# Surveys of Falmouth Bay to St Austell Bay SPA Winter 2020/21

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# Project details

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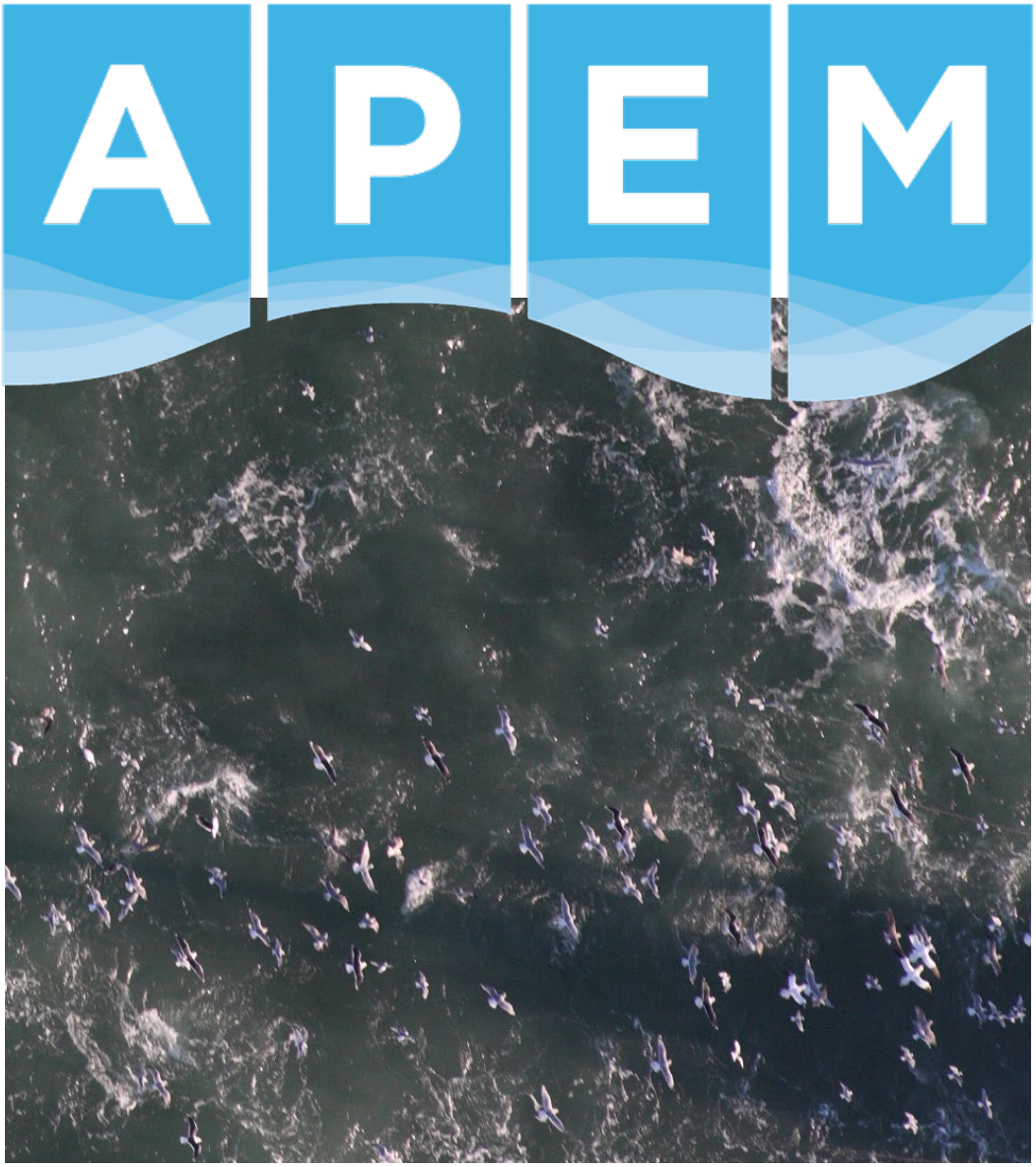

# Surveys of Falmouth Bay to St Austell Bay SPA Winter 2020/21

## Final Report

## Natural England

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Kate Rogerson, Amy J. Williams, Stephanie McGovern

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# Contents

## List of Figures

## List of Tables

# 1. Executive Summary

- Natural England commissioned APEM Ltd. to determine distribution and numbers of the qualifying features of the Falmouth Bay to St Austell Bay Special Protection Area (SPA) in the winter 2020/21. This work will assess the condition of the SPA to inform its future management.

- APEM undertook two digital aerial surveys of the open sea area of the Falmouth Bay to St Austell SPA (hereafter referred to as Survey Area) in both February and March 2021.

- The aerial digital surveys captured images along 32 transects spaced 1 km apart across the Survey Area. Images were collected continuously (abutting digital still imagery) along the survey lines, at approximately 1.5 cm ground sample distance (GSD). At least 60% of the sea surface within the survey area was covered.

- Observations of all bird and marine mammal species from the survey imagery were enumerated. Overall, 6,719 birds and 77 marine mammals were recorded in the February survey, and 7,149 birds and 65 marine mammals were recorded in the March survey.

- Data from the surveys was used to calculate robust population estimates of the three qualifying features of the SPA: black-throated diver, great northern diver and Slavonian grebe.

- For black-throated diver, aerial digital survey results from February produced a population estimate of four (with lower and upper 95% confidence limits of three and 12, respectively). The March aerial digital survey results produced a population estimate of 13 black-throated divers (with lower and upper 95% confidence limits of nine and 38, respectively). For great northern diver, aerial digital survey results from February produced a population estimate of 370 (with lower and upper 95% confidence limits of 255 and 507, respectively). The March aerial digital survey results produced a population estimate of 271 great northern divers (with lower and upper 95% confidence limits of 184 and 412, respectively). For Slavonian grebe, no individuals could be differentiated from black-necked grebe. Aerial digital survey results for Slavonian / black-necked grebe from February produced a population estimate of 6 (with lower and upper 95% confidence limits of 4 and 13, respectively). No Slavonian grebe, black-necked grebe or Slavonian / black-necked grebe were recorded in the March survey.

- Observations of individuals that were identified to the relevant species group levels (e.g., unidentified diver species and black / red-throated divers) were used to create population estimates for these species groups. The population estimates were apportioned across the identified diver species leading to revised peak population estimates of 20 for black-throated divers and 374 for great northern divers.

- Counts from Wetland Bird Surveys (WeBS) at the estuarine/creek areas of the SPA for the three qualifying features were made available from the British Trust of Ornithology (BTO). The peak counts from winter surveys across the last five years have been used as an estimate of the population at the three estuarine / creek sites (Carrick Roads, Outer Carrick Roads and Helford Estuary) that are within the SPA boundary. The counts from these WeBS sites have been combined with the final predicted abundance estimates from the aerial surveys of the open sea areas to give total SPA population estimates for the three qualifying features.

