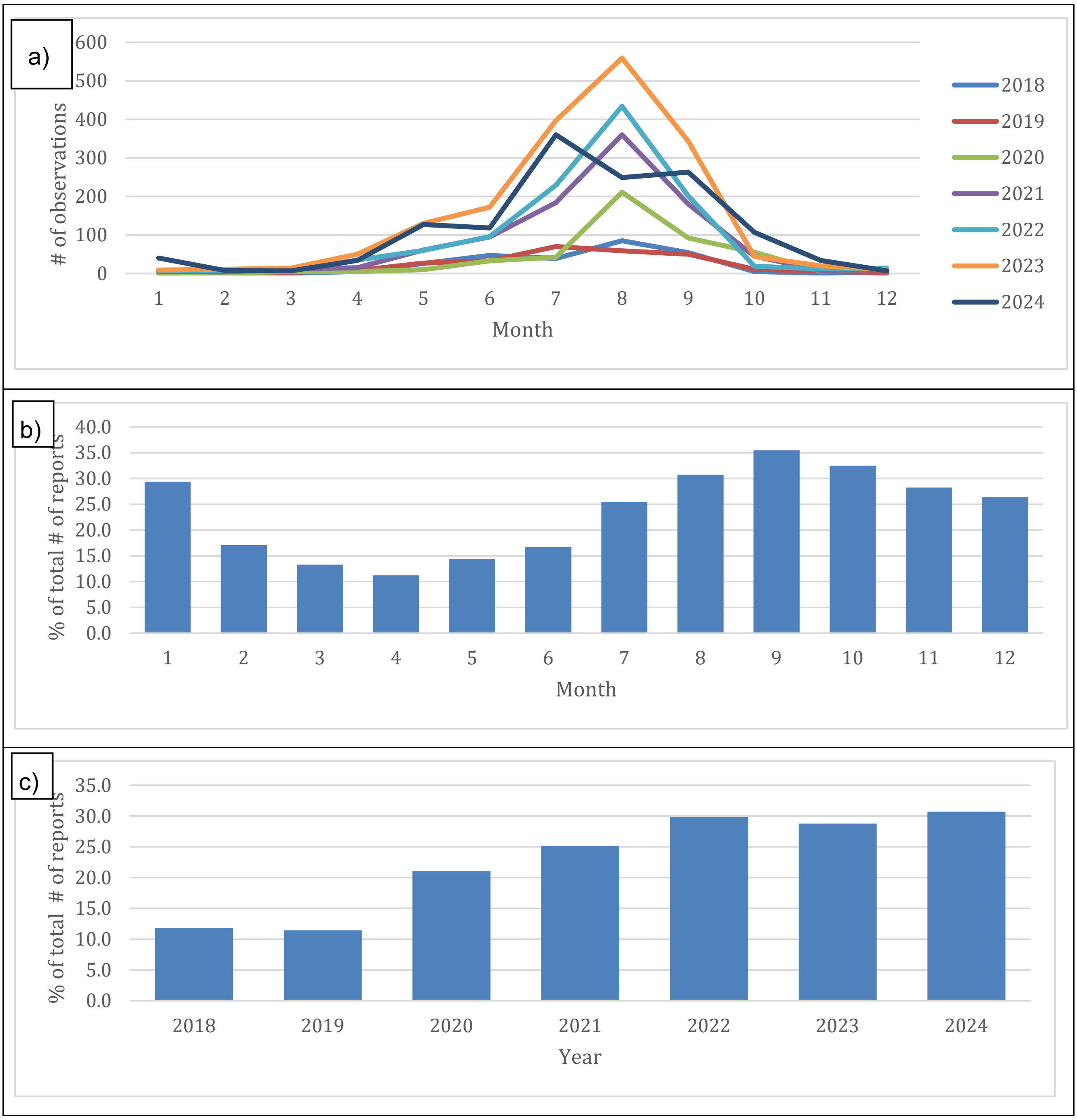


Figure 33 Whale Track Casual sightings reports of Common dolphin (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

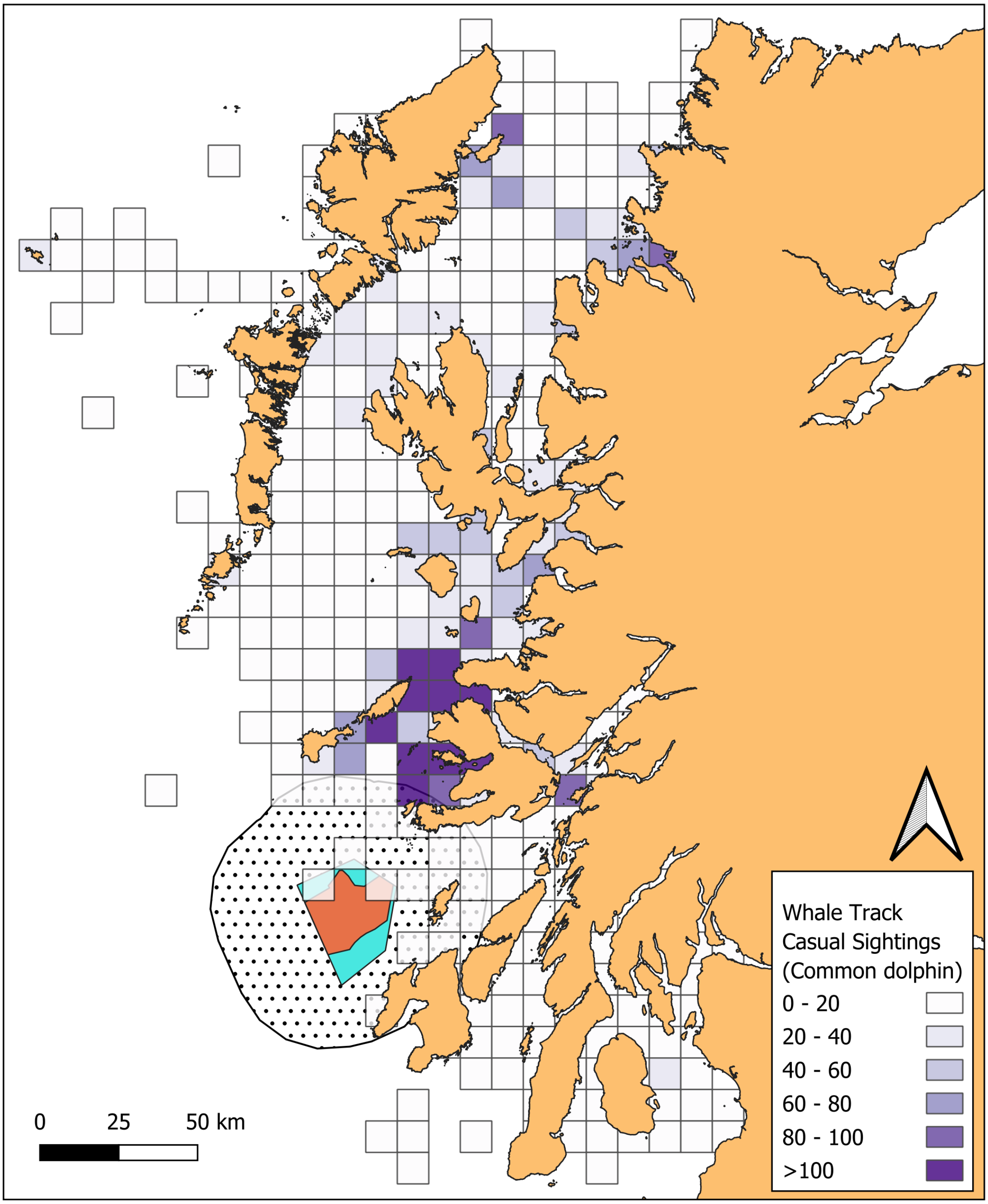


Figure 34 Distribution of common dolphin observations from Whale Track casual sightings data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.1.2.3 Minke whale

From 2018 to 2024, minke whale was reported 4,777 times, in absolute terms most commonly in the month of July (**Figure 35a**). Proportionally, this species was most often reported in late Spring/early Summer, with sighting rates particularly low in winter, which is expected for this migratory species (**Figure 35b**). A slow increase in % of all observations involving this species is apparent over time, although most recent observations from 2024 appear to buck this trend (**Figure 35c**). As with common dolphin, detections were particularly frequent to the north and west of Mull, immediately to the north of the WDA (**Figure 36**).

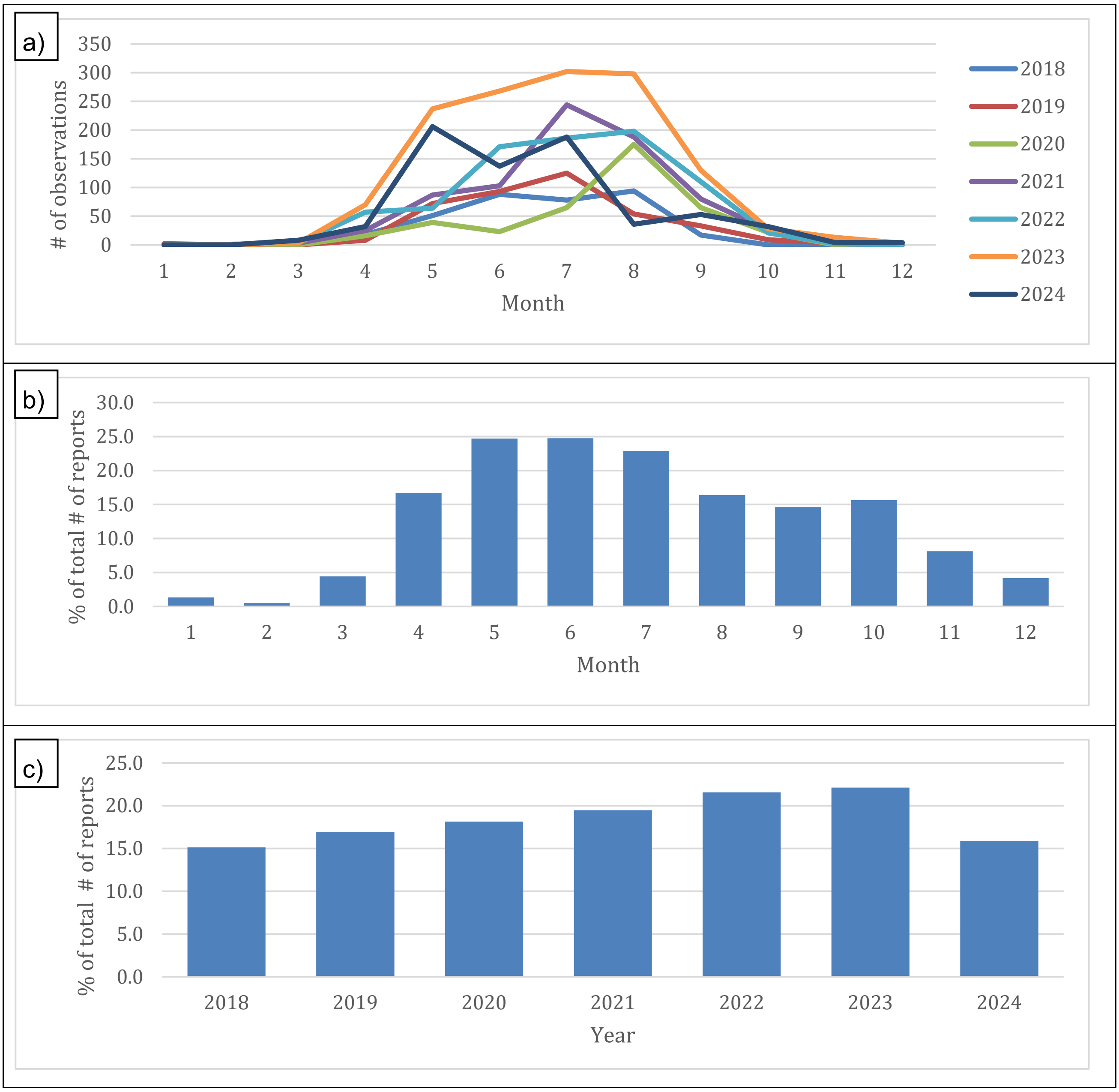


Figure 35 Whale Track Casual sightings reports of Minke whale (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

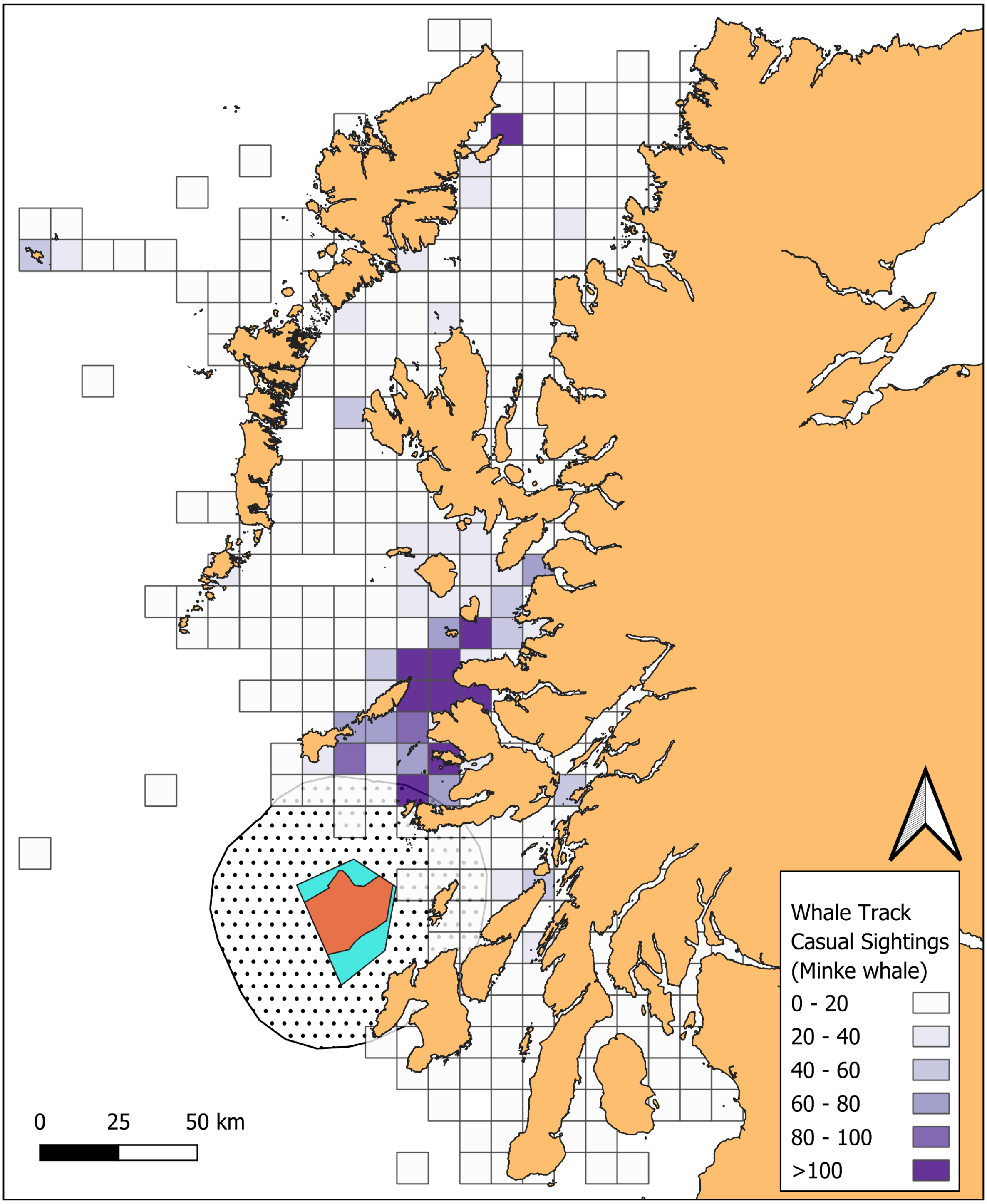


Figure 36 Distribution of minke whale observations from Whale Track casual sightings data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.1.2.4 Bottlenose dolphin

From 2018 to 2024, bottlenose dolphin was reported 2,452 times, in absolute terms most commonly in the month of July (**Figure 37a**). When considering sightings of this species as a proportion of total sightings by month across this period, the highest proportion of sightings occurred during winter months, when it is one of the few resident species present in coastal waters together with harbour porpoise and the seals. No clear interannual trend is notable in terms of proportion of bottlenose dolphin reports relative to the total number of reports (**Figure 37c**). For this species in particular, Whale Track sightings are an important source of information, as bottlenose dolphins tend to be observed in coastal waters and sometimes very close inshore in areas which cannot always be reached by HWDT surveys. The present observations therefore complement the findings from those surveys in terms of spatial coverage (**Figure 38**).

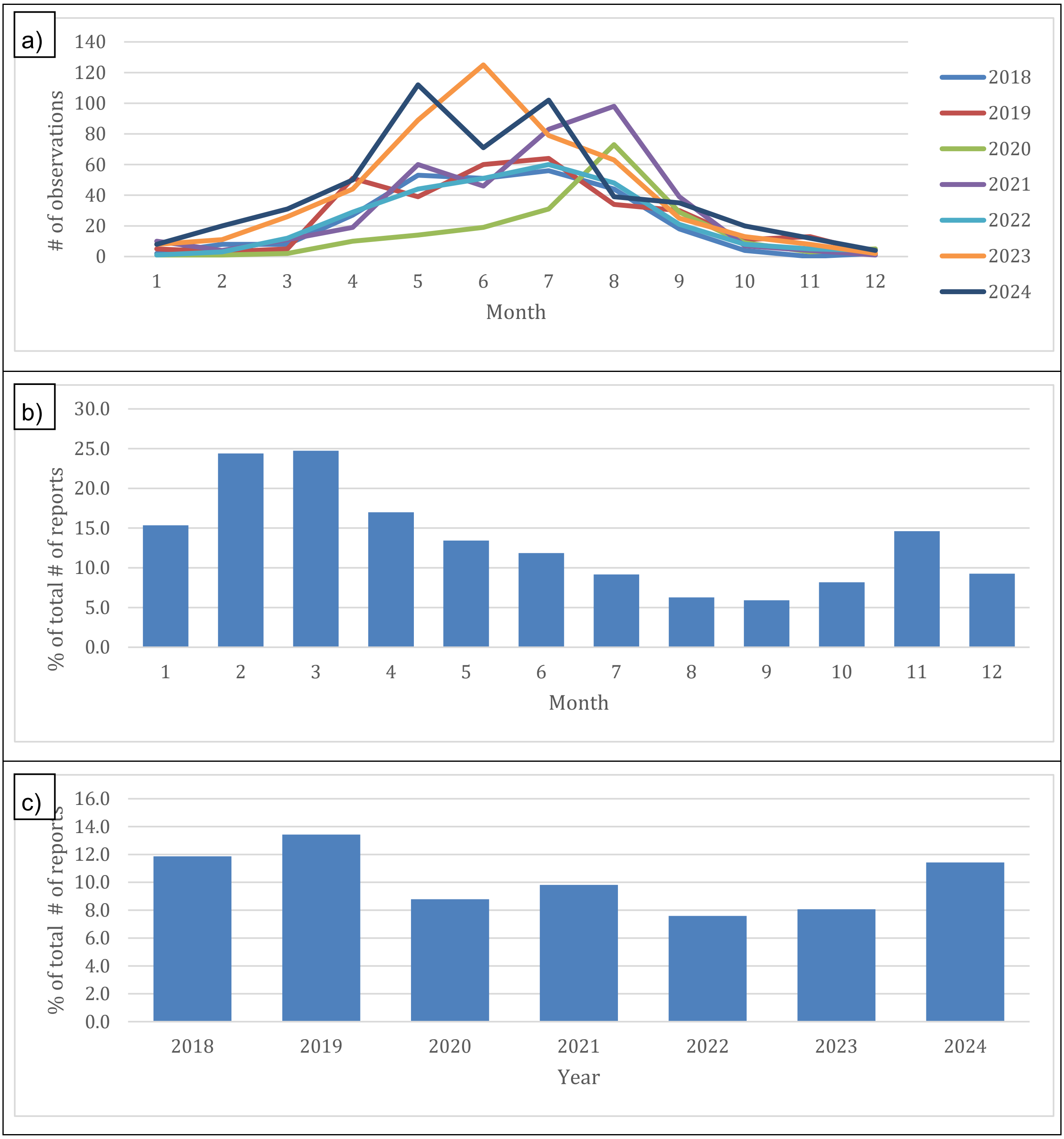


Figure 37 (continued). Whale Track Casual sightings reports of Bottlenose dolphin (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

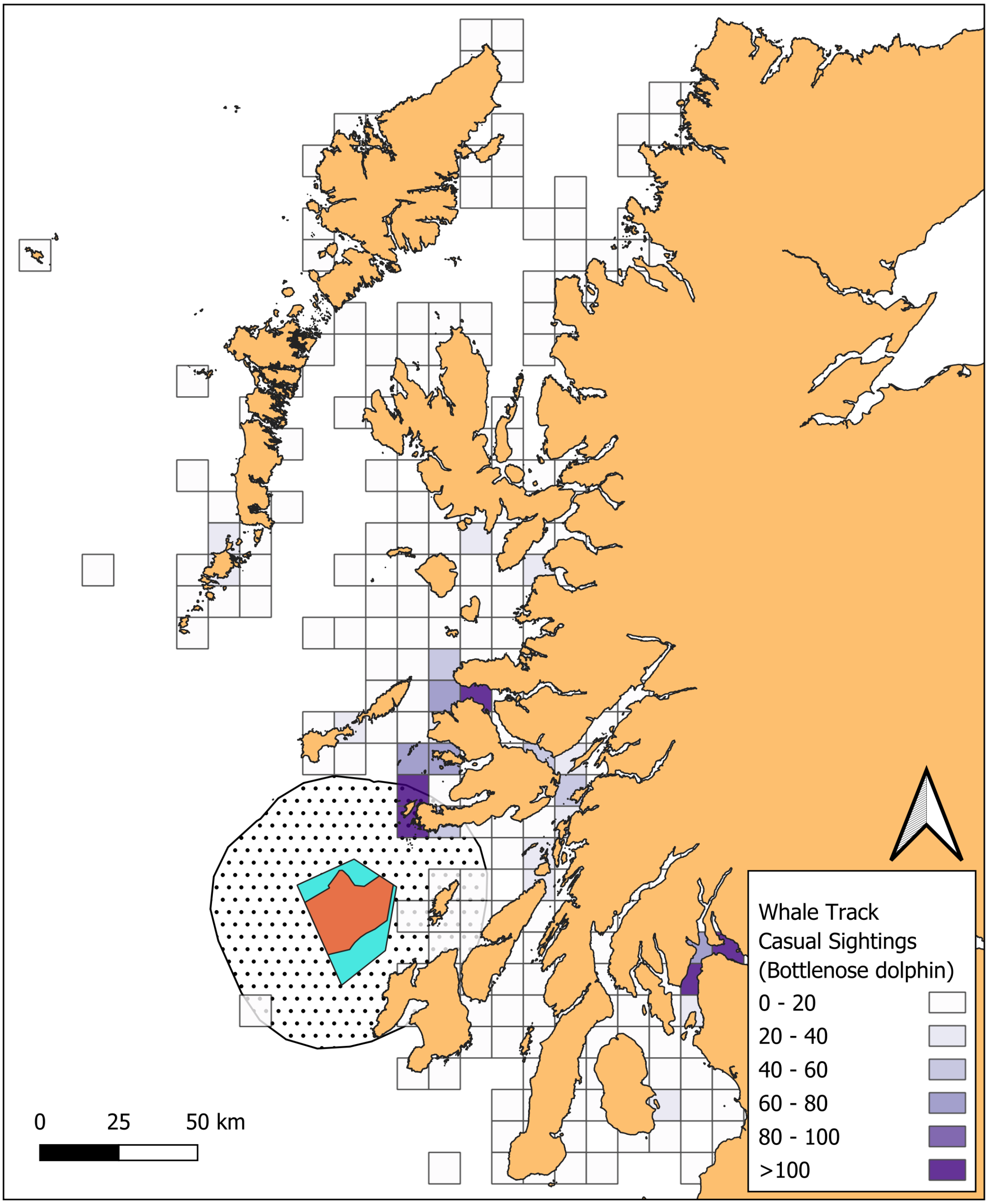


Figure 38 Distribution of bottlenose dolphin observations from Whale Track casual sightings data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.2 Whale Track Excursions

5.2.1 Methods

Whale Track Excursions refer to data recorded from moving vessels or other platforms during watches at sea. The trackline is automatically logged in the Whale Track app to provide effort-related data and is associated with any corresponding sighting data and environmental data. This includes required information on species, number of animals, bearing and distance of the sighting in relation to the vessel and reporter confidence for every sighting; sea state and visibility for environmental conditions logged every 15 mins; and vessel type, platform height, field of view, observer experience level, number of observers, and voyage type as ancillary information to categorise the excursion.

As with the casual data, all sightings records are subject to assessment against a verification protocol designed to maintain the accuracy and consistency of the dataset. Verification is undertaken by trained volunteers following a standardised protocol that assesses records against predefined criteria, including spatial and temporal plausibility, species identification, group size, and observed behaviour. Supporting photographic or video evidence is used where available to confirm species identification. Each record is assigned a verification status (correct, likely, plausible, pending, unlikely, or incorrect), with records classified as incorrect or unlikely removed prior to analysis. Pending records have undergone initial screening to remove clearly incorrect sightings and are retained where minimum verification criteria are met. Verification of recent years is near-complete, while verification of earlier records is ongoing.