- The peak population estimates for the entire SPA (digital aerial surveys of at sea areas plus WeBs counts from estuarine / creek areas) were 27 for black-throated diver, 395 for great northern diver, and 12 for Slavonian grebe / black-necked grebe.

- The qualifying feature counts for black-throated diver and great northern diver vary from previous studies of the SPA (NE, 2013; Liley *et al.*, 2014). Black-throated divers were observed in low numbers in this study compared to previous studies, although previous studies do indicate how variable the black-throated diver population is within and between seasons. Great northern divers were recorded in high numbers in this study, indicating that the surveys captured the peak population.

- Abundance estimates were created for the area of the Survey Area 2 km from the shoreline. These results along with the cumulative percentage of observations in relationship to distance from shoreline of each of the qualifying features showed that black-throated divers were usually observed within 2 km of the shoreline, whereas great northern divers and Slavonian / black-necked grebes were observed up to the seaward boundary of the SPA (up to 7 km from the shoreline). These results suggest that previous studies using land-based observations were not able to observe the full population of the great northern diver and the relevant grebe species.

# 2. Introduction

Natural England (NE) commissioned APEM Ltd. (APEM) to determine distribution and numbers of the qualifying features of the Falmouth Bay to St Austell Bay Special Protection Area (SPA) in the winter 2020/21. This work will be used to monitor the site and assess the condition of the SPA to inform its future management.

The Falmouth Bay to St Austell Bay SPA was designated in 2017. It is located along the south coast of Cornwall and covers a large marine area as well as shallow sandy bays, an estuarine area and part of a tidal river. At the time of classification, evidence indicated that this area was the most important UK site for black-throated divers (*Gavia arctica*) with the largest wintering population in the UK (O'Brien *et al*. 2014). It is the only SPA in England classified for wintering great northern divers (*Gavia immer*) and it held 1.4% of the wintering Slavonian grebe (*Podiceps auritus*) population in Great Britain (NE, 2013). These three species are the qualifying features for the SPA, and the wintering populations were monitored through shore-based surveys in the area prior to the designation of the site as an SPA (O'Brien *et al*. 2014, Liley *et al.* 2014). The estuarine / creek areas of Carrick Roads, Outer Carrick Roads and the Helford Estuary are monitored as part of the annual ground-based Wetland Bird Surveys (WeBS).

APEM undertook two high resolution aerial digital surveys of the open sea area of the Falmouth Bay to St Austell SPA (hereafter referred to as Survey Area; **Figure 1**) in February and March 2021. The survey design allows for a high precision and accuracy of population estimates and the 1.5 centimeter (cm) ground sampling distance (GSD) provides a high confidence in feature identification. The design also provides comprehensive coverage of the Survey Area (60%) and will provide key information that is currently unavailable on the distribution of the qualifying features across the site. The data will allow better analysis of distribution of birds compared to the previously spatially restricted ground-based surveys, as well as providing data to be able to calculate robust population estimates for the wintering populations of the three qualifying features.

This report summarises the findings of the surveys of the Survey Area undertaken in 2021. WeBS counts of the estuarine / creek areas of the SPA are used in conjunction with the data from aerial digital surveys to provide population estimates of the entire SPA.

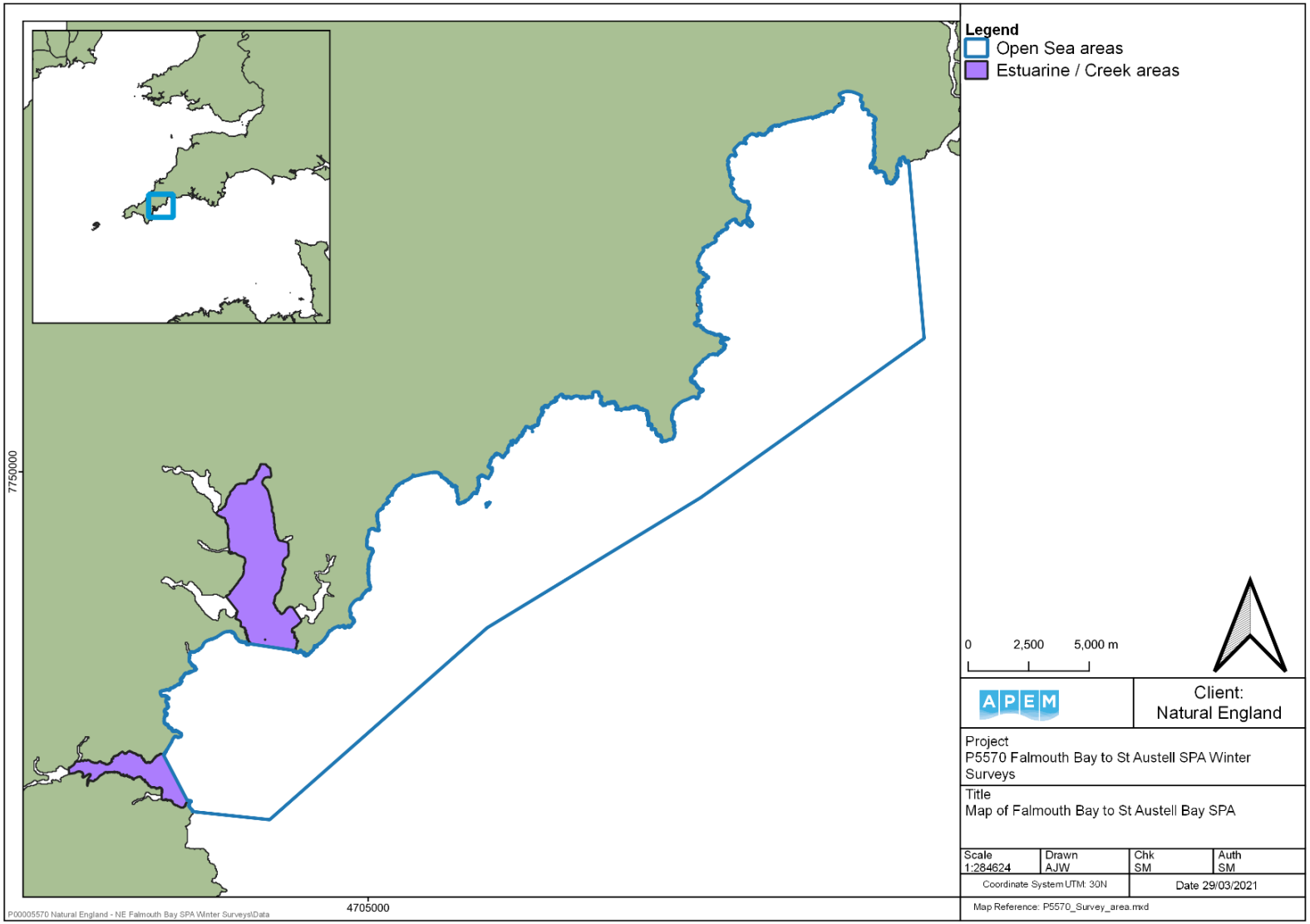


**Figure 1 Falmouth Bay to St Austell Bay SPA open sea and estuarine/creek areas.**

# 3. Methodology

## 3.1 Survey Design

The survey design was informed by power analysis to ensure robust design-based population estimates could be calculated. The method used population estimates from previous surveys (O'Brien *et al*. 2014, Liley *et al.* 2014) for the three key species: black-throated diver, great northern diver, and Slavonian grebe. The population counts used in the analysis were calculated from the maximum count of the species at each vantage point summed across visits: black-throated diver = 185; great northern diver = 90 and Slavonian grebe = 17 (Liley *et al.* 2014).