Data from these surveys were provided by HWDT. As with the casual sightings, the Whale Track data were assessed on an encounter basis as presence-only sightings (i.e., survey effort was not accounted for in this analysis). While associated effort data were available for this dataset from HWDT, it was decided by the Project Team that incorporating effort-based analysis of these data was outside the scope of the present project. Any data points that were more than 1 km inland from the coastline and outside of the preset grid were removed (96 records), resulting in 17,182 records available for analysis. All records in this dataset included species classification information. Records lacking a confidence assessment on correct species identification (190) were removed, resulting in 16,992 records which were analysed in more detail. Data were analysed to assess species presence and distribution, and to identify any monthly and interannual trends within the data range (2018-2024). Distribution was visualised by mapping the number of sightings per 10x10 km grid cell relative to WDA.

5.2.2. Results

Analysis of the 16,992 records showed that reporting rates have varied over time. Within the 2018-2024 dataset analysed here, most sightings were recorded in 2019 (3,535, or 20.80% of all received sighting reports; **Figure 39c**). Recorded sightings were highly seasonal, with most reports made during the May-September period (15,802, or 93.00% of total; Figure 39a-b). July 2019 was particularly high in terms of reports received (1,269). A low number of observations were logged in winter (December-February) with a total of 90 records across these years (0.53% of total number of records). As before, relatively few sightings (533) were made in 2020, with most reports provided during the second half of the year when some COVID-19-related restrictions were lifted and some activities could resume (**Figure 39a** and **Figure 39c**).

Spatial coverage of whale Track Excursions data is more spatially restricted than the Casual records dataset (Section 5.1, this report), with observations mainly originating in areas where marine wildlife-watching tour boat operators or passenger ferries provide access to the marine environment, including the northern Minch, around Mull/Ardnamurchan, and the central Firth of Lorn (especially the Gulf of Corryvreckan between Scarba and Jura). Although reporting rates were relatively low, some Excursion-based observations were reported from within the 30 km WDA buffer area (**Figure 30**).

The majority of excursion sighting reports across 2018-2024 involved a small number of species, with harbour porpoise, common dolphin and minke whale together representing >90% of all sightings (**Table 9**). Data from these species will be presented in more detail below. Lower numbers of sightings were reported for humpback whale, basking shark, bottlenose dolphin, Risso’s dolphin and fin whale, with the presence of other species each representing <0.5% of this dataset (**Figure 39b-c**; **Table 9**).

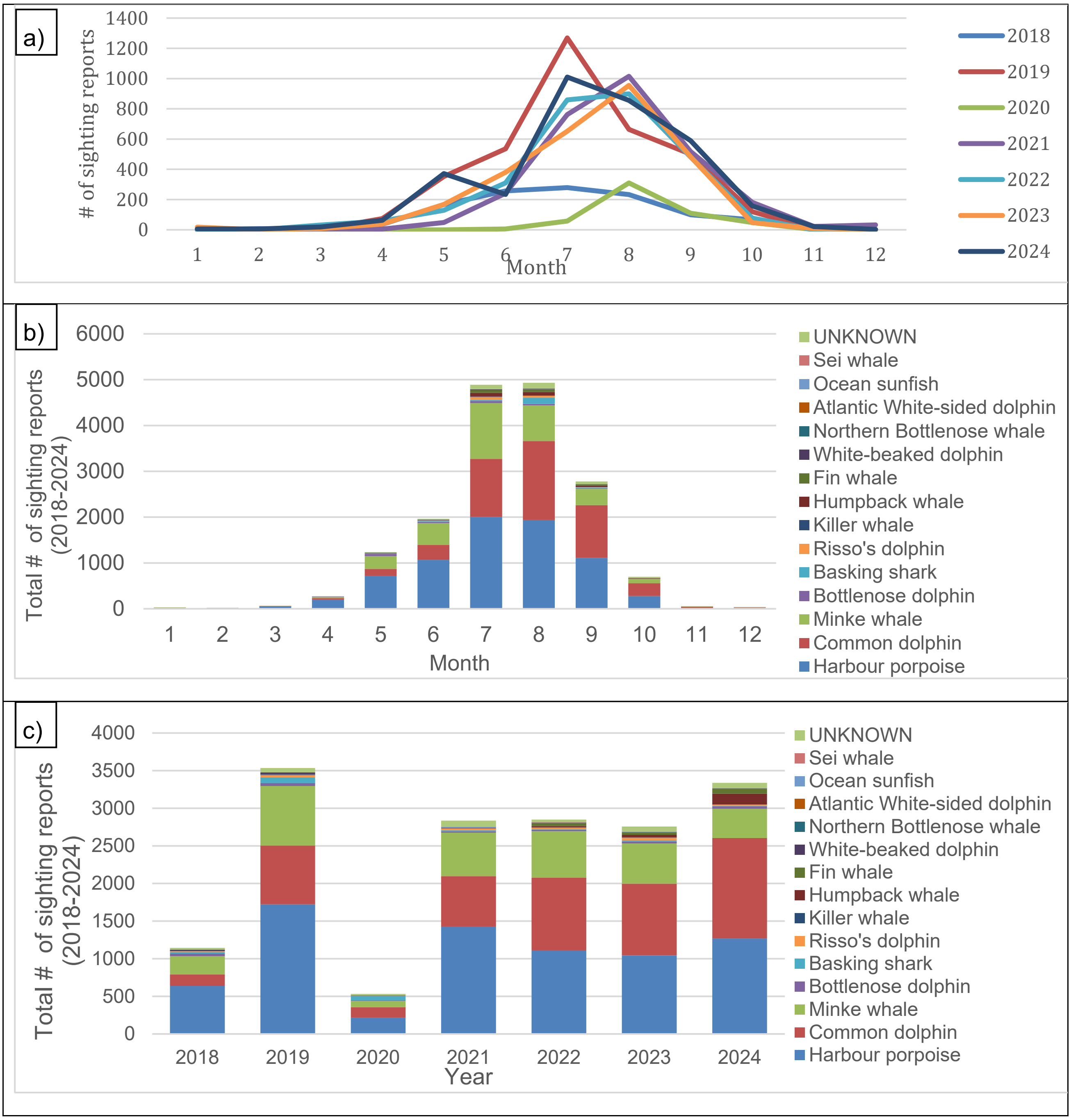


Figure 39 Summary of Whale Track Excursion sightings data (2018 – 2024). a) Number of sighting reports per month for all species combined; b) Number of sighting reports per month showing all species (2018-2024 data combined); c) Number of sighting reports per year showing all species (2018-2024 data combined).

Table 9 Summary of Whale Track Excursion sighting reports of all reported species (2018-202).

Species	Number of reports	Percentage of total
Harbour porpoise	7427	43.7%
Common dolphin	4999	29.4%
Minke whale	3238	19.1%
Humpback whale	202	1.2%
Unidentified dolphin	197	1.2%
Basking shark	188	1.1%
Bottlenose dolphin	180	1.1%
Risso's dolphin	142	0.8%
Fin whale	139	0.8%
Unidentified whale	71	0.4%
White-beaked dolphin	64	0.4%
Unidentified cetacean	52	0.3%
Killer whale	28	0.2%
Unknown	17	0.1%
Ocean Sunfish	15	0.1%
Other	15	0.1%
Northern bottlenose whale	8	<0.1%
Sei whale	6	<0.1%
Atlantic white-sided dolphin	4	<0.1%

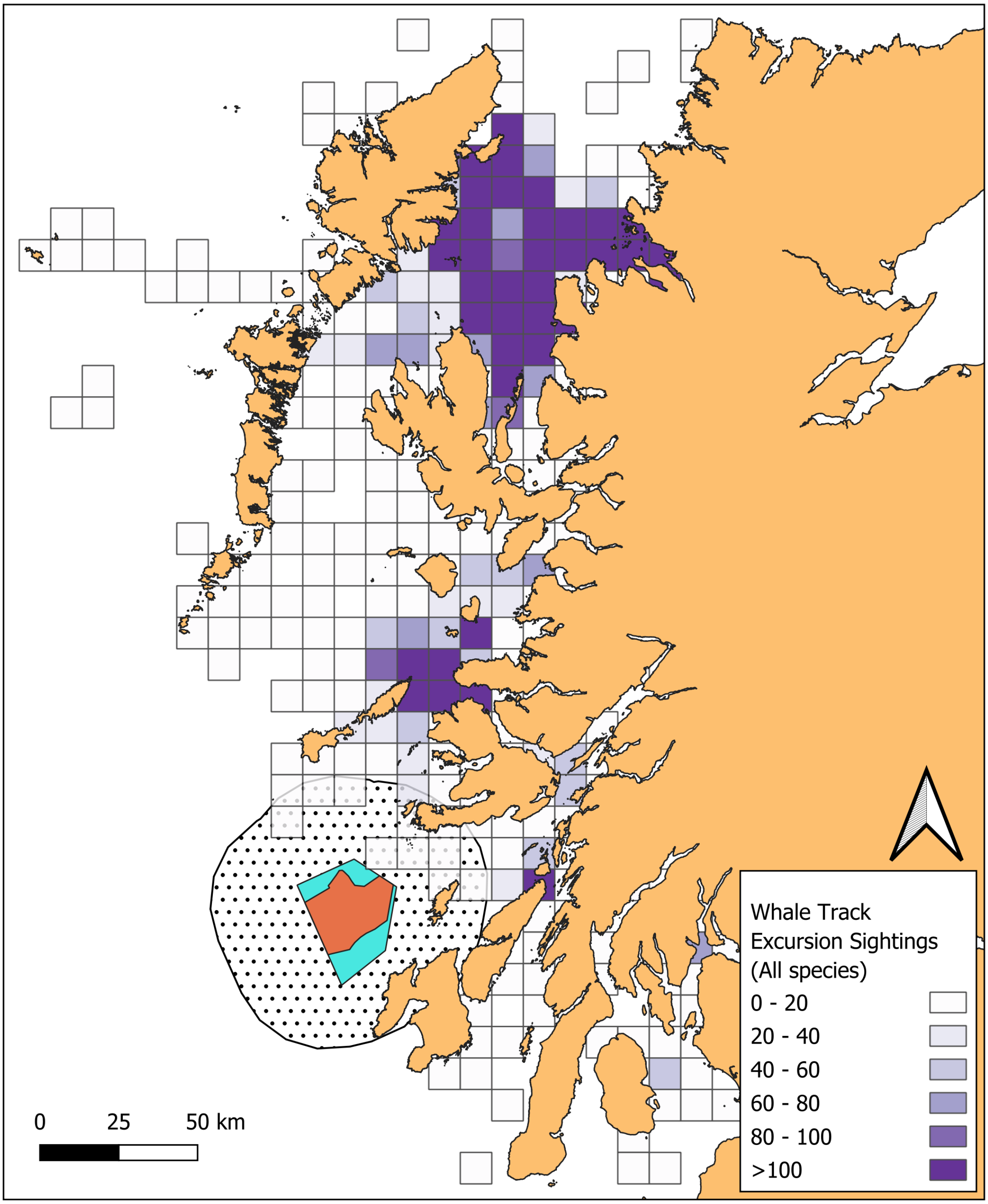


Figure 40 Overview of observations from Whale Track Excursions data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.2.1.1 Harbour porpoise

From 2018 to 2024, harbour porpoise was reported 7,427 times, in absolute terms most frequently in the month of July (**Figure 41a**), which is to be expected, given that the majority of reports are typically received in summer. When considering sightings of this species as a proportion of total sightings by month across this period, the highest proportion of sightings occurred during early Spring when it is one of the few resident species present in coastal waters (**Figure 41b**) outlines the distribution of harbour porpoise from 2018 to 2024.

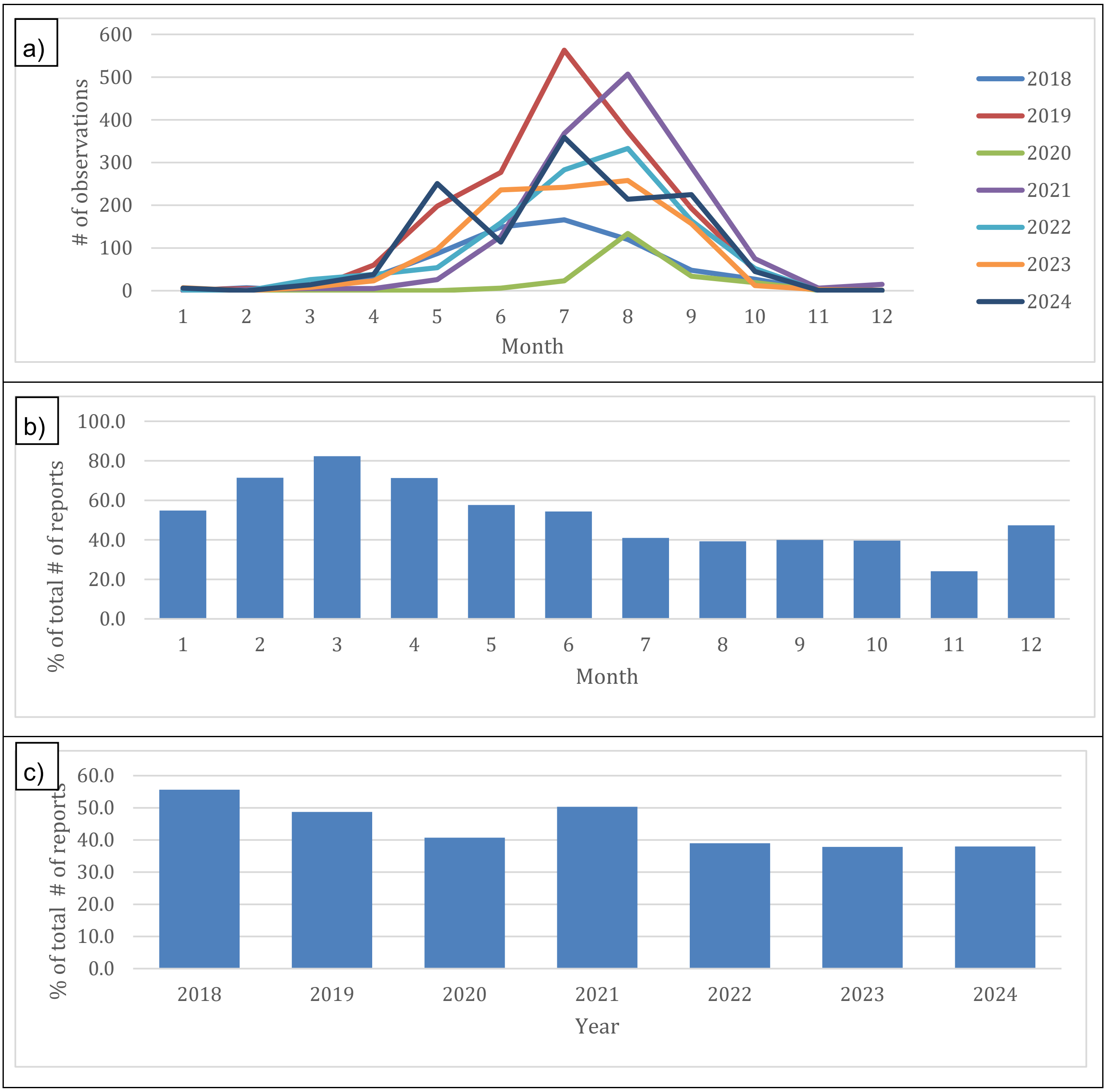


Figure 41 Whale Track Excursion sightings reports of Harbour porpoise (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

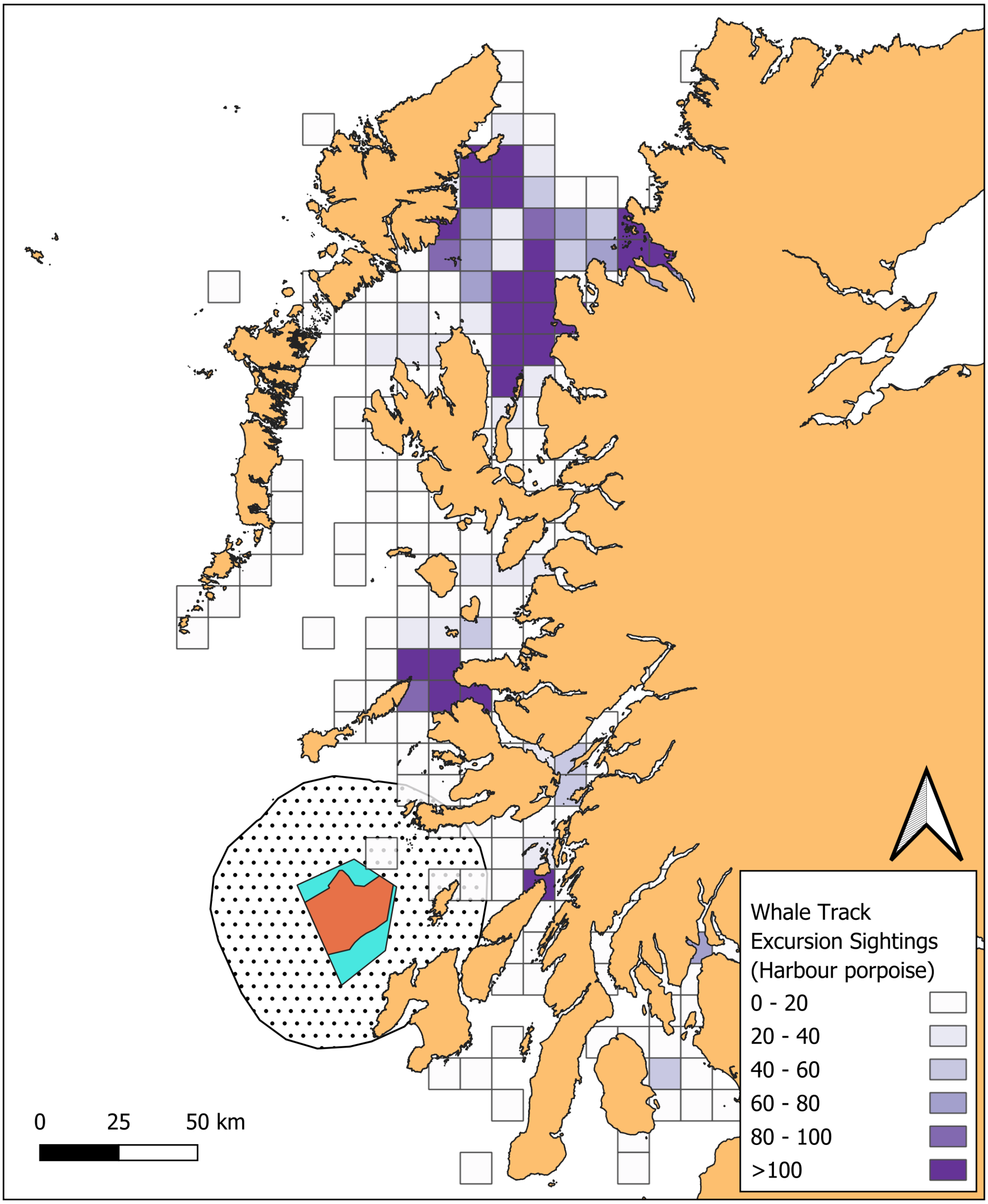


Figure 42 Distribution of harbour porpoise observations from Whale Track Excursions data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.2.1.2 Common dolphin

From 2018 to 2024, common dolphin was reported 4,999 times, in absolute terms most frequently in the month of August (**Figure 43a**). Proportionally, common dolphin sightings were lowest during Spring and most likely during late Summer and Autumn (**Figure 43b**), similar to Casual Sightings (**Figure 33b**). Proportional reporting rates increased over time (**Figure 43c**), in apparent agreement with HWDT survey observations (Figure 10). Sighting rates during this time were particularly high in the northern Minch and around Skye (**Figure 44**), in line with overall excursions data (**Figure 40**).

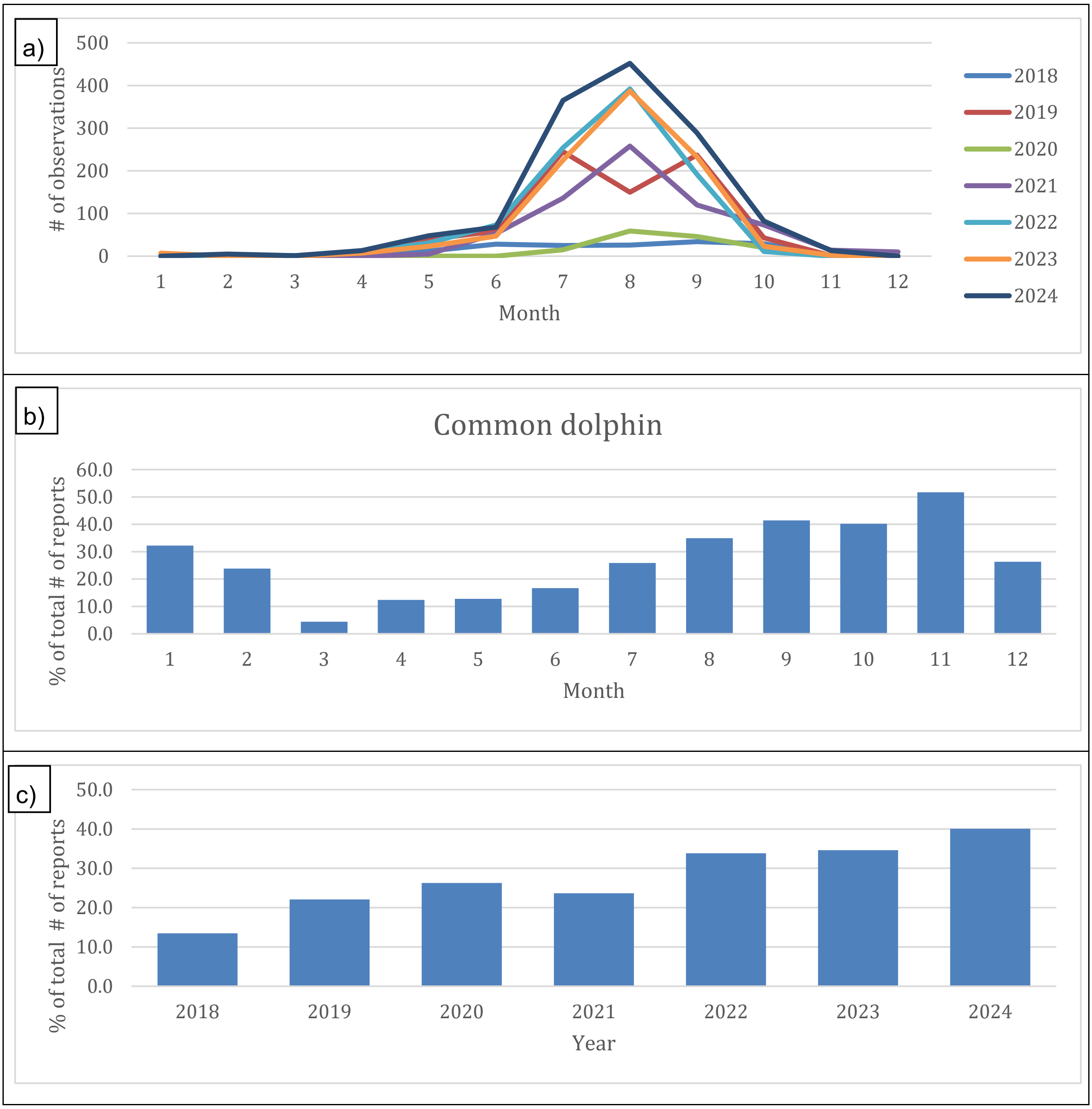


Figure 43 Whale Track Excursion sightings reports of Common dolphin (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

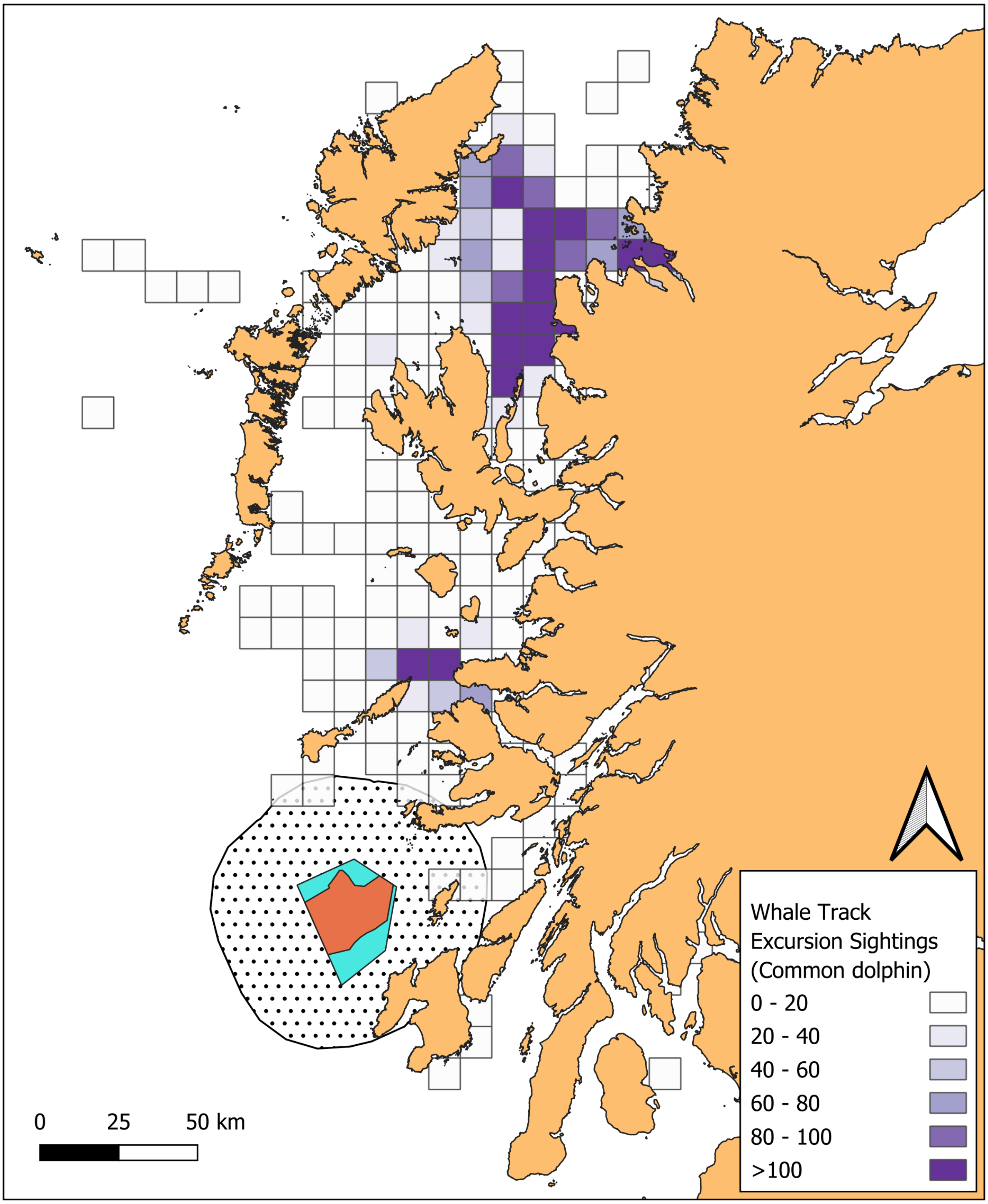


Figure 44 Distribution of common dolphin observations from Whale Track Excursions data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.2.1.3 Minke whale