The population estimate was randomly distributed across the SPA area. Then example transect scenarios (varying number of transects and coverage) were used to "survey" the area, observing a sample of the individuals. The sample was used to calculate design-based abundance estimates and the corresponding precision value (coefficient of variation, CV; section 3.6). This was repeated 100 times. APEM aimed for CV values less than 0.16 as this would allow the detection of a population change of a factor as small as two.

We included survey designs with 1 km, 1.5 km, 2 km and 2.5 km spaced transects (**Table 1**). Black-throated diver had 100% success rates of calculating a sufficient CV value for a robust population estimate with all survey designs for 1 km and 1.5km spaced transects. Great northern diver had high success in 1 km and 1.5 km spaced transect designs (99% and 59% respectively), but the likelihood of robust population estimates fell to 28% for 2 km and 6% for 2.5 km spaced transect design. For Slavonian grebe, the analysis showed that a population estimate could not be calculated with a suitable CV value across the survey designs.

**Table 1 Outcome of power analysis for population estimates of black-throated diver, great northern diver and Slavonian grebe using maximum count of each species at each vantage point summed across visits.**

| Species | Transect Design | Percentage (%) of population estimate with suitable CV (<0.16) |
|---|---|---|
| ***Population figure*** | | ***185*** |
| Black-throated Diver | 1 km | 100 |
| | 1.5 km | 100 |
| | 2 km | 99 |
| | 2.5 km | 83 |
| ***Population figure*** | | ***90*** |
| Great Northern Diver | 1 km | 99 |
| | 1.5 km | 59 |
| | 2 km | 28 |
| | 2.5 km | 6 |
| ***Population figure*** | | ***17*** |
| Slavonian Grebe | 1 km | 0 |
| | 1.5 km | 0 |
| | 2 km | 0 |
| | 2.5 km | 0 |

Additionally, a grid-based survey design (across the four transect spacing designs) was investigated to improve the CV values for Slavonian grebe, however this was not achieved. Thus, with such a low predicted population of Slavonian grebe it cannot be guaranteed the design-based population estimates will have suitable CV values to show significant changes in the future.

The outcome of this analysis led to the decision to use a survey design with 1 km spaced transects to produce the most robust population estimates. Ensuring that the survey design was planned to allow for the most efficient coverage of the area to provide the most robust population estimates of the three key species.

## 3.2 Survey Planning

APEM's bespoke camera system was fitted into a twin-engine aircraft (provided by Ravenair). Custom flight planning software allowed each flight line to be accurately mapped out before take-off. The camera system captured abutting still imagery along thirty-two transects spaced 1 km apart. The average transect swathe was 656 meters (m). The aircraft collected the data at an altitude of approximately 1,350 feet (ft; approximately 410 m), and a speed of approximately 120 knots. The data collected were captured in 1.5 cm ground sample distance (GSD) digital still images, and at least 60% coverage of the Survey Area was collected.

Operational restrictions, wind turbines and high ground areas, were taken into account and resulted in the decision to use north to south transects across the Survey Area, to ensure safety standards were met. There are four Ministry of Defense danger areas (D006/006A/007/007A) in the area, these did not pose risks to undertaking the surveys in the correct time scales but had to be planned for as the surveys could only be undertaken when the danger areas were inactive. APEM liaised with their aircraft sub-contractor to plan surveys for days when danger areas were not active and with suitable weather windows (Appendix I).

The surveys were completed in one day by one aircraft with approximately two hours on task. The aircraft crew included a pilot (Ravenair) and an APEM aerial survey technician. Sample imagery was continually monitored during the survey to make sure it was of suitable quality for analysis. Data was then backed up on more than one secure server after each survey and prepared for analysis.

## 3.3 Data Processing

All images collected on both surveys were georeferenced using the geographical data derived from the GPS-linked bespoke flight management system. A GPS Log was recorded during the survey flights, with GPS positions recorded at the start and end of each line flown and for each image captured. These data were uploaded to a GIS to generate flight log shapefiles to represent the flight lines flown and the image nodes captured.

## 3.4 Image Analysis

Images were analysed using APEM's bespoke image analysis software and by our trained ornithologists for the presence of black-throated diver, great northern diver and Slavonian grebe and other seabirds and megafauna. The images were georeferenced, and the spatial location was accurately determined for any individuals at the water surface or in flight.

APEM scientists are trained to identify birds to species level and have considerable experience in identifying and quantifying bird populations from aerial images. Every bird recorded on these surveys was viewed by at least two members of staff as part of our comprehensive quality assurance (QA) service. The individuals recorded as “unidentified diver species” underwent a second QA by the QA Manager to determine if they could be grouped as black / red-throated diver or if they could only be identified to “unidentified diver species”.

Blank image QA was performed on at least 10% of the imagery to ensure the images had been comprehensively screened for targets. Finally, all birds’ identifications were checked by our experienced QA manager and all marine mammals were checked by our in-house marine mammal specialist.

Once the image analysis was completed, APEM’s BIRD software automatically generated a tabulated database containing information corresponding to each individual sighting including group / species, geographical position of the individual, timing of the sighting and behaviour (flying, sitting, submerged etc.). The database was exported into Excel format to provide simple raw count-based data. Taking the positional information stamped to each sighting, the sightings were plotted directly into a GIS to create shapefiles, whereby each sighting is represented by a single point. The digital nature of both the outputs (tables and shapefiles) has facilitated both the statistical and spatial statistical analyses to be performed on the data.

Example snags of the three qualifying features are presented in Appendix II.

## 3.5 WeBS Count Data

Data from the Wetland Bird Survey (WeBS) was provided for the winter counts at the three WeBS sites that make up the estuarine / creek areas of the Falmouth Bay to St Austell Bay SPA, i.e. the parts of the SPA not covered by the digital aerial Survey Area (**Figure 1**). The three sites are: Helford Estuary (WeBS sector 10415), Carrick Roads (10421) and Outer Carrick Roads (10402). Data from 2014/2015 to 2019/2020 were used.

The data from the three sites varies across the years: Helford Estuary (10415) has counts for six years from winter 2014/2015 to 2019/2020 (all months); Carrick Roads (10421) has counts for three years: 2014/2015, 2018/2019 (only January and March) and 2019/2020 (January and March); Outer Carrick Roads (10402) has counts for three years: 2017/2018 (November and December), 2018/2019 (October and January) and 2019/2020 (January). Data from the winter (October to March) were used to generate the peak winter count of each of the three qualifying species.

Data were provided by WeBS, a Partnership jointly funded by the British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and Joint Nature Conservation Committee (JNCC), in association with The Wildfowl & Wetlands Trust (WWT), with fieldwork conducted by volunteers. Although WeBS data are presented within this report, in some cases the figures may not have been fully checked and validated. Therefore, for any detailed analyses of WeBS data, enquiries should be directed to the WeBS team at the British Trust for Ornithology, The Nunnery, Thetford, IP24 2PU (webs@bto.org).

## 3.6 Data Analysis

Data processing and analyses were carried out in R (R core team, 2020). GIS software (QGIS) has been used to create maps and present spatial data.

### 3.6.1 Abundance and Distribution of Species

The enumerated data on species observations are presented in tables of raw counts of the observed birds and mammals in Section 4.2. The behaviour of the individuals is also presented.

Each bird and marine mammal located in the imagery from the surveys is geo-referenced and from these locations' distribution maps are created to show the spatial distribution of species within the SPA in Section 4.2.

### 3.6.2 Density Maps

For the three qualifying features, maps showing density surfaces were created from kriging interpolation. These maps allow easy identification of clustering of species across the survey area. The maps were created for species with samples over 20 individuals.

GIS software (QGIS) was used to undertake the analysis, using the kernel density estimation method. The point locations of each species are the input variables. The density is calculated based on the number of points in a location, with larger numbers of clustered points resulting in larger values (QGIS.org, 2021). The kernel bandwidth (heatmap search radius) specifies the distance around a point at which the influence of the point on the density will be assessed. Larger bandwidths result in greater smoothing, while smaller values show finer details and variation in point density. The size of the bandwidth depends on the number of observations and their spatial distribution across the area. The analysis outputs a raster file showing the density of each species across the Survey Area for each survey. The data are presented in maps with suitable colouration to allow easy identification of areas with high and low densities of the qualifying features.

### 3.6.3 Design-based Population Estimates

Statistically robust, design-based baseline population estimates were calculated for the wintering black-throated diver, great northern diver and Slavonian grebe in the Falmouth Bay to St Austell Bay SPA. These were created by combining the observations from the digital aerial surveys in the open sea area of the SPA along with the WeBS counts from the Helford Estuary, Carrick Roads and Outer Carrick Roads sites.

For each aerial digital survey, a species-specific abundance and density estimate for the Survey Area was produced, with upper and lower confidence limits and precision estimates in the form of a coefficient of variation (CV). Geo-referenced locations of birds contained within each individual digital still image were used to generate raw counts.

Only individuals located within the Survey Area boundary were used to calculate the population estimates.

For the Survey Area, population estimates were calculated by the following methodology:

1. The raw counts are divided by the number of transects to give the mean number of birds per transect (i). Population estimates (N) for each survey month are then generated by multiplying the mean number of birds per transect by the total number of transects required to cover the entire study area (A): $N = i\ A$
2. Non-parametric bootstrap methods are used for variance estimation. A variability statistic is generated by re-sampling 999 times with replacement from the raw count data. The statistic is evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values is taken as the variability of the statistic over the population (Efron & Tibshirani, 1993). The non-parametric 95%

confidence intervals are generated using the 'boot' library of function (Canty & Ripley, 2010).

3. Measures of precision are calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produces a CV based on the relationship of the standard error to the mean. A CV or target precision of ≤ 0.16 would allow the detection of a population change of a factor as small as 2.

As well as the population estimate for the Survey Area, the population estimate for the part of the Survey Area within 2 km of the shoreline has also been created as above to allow for comparison with the SPA citation figures.

The population estimates for the birds identified to species groups that are relevant to the qualifying species (e.g., unidentified diver species, black / red-throated divers) were created using the above method. The population abundances were apportioned across the population estimates for the individuals identified to species level (e.g., black-throated diver, great northern diver, and red-throated diver) based on the proportion of the population estimates of each identified species of the total population estimates for all diver species and relevant species groups. The apportioned estimates were added to the population estimates to create revised population estimates for the Survey Area.

The peak winter WeBS count from the last five years was used as the raw count for each of the three WeBS count sites. WeBS counts are assumed to cover 100% of each sector and we acknowledge that the data does not give any distribution information for these areas of the SPA.

The predicted population estimates of the open sea area (Survey Area) were combined with the raw count of the estuarine / creek areas (WeBS sites) to create a population estimate of each qualifying species for the whole SPA area. The variance in the total SPA estimate is only applicable for the Survey Area.

#### *3.6.4 Distribution of Sightings*

For each species, the percentage of observations in open sea and the estuarine / creek areas of the SPA were analysed and compared to the results from the previous studies (O'Brien *et al*. 2014, Liley *et al.* 2014).

The proportion of observations from the estuarine / creek areas and open sea areas of the SPA are calculated to indicate the importance of the different habitats to the qualifying features.

## 3.7 Project Management

The project was managed by the APEM project manager with close contact with the NE project manager. A kick-off meeting in January 2021, between the project managers and project director confirmed the scope of the project, priorities in relation to reports, invoicing and timing of surveys were laid out. Surveys were planned for early February and early March 2021 but were dependent on suitable weather windows and inactive danger zones.

A survey plan, including planned flight lines, was created and approved by NE prior to the surveys taking place. On completion of each survey, a map of the flight lines was presented to NE.

Ongoing dialogue continued between APEM and Natural England during the contract period to ensure delivery first of a draft report, then during fuller data analysis and reporting.

# 4. Results

## 4.1 Summary of Surveys

Surveys were planned for early February and early March 2021, but poor weather conditions and activity within the danger zones led to the first survey being undertaken late in February. Following prior agreement from Natural England a minimum of two weeks were required between surveys; suitable weather and inactive danger zones allowed for the second survey to be undertaken 15 days after the first survey in the second week of March.

The aerial surveys were flown on 22nd February 2021 (starting at 11:52 UTC and ending at 14:03 UTC) and the 9th March 2021 (starting at 11:11 UTC and ending at 13:18 UTC). On the 22nd February, visibility was greater than 10 km, the outside air temperature was 5–8°C and winds of 10 knots were blowing from the west/southwest. Sea state was recorded as 0 (calm (glass); Appendix I) and cloud cover was clear to scattered (0–25%). On the 9th March, visibility was greater than 10 km, the outside air temperature was 7°C and winds of 15 knots were blowing from the west / southwest. Sea state was recorded as 1 (calm (rippled); Appendix I) and cloud cover was broken (60–80%).

The maps of the GPS logs of the surveys showing the image capture points are shown in **Figure 2** and **Figure 3.** All images collected on the surveys, within the boundary of the Survey Area, and the resulting coverage of the Survey Area were used in the statistical analysis (**Table 2**).

No health and safety issues were reported during the surveys.