From 2018 to 2024, minke whale was reported 3,238 times, in absolute terms most frequently in the month of July (**Figure 45a**). Proportionally, minke whale sightings were absent during Winter and most likely during Summer (**Figure 45b**). Unlike Whale Track Casual reports (**Figure 35c**), the proportion of minke whale sightings in the Excursions dataset does not indicate a clear upward trend (**Figure 45c**). The spatial distribution of minke whale observations is plotted in **Figure 46**. Sighting rates during this time were particularly high in the northern Minch and around Skye, in line with overall Excursions data (**Figure 40**).

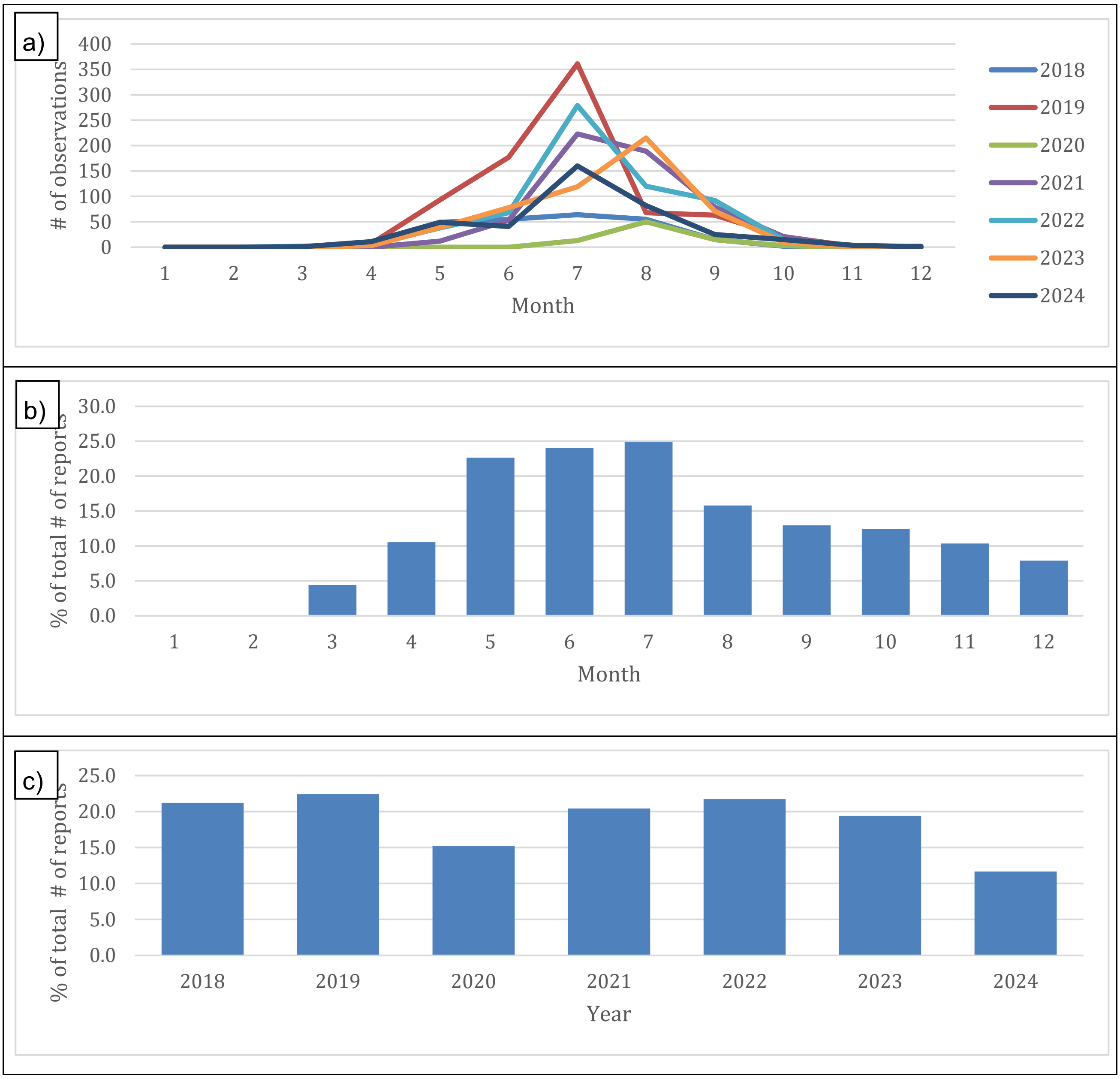


Figure 45 Whale Track Excursion sightings reports of Minke whale (2018 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

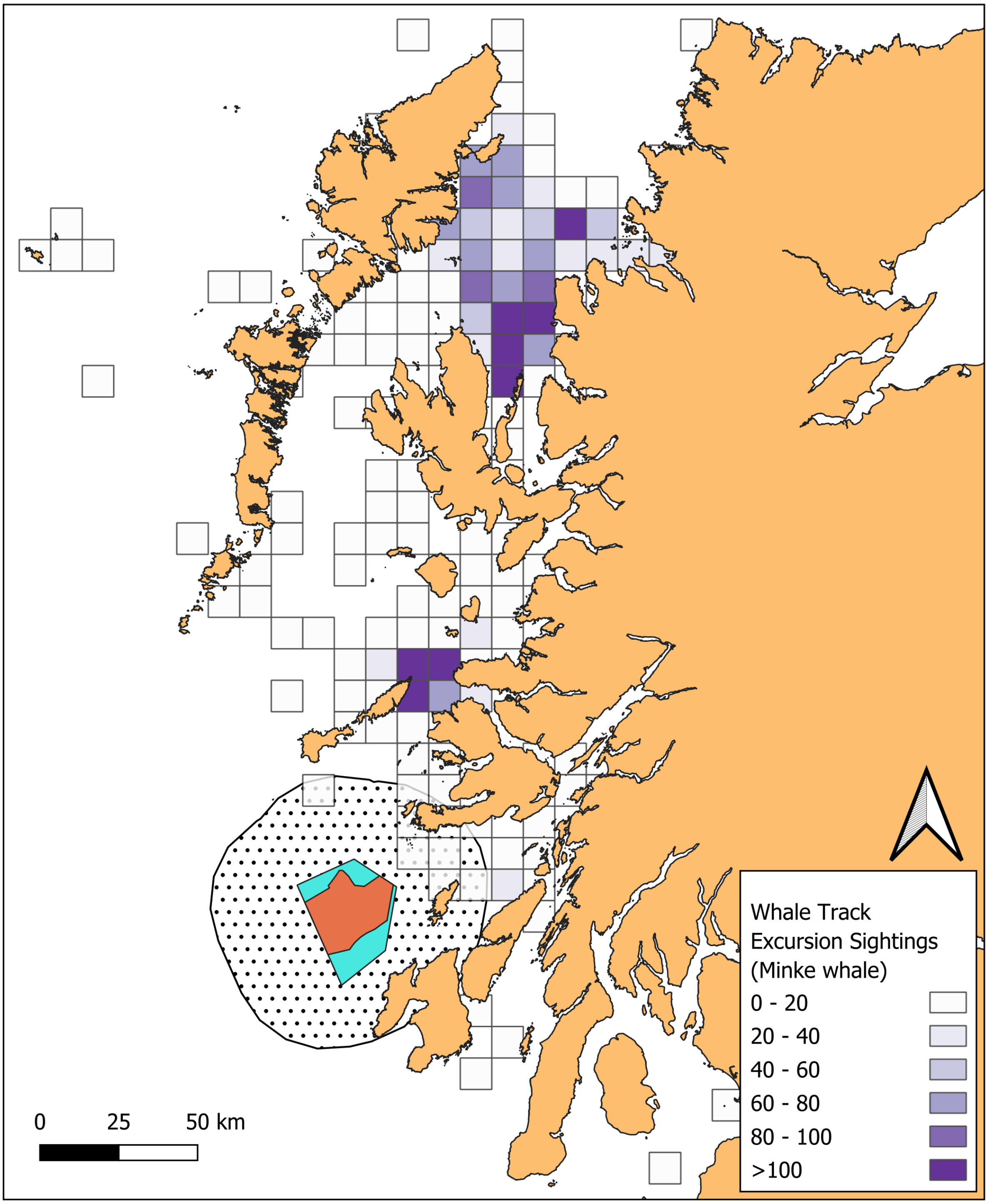


Figure 46 Distribution of minke whale observations from Whale Track Excursions data 2018-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.3 Whale Track Land Surveys

5.3.1 Methods

Whale Track land-based surveys (hereafter referred to as 'land surveys') included a special category of visual monitoring survey, undertaken from land-based vantage points overlooking the sea, and was added to the Whale Track app in 2022. Similarly to Whale Track Excursions, survey effort is recorded systematically, in this case as the location and duration of observation. Observers submit data through the Whale Track app, including required information on species, number of animals, reporter confidence for each sighting; observations of sea state and visibility every 15 mins; and ancillary details about the watch such as observer experience level, number of observers and elevation.

All land-based sightings are subject to the same structured verification process as casual and excursion data. Verification is undertaken by trained volunteers following a standardised protocol that assesses records against predefined criteria, including spatial and temporal plausibility, species identification, group size, and observed behaviour. Supporting photographic or video evidence is used where available to confirm species identification. Each record is assigned a verification status (correct, likely, plausible, pending, unlikely, or incorrect), with records classified as incorrect or unlikely removed prior to analysis. Pending records have undergone initial screening to remove clearly incorrect sightings and are retained where minimum verification criteria are met. Verification of recent years is near-complete, while verification of earlier records is ongoing.

Whale Track land survey data were provided by HWDT. While associated effort data were available for this dataset from HWDT, it was decided by the Project Team that incorporating effort-based analysis of these data was outside the scope of the present project; hence these data are described here as observations only. All records in this dataset included species classification information and confidence assessment on correct species identification. Any data points that fell more than 1 km inland from the coastline and outside of the preset grid were removed (165 records), resulting in 579 records available for analysis. This sample size is relatively small, mainly owing to the relatively short period of time that this type of Whale Track survey has existed; this small sample size does, however, presently limit assessment of trends at these specific locations. Data were analysed to calculate the total abundance of records for each species and to identify any monthly and interannual trends within the data range (2022-2024). Species-specific distributions of observations were visualised by mapping the number of sightings per 10x10 km grid cell.

5.3.2 Results

Analysis shows that there has been variability in reporting rates over time for the 579 records analysed (**Figure 47c**). In terms of number of individual reports received, 2023 was the best year to date with 305 reports (52.7% of total). Reporting rates are influenced by seasonality, with most reports across 2022-2024 occurring between the July-September period (387, or 66.8% of total) (**Figure 47a-b**). Winter observations (November-March) have to date been limited (27, or 4.7% of total). As mentioned previously, this is most likely related to temporal distribution of observer effort, with more people on or near the water during the May-September period, overall better weather and sea state conditions of spotting sightings, as well as longer daylight hours and the seasonal presence of migratory species increasing both species diversity and number of sightings. The reduction in report submissions in 2024 may also be related to the especially poor weather conditions experienced during 2024 by HWDT.

Harbour porpoise, common dolphin and minke whale were the most commonly sighted species, contributing to >80% of all sighting reports across 2022-2024 (**Figure 47b-c**; **Table 10**). Risso's dolphin were recorded in 3.6% of the reported sightings, with various other species identified less frequently.

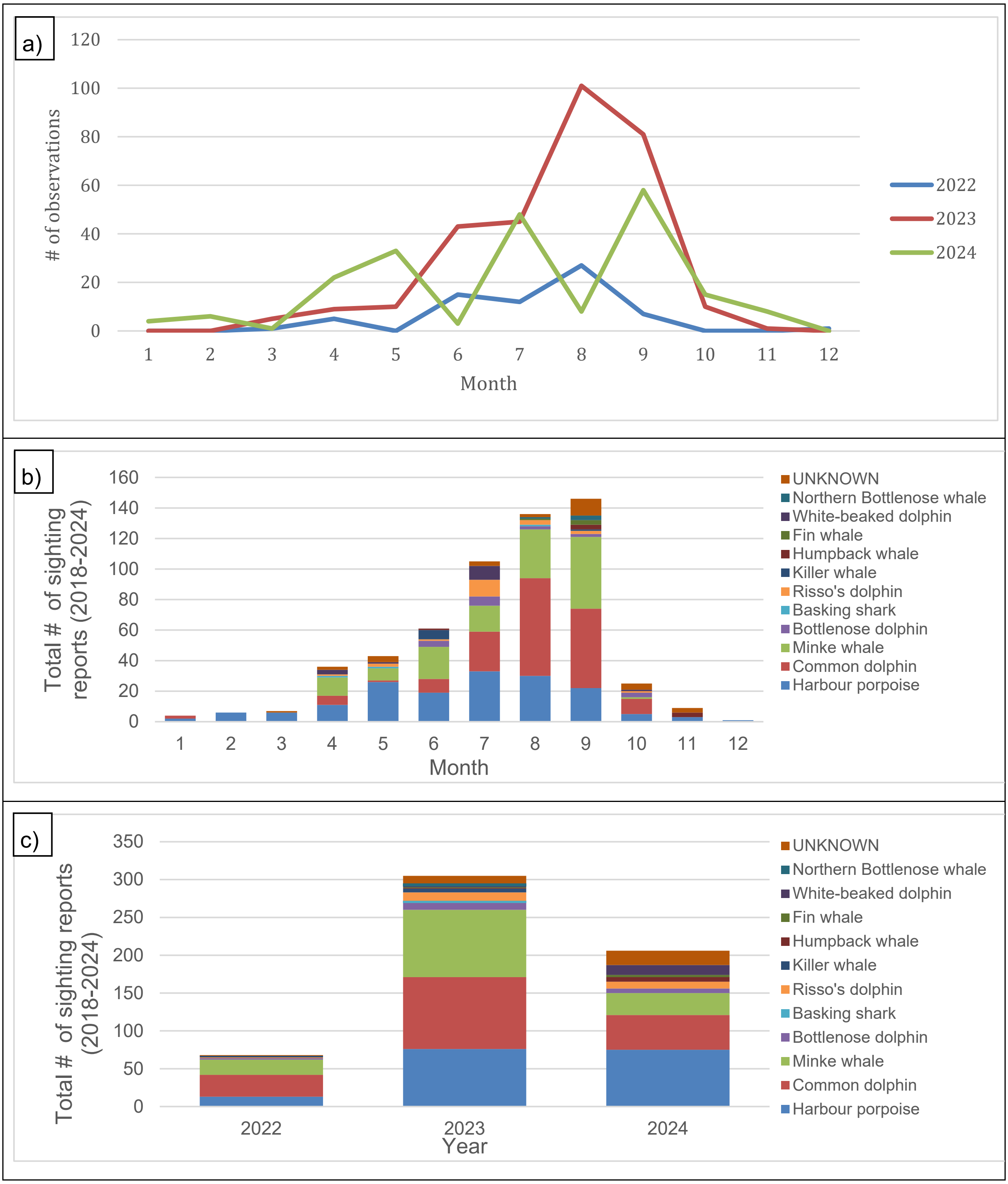


Figure 47 Summary of Whale Track Land survey sightings data (2022 – 2024). a) Number of sighting reports per month for all species combined; b) Number of sighting reports per month showing all species (2022-2024 data combined); c) Number of sighting reports per year showing all species (2022-2024 data combined).

Table 10 Summary of Whale Track land survey sighting reports of all reported species (2022-2024).

Species	Number of reports	Percentage of total
Common dolphin	170	29.4%
Harbour porpoise	164	28.3%
Minke whale	138	23.8%
Risso's dolphin	21	3.6%
Unidentified dolphin	17	2.9%
Bottlenose dolphin	17	2.9%
White-beaked dolphin	14	2.4%
Unidentified whale	8	1.4%
Humpback whale	7	1.2%
Killer whale	7	1.2%
Unidentified cetacean	4	0.7%
Northern bottlenose whale	4	0.7%
Fin whale	4	0.7%
Basking shark	3	0.5%
Unknown	1	0.1%

These data were collected from suitably elevated vantage points on land; all sightings were therefore restricted to areas of sea which were relatively close to the shoreline. The highest number of sightings were reported north of the Isle of Mull, particularly from popular observation sites at Glengorm and Ardnamurchan lighthouse; sightings are also clustered around other notable land-based watching sites such as Tiumpan Head and Butt of Lewis on the Isle of Lewis, Clachtoll in Assynt, as well as Coll, Tiree, the Small Isles and Arran. Conversely, there are large areas along the Scottish coast where few or no land-based watches have taken place to date, potentially due to an absence of easily accessible suitable vantage points and/or observer availability (e.g., around most of the Outer Hebrides and Skye, around Islay, Jura or Colonsay). Given the WDA's location, sighting rates from this dataset are low even within the 30 km WDA buffer (**Figure 48**).

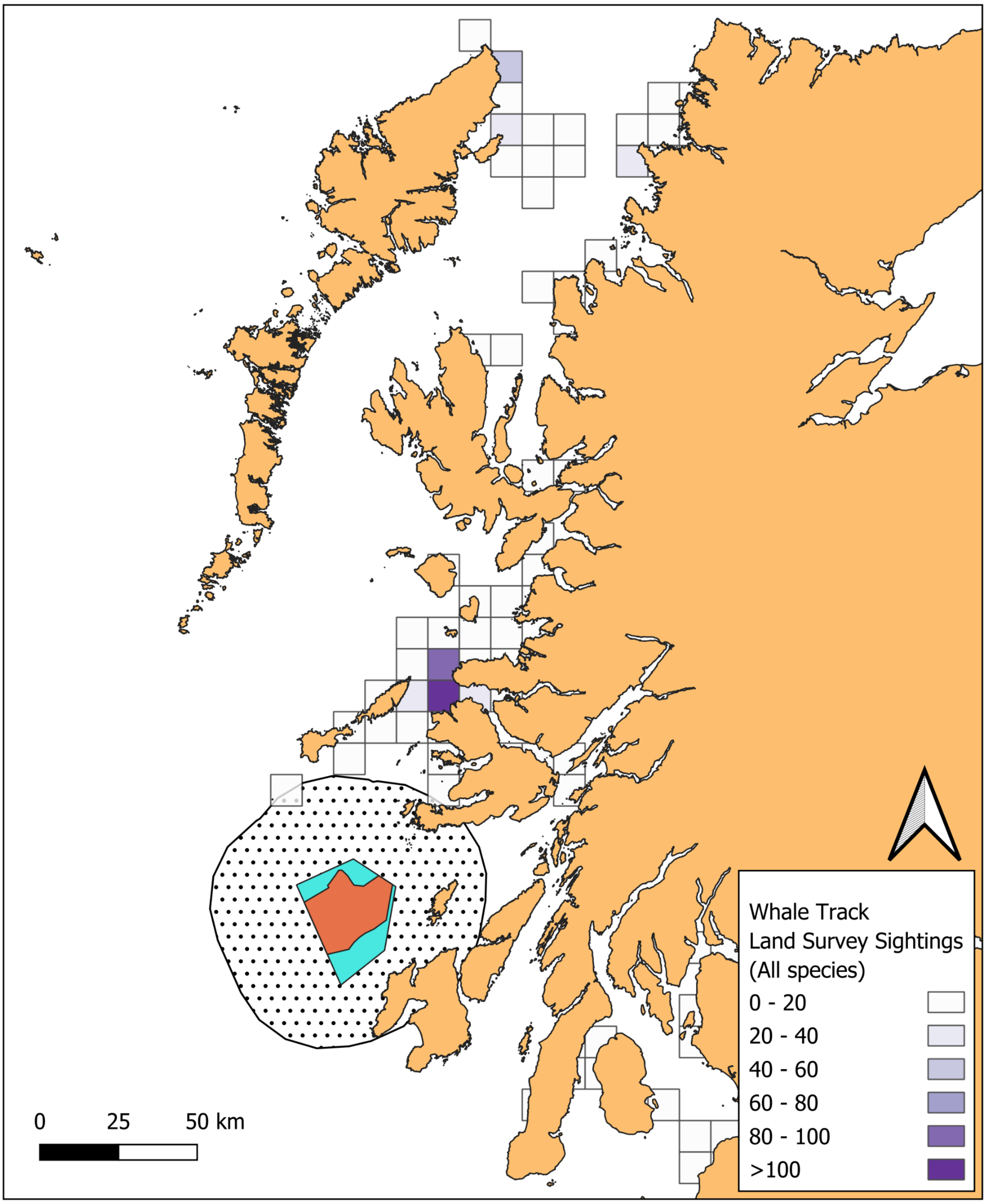


Figure 48 Overview of Whale Track land survey data 2022-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.3.2.1 Harbour porpoise

From 2022 to 2024, harbour porpoise was reported 164 times, in absolute terms most frequently in Spring and Summer months (**Figure 49a**). Proportionally, porpoise sightings were most likely to dominate in colder months, potentially because few other species are present and due to lower observer coverage overall (**Figure 49b**). Proportionally, the species has been reported increasingly regularly over time (**Figure 49c**). The spatial distribution of harbour porpoise observations is plotted in **Figure 50**. Unsurprisingly, these observations are highly clustered spatially.

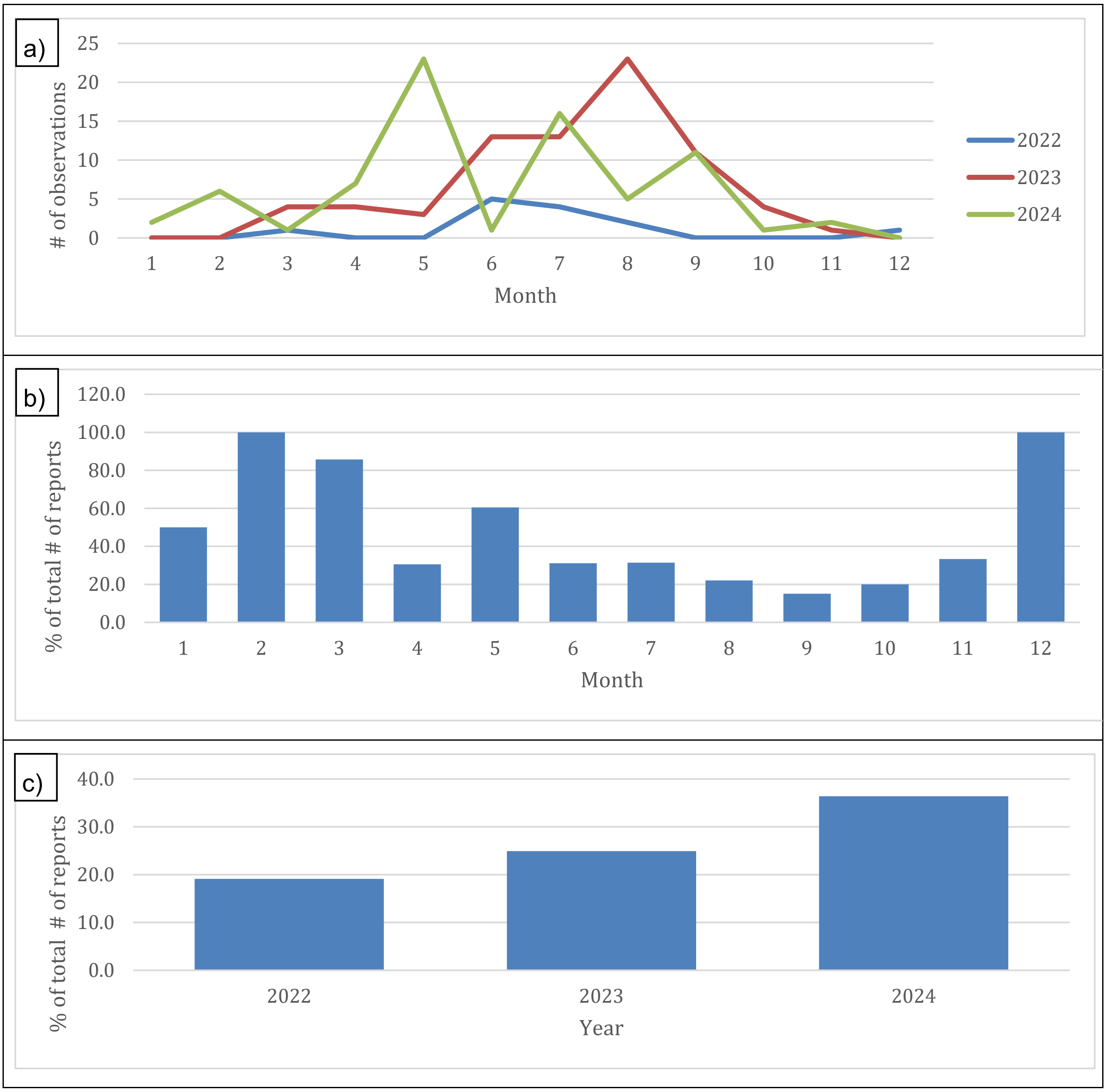


Figure 49 Whale Track Land-based sightings reports of Harbour porpoise (2022 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