**Table 2 Image number and coverage of the Survey Area for each survey.**

| Survey | Images | Coverage (%) |
|---|---|---|
| February Survey | 5,670 | 68.99% |
| March Survey | 5,667 | 68.02% |

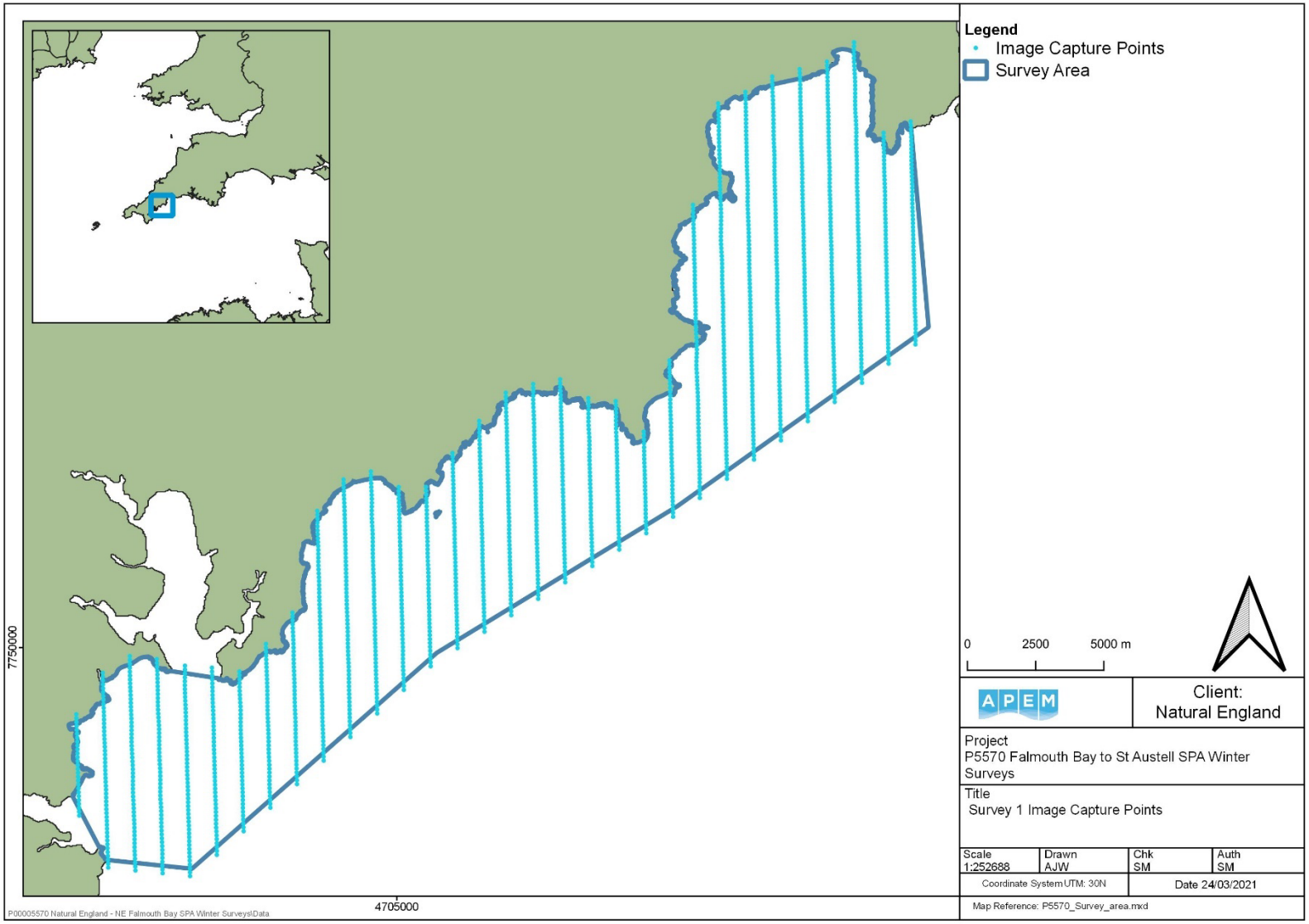


**Figure 2 Image Capture Points for the February survey of the Survey Area**

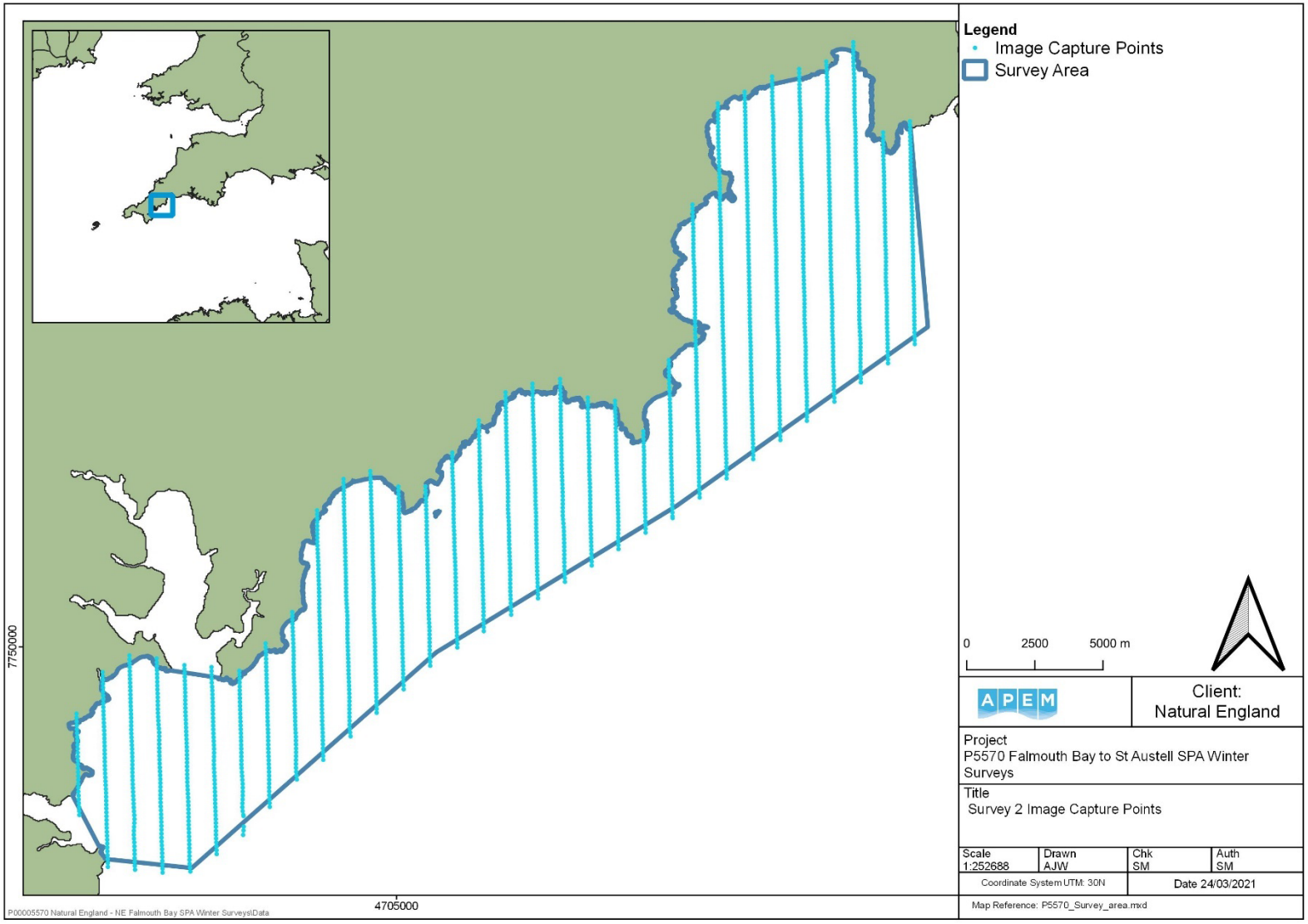


**Figure 3 Image Capture Points for the March survey of the Survey Area**

## 4.2 All Species Abundance and Distribution

### *4.2.1 February Survey Abundance*

A total of 6,719 birds were recorded in the Survey Area during the February survey (**Table 3**). The most abundant species recorded was herring gull (n=2,064), followed by guillemot / razorbill (n=813), razorbill (n=699), guillemot (n=495), unidentified large gull species (n=451), kittiwake (n=370), unidentified gull species (n=314), great northern diver (n=255), cormorant / shag (n=216), unidentified small gull species (n=212), shag (n=202), great black-backed gull (n=167), gannet (n=102), black-backed gull species (n=101), common gull (n=92), black-headed gull (n=28), cormorant (n=19), lesser black-backed gull (n=16), common eider (n=15), red-throated diver (n=16), unidentified bird species (n=15), fulmar (n=11), unidentified auk species (n=10), oystercatcher (n=9), Mediterranean gull (n=8), black-necked / Slavonian grebe (n=5), black / red throated diver (n=4), black-throated diver (n=3), unidentified diver species (n=3), carrion crow (n=2) and pomarine skua (n=1).

A total of 1,136 birds (17%) were recorded in flight during this survey, these consisted of herring gull (n=609), kittiwake (n=155), great black-backed gull (n=66), common gull (n=61), guillemot / razorbill (n=31), black-headed gull (n=28), gannet (n=28), razorbill (n=28), unidentified large gull species (n=27), shag (n=17), lesser black-backed gull (n=15), fulmar (n=11), unidentified gull species (n=9), oystercatcher (n=9), unidentified small gull species (n=9), guillemot (n=8), Mediterranean gull (n=8), cormorant / shag (n=5), black-backed gull species (n=4), cormorant (n=4), carrion crow (n=2) and pomarine skua (n=1). There were 5,583 birds (83%) recorded as sitting.

A total of 77 marine megafauna were recorded in the Survey Area during the February survey (**Table 4**), these were recorded as harbour porpoise (n=32), common dolphin (n=24), grey seal (n=13), dolphin / porpoise (n=4), bottlenose dolphin (n=2), unidentified dolphin species (n=1) and unidentified marine mammal species (n=1).

**Table 3 Raw counts of avian species recorded during the February 2021 survey of the Survey Area**

| Species | Sitting | Flying | Total |
|---|---|---|---|
| Common Eider | 15 | - | 15 |
| Black-necked / Slavonian Grebe | 5 | - | 5 |
| Oystercatcher | - | 9 | 9 |
| Kittiwake | 215 | 155 | 370 |
| Black-headed Gull | - | 28 | 28 |
| Mediterranean Gull | - | 8 | 8 |
| Common Gull | 31 | 61 | 92 |
| Unidentified Small Gull Species | 203 | 9 | 212 |
| Great Black-backed Gull | 101 | 66 | 167 |
| Herring Gull | 1455 | 609 | 2,064 |
| Lesser Black-backed Gull | 1 | 15 | 16 |
| Black-backed Gull Species | 97 | 4 | 101 |
| Unidentified Large Gull Species | 424 | 27 | 451 |
| Unidentified Gull Species | 305 | 9 | 314 |
| Pomarine Skua | - | 1 | 1 |
| Guillemot | 487 | 8 | 495 |
| Razorbill | 671 | 28 | 699 |
| Guillemot / Razorbill | 782 | 31 | 813 |

| Species | Sitting | Flying | Total |
|---|---|---|---|
| Unidentified Auk Species | 10 | - | 10 |
| Red-throated Diver | 16 | - | 16 |
| Black-throated Diver | 3 | - | 3 |
| Black / Red-throated Diver | 4 | - | 4 |
| Great Northern Diver | 255 | - | 255 |
| Unidentified Diver Species | 3 | - | 3 |
| Fulmar | - | 11 | 11 |
| Gannet | 74 | 28 | 102 |
| Cormorant | 15 | 5 | 20 |
| Shag | 185 | 17 | 202 |
| Cormorant / Shag | 211 | 5 | 216 |
| Carrion Crow | - | 2 | 2 |
| Unidentified Bird Species | 15 | - | 15 |
| ***Total Birds*** | ***5,583*** | ***1,136*** | ***6,719*** |

**Table 4 Raw counts of marine megafauna species recorded during the February 2021 survey of Survey Area**

| Species | Submerged | Surfacing | Total |
|---|---|---|---|
| Grey Seal | 5 | 8 | 13 |
| Common Dolphin | 23 | 1 | 24 |
| Bottlenose Dolphin | 2 | - | 2 |
| Dolphin species | 1 | - | 1 |
| Harbour Porpoise | 26 | 6 | 32 |
| Dolphin / Porpoise | 4 | - | 4 |
| Marine Mammal species | 1 | - | 1 |
| ***Total Marine Megafauna*** | ***62*** | ***15*** | ***77*** |

### *4.2.2 March Survey Abundance*

A total of 7,149 birds were recorded in the Survey Area during the March survey (**Table 5**). The most abundant species recorded was herring gull (n=2,093), followed by guillemot (n=1,666), guillemot / razorbill (n=1,212), gannet (n=517), razorbill (n=485), common gull (n=324), great northern diver (n=184), unidentified gull species (n=159), kittiwake (n=110), great black-backed gull (n=81), unidentified large gull species (n=81), cormorant / shag (n=42), fulmar (n=29), shag (n=27), unidentified small gull species (n=24), black-headed gull (n=19), lesser black-backed gull (n=17), common eider (n=16), cormorant (n=12), black-throated diver (n=9), unidentified diver species (n=9), black / red-throated diver (n=6), Mediterranean gull (n=6), red-throated diver (n=5), unidentified black-backed gull species (n=3), little egret (n=3), puffin (n=3), unidentified bird species (n=3), unidentified auk species (n=2) and great skua (n=2).