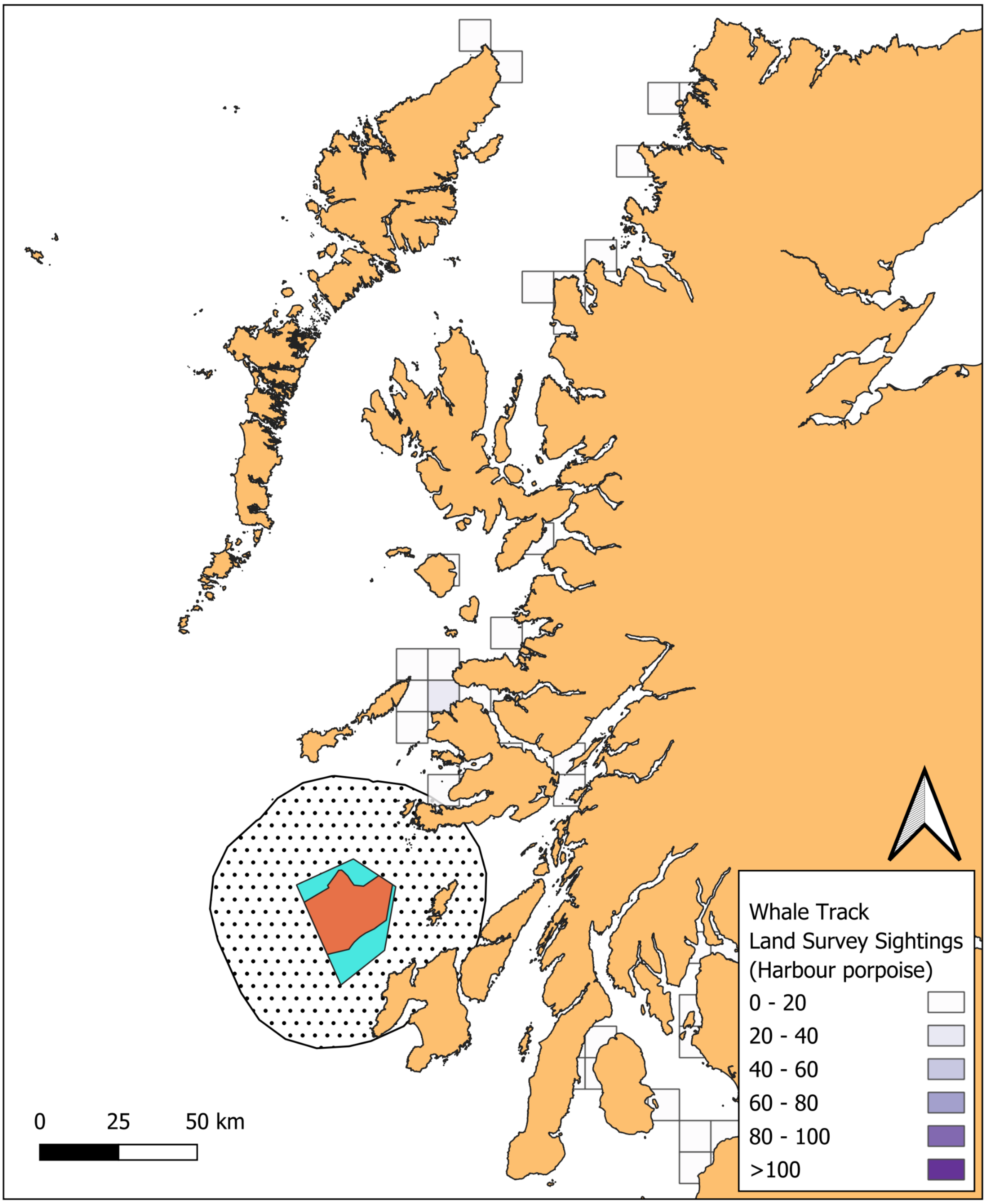


Figure 50 Distribution of harbour porpoise observations from Whale Track land survey data 2022-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.3.2.2 Common dolphin

From 2022 to 2024, common dolphin was reported 170 times, in absolute terms most frequently in the month of August (**Figure 51a**). Proportionally, this species was most likely to be observed in late Summer and early Autumn, in line with trends from HWDT surveys and other Whale Track datasets mentioned previously (**Figure 51b**). Interestingly, interannual trends suggest a local decline in the proportion of common dolphin observations, at least around these specific vantage points (**Figure 51c**). The spatial distribution of common dolphin observations is plotted in **Figure 52**. Unsurprisingly, these observations are highly clustered spatially.

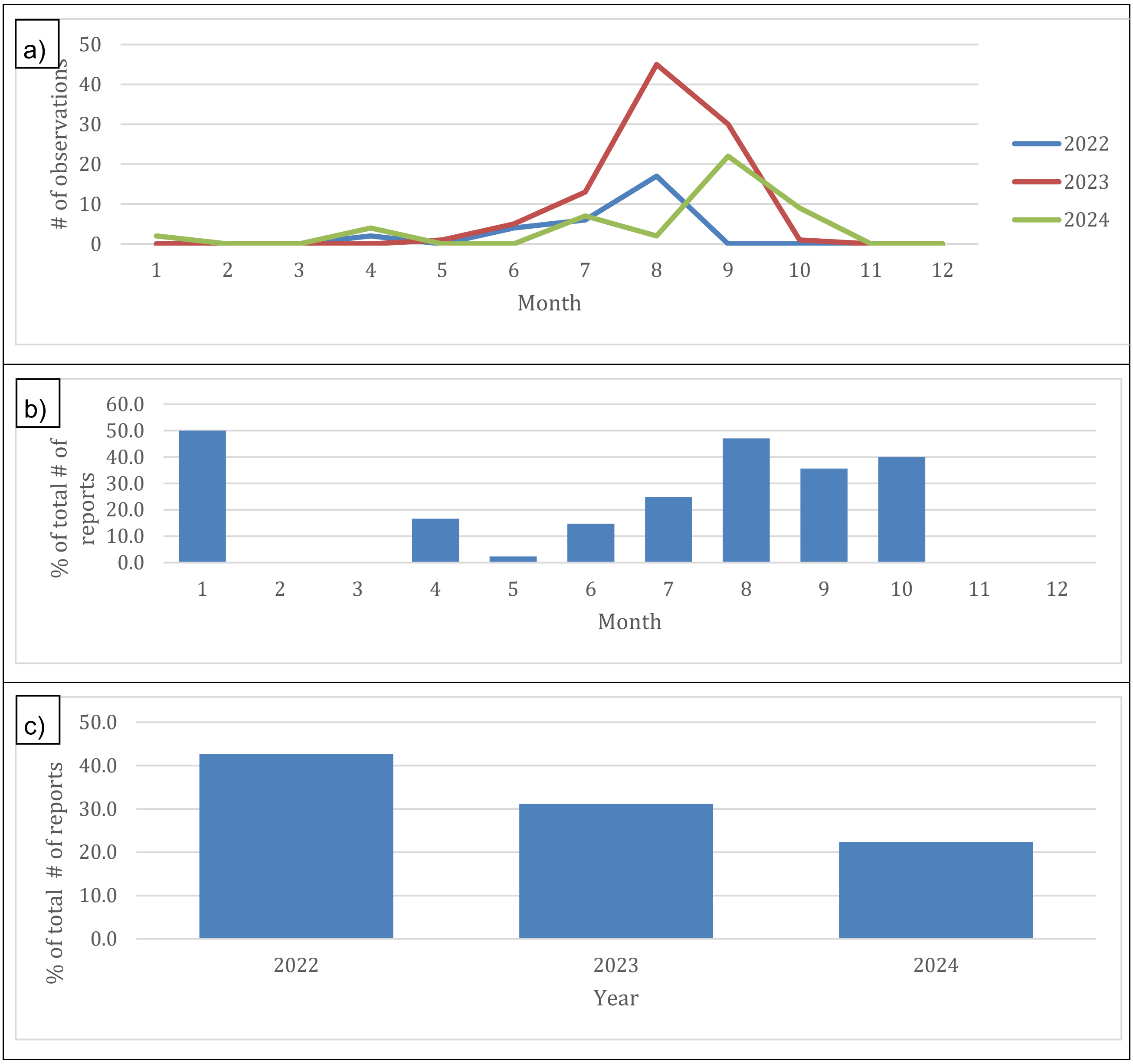


Figure 51 Whale Track Land-based sightings reports of Common dolphin (2022 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

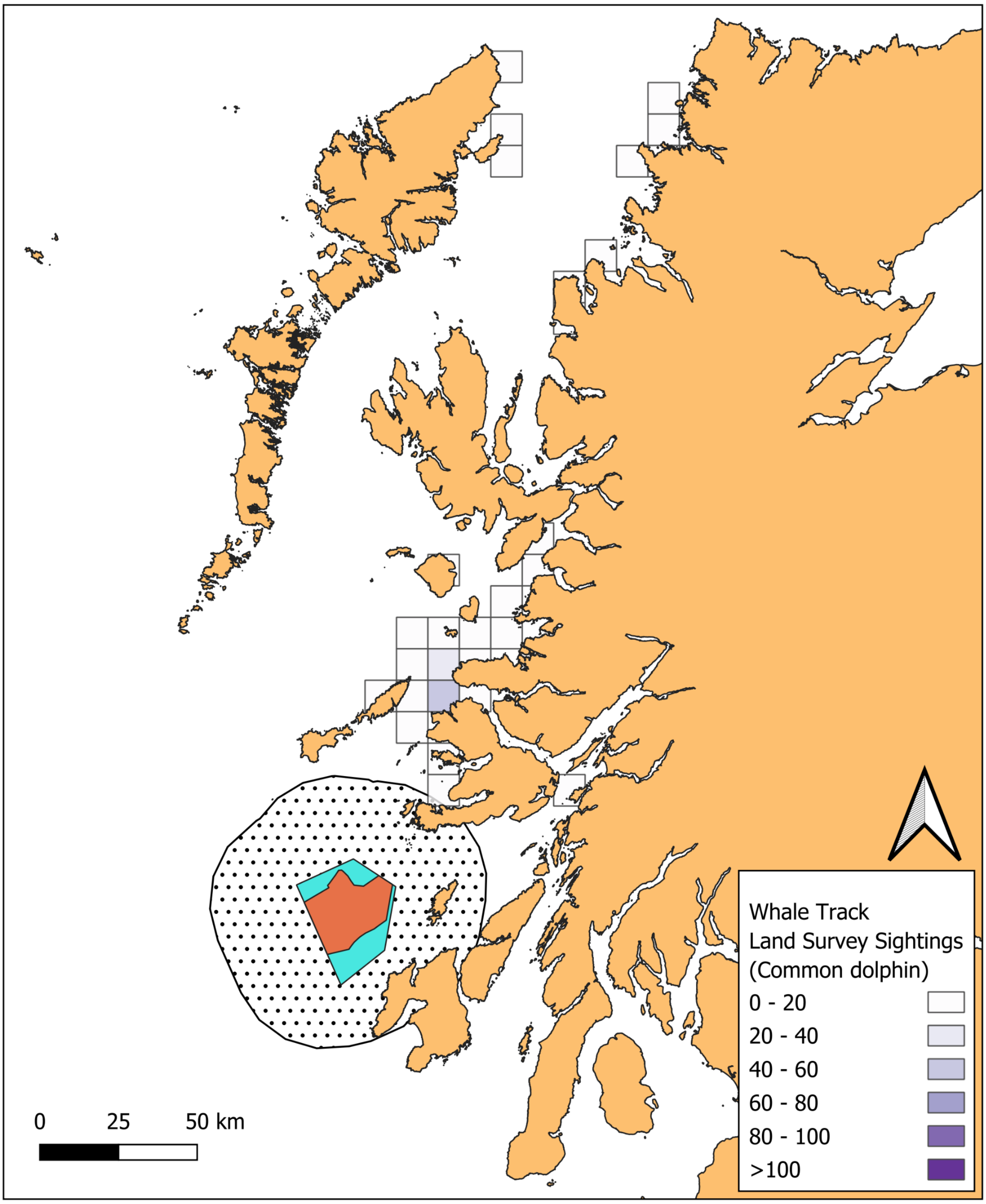


Figure 52 Distribution of common dolphin observations from Whale Track land survey data 2022-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

5.3.2.3 Minke whale

From 2022 to 2024, minke whale was reported 138 times, in absolute terms most frequently in the month of September (**Figure 53a**). Proportionally, minke whale sighting rates were highest in late Spring and Summer, in line with this species' migratory behaviour (**Figure 53b**). Interestingly, interannual trends suggest a local decline in the proportion of minke whale observations, at least around these specific vantage points (Figure 53c). The spatial distribution of minke whale observations is plotted in **Figure 54**. Unsurprisingly, these observations are highly clustered spatially.