A total of 1,662 birds (23%) were recorded in flight during this survey, these consisted of herring gull (n=1,034), gannet (n=267), common gull (n=122), kittiwake (n=45), great black-backed gull (n=35), guillemot (n=31), guillemot / razorbill (n=23), black-headed gull (n=19), unidentified gull species (n=16), lesser black-backed gull (n=14), razorbill (n=10), fulmar (n=9), unidentified large gull species (n=9), cormorant (n=8), shag (n=7), puffin (n=3), cormorant /

shag (n=2), great skua (n=2), little egret (n=2), Mediterranean gull (n=2), great northern diver (n=1) and unidentified small gull species (n=1). There were 5,314 birds (74%) recorded as sitting. There were 172 birds recorded as perching. One unidentified bird was recorded as deceased.

A total of 65 marine megafauna were recorded in the Survey Area during the March survey (**Table 6**), these were recorded as common dolphin (n=33), grey seal (n=14), dolphin / porpoise (n=9), harbour porpoise (n=4), unidentified dolphin species (n=3), bottlenose dolphin (n=1) and unidentified marine mammal species (n=1).

**Table 5 Raw counts of avian species recorded during the March 2021 survey of Survey Area**

| Species | Sitting | Perched | Flying | Deceased | Total |
|---|---|---|---|---|---|
| Common Eider | 16 | - | - | - | 16 |
| Kittiwake | 65 | - | 45 | - | 110 |
| Black-Headed Gull | - | - | 19 | - | 19 |
| Mediterranean Gull | 4 | - | 2 | - | 6 |
| Common Gull | 202 | - | 122 | - | 324 |
| Unidentified Small Gull Species | 23 | - | 1 | - | 24 |
| Great Black-Backed Gull | 38 | 8 | 35 | - | 81 |
| Herring Gull | 928 | 131 | 1,034 | - | 2,093 |
| Lesser Black-Backed Gull | 3 | - | 14 | - | 17 |
| Black-Backed Gull Species | 2 | 1 | - | - | 3 |
| Unidentified Large Gull Species | 71 | 1 | 9 | - | 81 |
| Unidentified Gull Species | 143 | - | 16 | - | 159 |
| Great Skua | - | - | 2 | - | 2 |
| Guillemot | 1,635 | - | 31 | - | 1,666 |
| Razorbill | 475 | - | 10 | - | 485 |
| Guillemot / Razorbill | 1,189 | - | 23 | - | 1,212 |
| Puffin | - | - | 3 | - | 3 |
| Unidentified Auk Species | 2 | - | - | - | 2 |
| Red-throated Diver | 5 | - | - | - | 5 |
| Black-throated Diver | 9 | - | - | - | 9 |
| Black / Red-throated Diver | 6 | - | - | - | 6 |
| Great Northern Diver | 183 | - | 1 | - | 184 |
| Unidentified Diver Species | 9 | - | - | - | 9 |
| Fulmar | 20 | - | 9 | - | 29 |
| Gannet | 250 | - | 267 | - | 517 |
| Cormorant | 4 | - | 8 | - | 12 |
| Shag | 13 | 7 | 7 | - | 27 |
| Cormorant / Shag | 16 | 24 | 2 | - | 42 |
| Little Egret | 1 | - | 2 | - | 3 |
| Unidentified Bird Species | 2 | - | - | 1 | 3 |
| ***Total Birds*** | ***5,314*** | ***172*** | ***1,662*** | ***1*** | ***7,149*** |

**Table 6 Raw counts of marine megafauna species recorded during the March 2021 survey of Survey Area**

| Species | Submerged | Surfacing | Total |
|---|---|---|---|
| Grey Seal | 13 | 1 | 14 |
| Common Dolphin | 32 | 1 | 33 |
| Bottlenose Dolphin | 1 | - | 1 |
| Dolphin species | 3 | - | 3 |
| Harbour Porpoise | 2 | 2 | 4 |
| Dolphin / Porpoise | 7 | 2 | 9 |
| Marine Mammal Species | 1 | - | 1 |
| ***Total Marine Megafauna*** | ***59*** | ***6*** | ***65*** |

### *4.2.3 Species Identification Rates*

The overall identification rate of birds and marine megafauna to species level for the two surveys are shown in **Table 7**. This only included birds which were identified to species level species; those that were included in groups such as unidentified small gull species, guillemot / razorbill and dolphin / porpoise were not included as being identified to species level.

**Table 7 Identification rates (%) of birds and marine megafauna to species level**

| Taxa | February Survey | March Survey |
|---|---|---|
| Birds | 68 % | 78 % |
| Marine Megafauna | 92 % | 80 % |

### *4.2.4 Spatial Distribution*

**Figure 4** and **Figure 5** show the location of birds and marine megafauna recorded in the Survey Area in February 2021 and March 2021, respectively. In both surveys, species were distributed throughout the Survey area, concentrations are seen along the coastal edge of the Survey Area but are also seen in large numbers along the seaward edge of the Survey Area.

### *4.2.5 Anthropogenic Features*

A total of 22 anthropogenic objects were recorded in the Survey Area during the February survey, these were recorded as buoy (n=13), fishing vessel (n=7), cargo ship (n=1) and sailing boat (n=1).

Two anthropogenic structures were observed from the aircraft during the March survey. These consisted of a power boat (stationary) and a crane. A total of 20 anthropogenic objects were recorded in the Survey Area during the March survey, these were recorded as buoy (n=18) and fishing vessel (n=2).