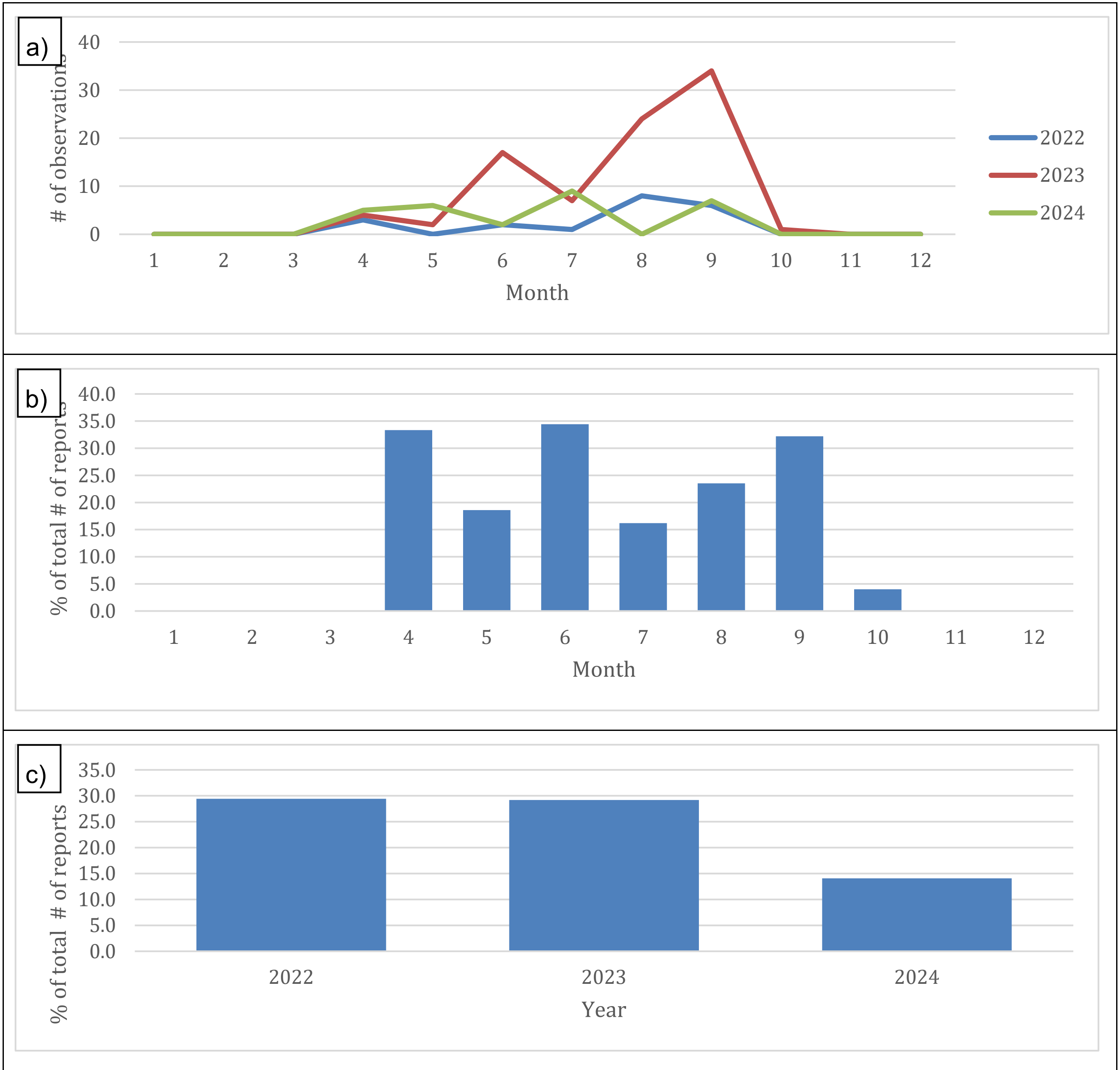


Figure 53 Whale Track Land-based sightings reports of minke whale (2022 – 2024). a) Monthly reporting rates per year; b) % of total # of reports aggregated by month, c) % total # of reports aggregated by year.

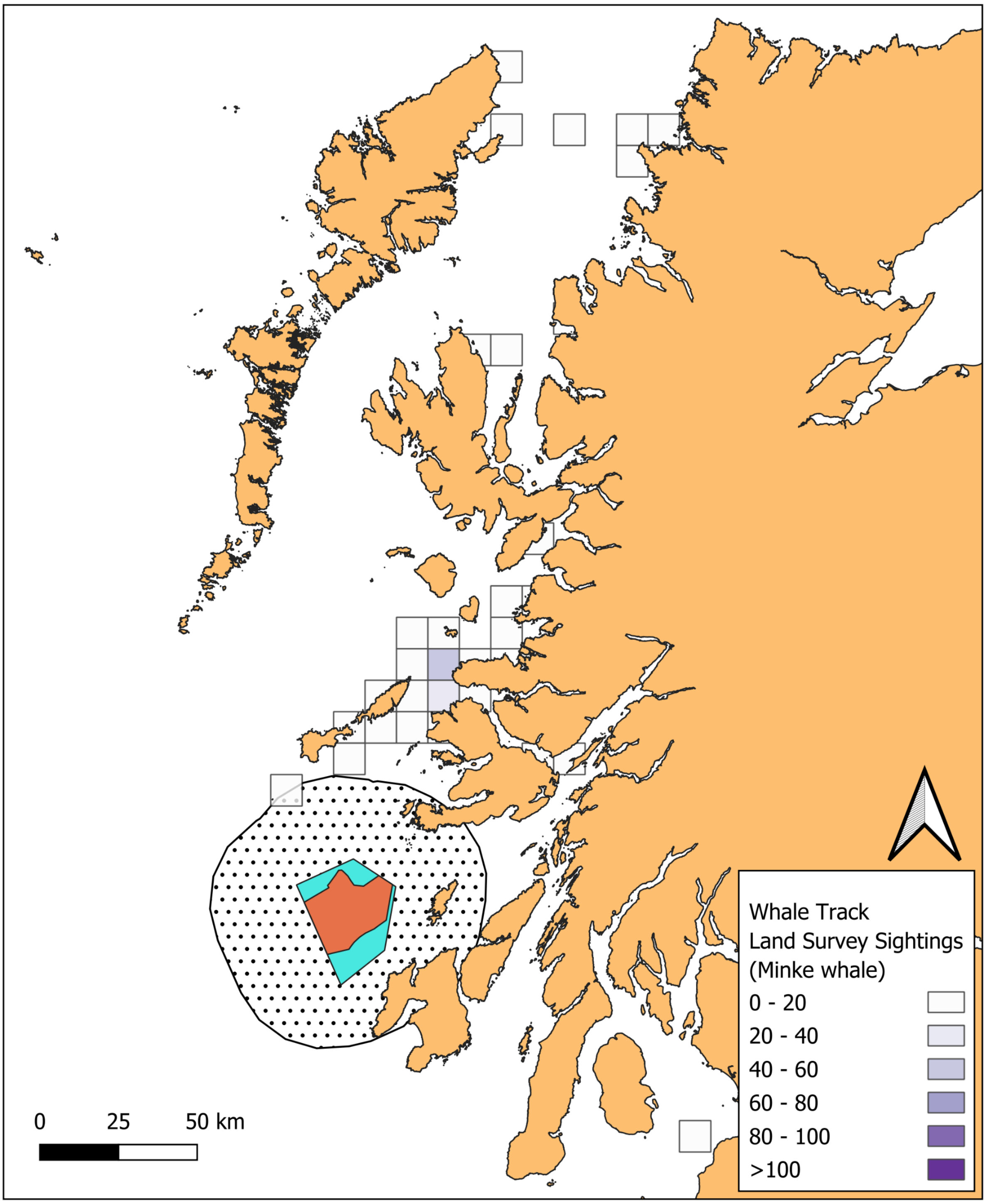


Figure 54 Distribution of minke whale observations from Whale Track land survey data 2022-2024 (number of sightings per 10x10 km grid cell) relative to the WDA/OAA (red/blue polygons). The dotted polygon indicates the 30 km buffer zone around the WDA.

6 CONCLUSIONS

Waters in the vicinity of the WDA are inhabited by a variety of marine mammals and other megafauna. HWDT visual and acoustic survey effort during 2018-2024 has fortuitously encompassed part of the WDA and the surrounding 30 km buffer zone, with most effort concentrated towards the north and east. The available data allow for consideration of spatiotemporal trends in detection rates of various species within this area as well as across western Scottish waters more generally.

A total of 14 species of marine mammals and other megafauna were observed through HWDT's visual survey effort during 2018-2024. Some species, such as harbour porpoise, have been detected frequently every year, whereas others, such as Risso's dolphins and basking sharks, are more unusual and may not be observed in the vicinity of the WDA each year; however, their presence in the vicinity of the site cannot be excluded. Spatiotemporal heterogeneity in Detections per Unit Effort (DPUE) rates during this time will have been influenced by operational factors such as sea state, as well as changes in animal abundance and distribution. The analysis completed in the present report does not allow these aspects to be disentangled in most cases. One species where DPUE rates have increased strongly across the 2018-2024 period has been the common dolphin, suggesting that waters off western Scotland are presently providing more suitable habitat than might have been the case previously. For other species, such as the harbour porpoise, successive DPUE rate estimates are more equivocal and suggest the possibility of decline over time.

The Whale Track datasets provide useful contextual information of the dedicated HWDT surveys, including in areas where survey effort is limited (e.g., close to shore, or where navigation is hazardous). Species observed were mostly similar to those observed through the HWDT dedicated surveys, although the wider spread of citizen scientist contributors resulted in observations of a few additional species, as well as more sightings of some of the more unusual species. Despite the relative lack of coverage of the WDA by the Whale Track volunteers, these datasets still contribute to greater understanding of the spatiotemporal variability in distribution of marine mammals and other marine megafauna in these waters.

The present report has summarised the HWDT survey dataset and Whale Track observations in relation to the WDA. Importantly, when analysing the HWDT visual and passive acoustic survey data, the present report has focused exclusively on assessing rates of DPUE, expressed as number of individuals of a given species detected per km travelled, aggregated over a 10x10 km grid. This is not equivalent to estimating absolute density across the survey area, which was deemed to be out of scope for this project. This approach was used to eliminate heterogeneity in survey effort between years and thereby make data from consecutive years more readily comparable. The DPUE rates need to be interpreted in conjunction with interannual effort distribution maps to determine to what degree a reported high (or low) DPUE rate in a given grid cell might be due to high abundance and/or low effort.

It is worth reiterating that while HWDT surveys were undertaken across western Scotland, survey effort was not distributed uniformly across the area, principally driven by weather conditions and sea state (**Figure 6**). This means that our understanding of marine mammal presence is more comprehensive in some areas (e.g., the central and northern Minch, particularly the waters between Mull, the Small isles and Skye) than in other areas that are surveyed less frequently (e.g., west of the Outer Hebrides, the WDA). Moreover, the data described in the present report were not originally collected with the explicit intent of supporting the WDA development. The amount of observational data collected within the WDA and the surrounding 30 km buffer zone therefore varies, both in terms of numbers of observations and of spatiotemporal coverage. Generally speaking, fewer data are available from more distant, exposed offshore areas such as the WDA and adjacent waters, particularly to the west of the WDA. This lack of explicit spatial focus is counterbalanced by the fact that many of the species observed through these survey efforts are highly mobile, and often migratory, within western Scottish waters across spatial scales far greater than the WDA and are therefore likely to be found there even if only seasonally and/or in small numbers. Survey efforts in adjacent areas across western Scotland continue to show a high diversity in marine mammals and other megafauna, including species whose distribution and behaviours in these areas remain poorly understood (e.g., humpback whale, long-finned pilot whale). The importance of these waters surrounding the WDA to marine mammals and other marine megafauna is further underlined by the establishment of the Sea of the Hebrides MPA and the Inner Hebrides and the Minches SAC. Despite the lack of focused effort within the WDA, the HWDT and Whale Track datasets therefore collectively provide a detailed understanding of the diversity of marine mammals and other species likely to be found there, reinforcing the importance of western Scotland as a marine megafauna 'hotspot' (IUCN-MMPATF 2024).

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