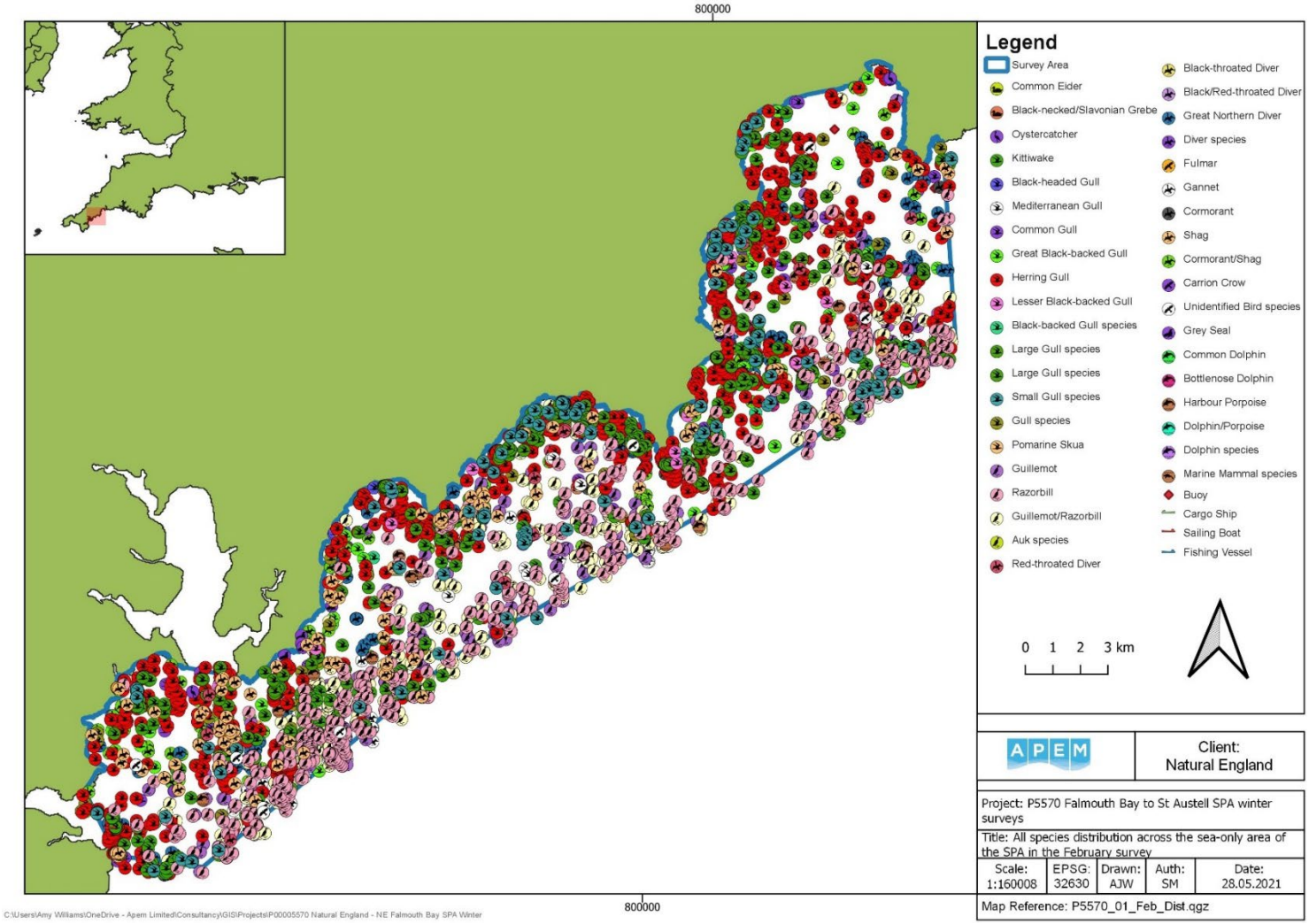


**Figure 4 Spatial distribution of the recorded bird and marine mammal species during the February 2021 survey.**

Figure Note: Individuals may appear to overlap if they are in close proximity to each other.

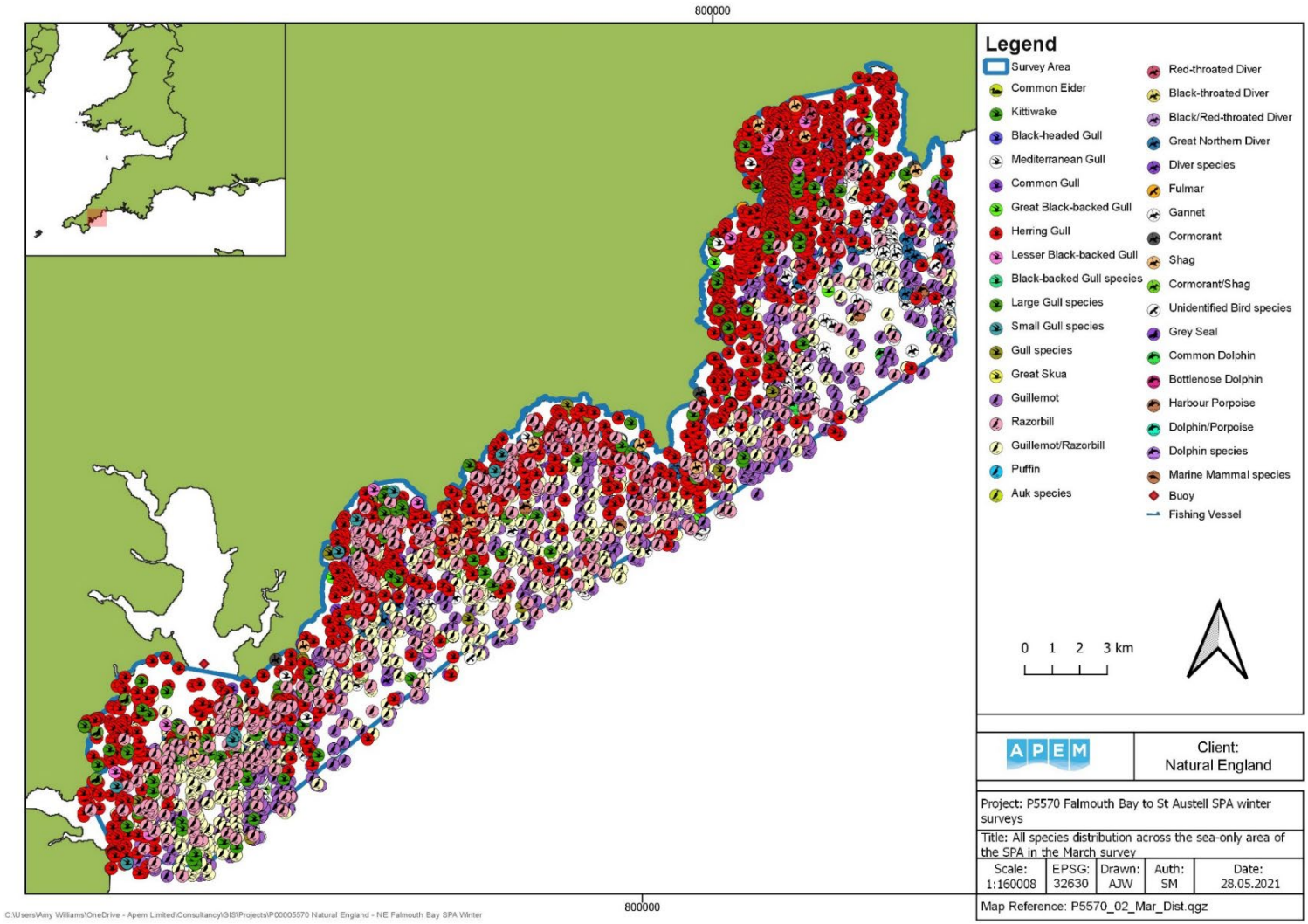


**Figure 5 Spatial distribution of the recorded bird and marine mammal species during the March 2021 survey.**

Figure Note: Individuals may appear to overlap if they are in close proximity to each other.

## 4.3 WeBS Count Data

WeBS count data were collated for the three WeBS sites that make up the estuarine/creek areas within the boundary of the Falmouth Bay to St Austell SPA for winter counts from the winter of 2014/15 to 2019/20. Peak winter counts (October to March) for the three qualifying species across the three sites across the years are presented in **Figure 6.**

The peak counts for black-throated diver across the three sites were: Helford Estuary = 3, Carrick Roads = 2 and Outer Carrick Roads = 2. The peak counts for great northern diver across the three sites were: Helford Estuary = 12, Carrick Roads = 3 and Outer Carrick Roads = 6. The peak counts for Slavonian grebe across the three sites were: Helford Estuary = 2, Carrick Roads = 4 and Outer Carrick Roads = 0.

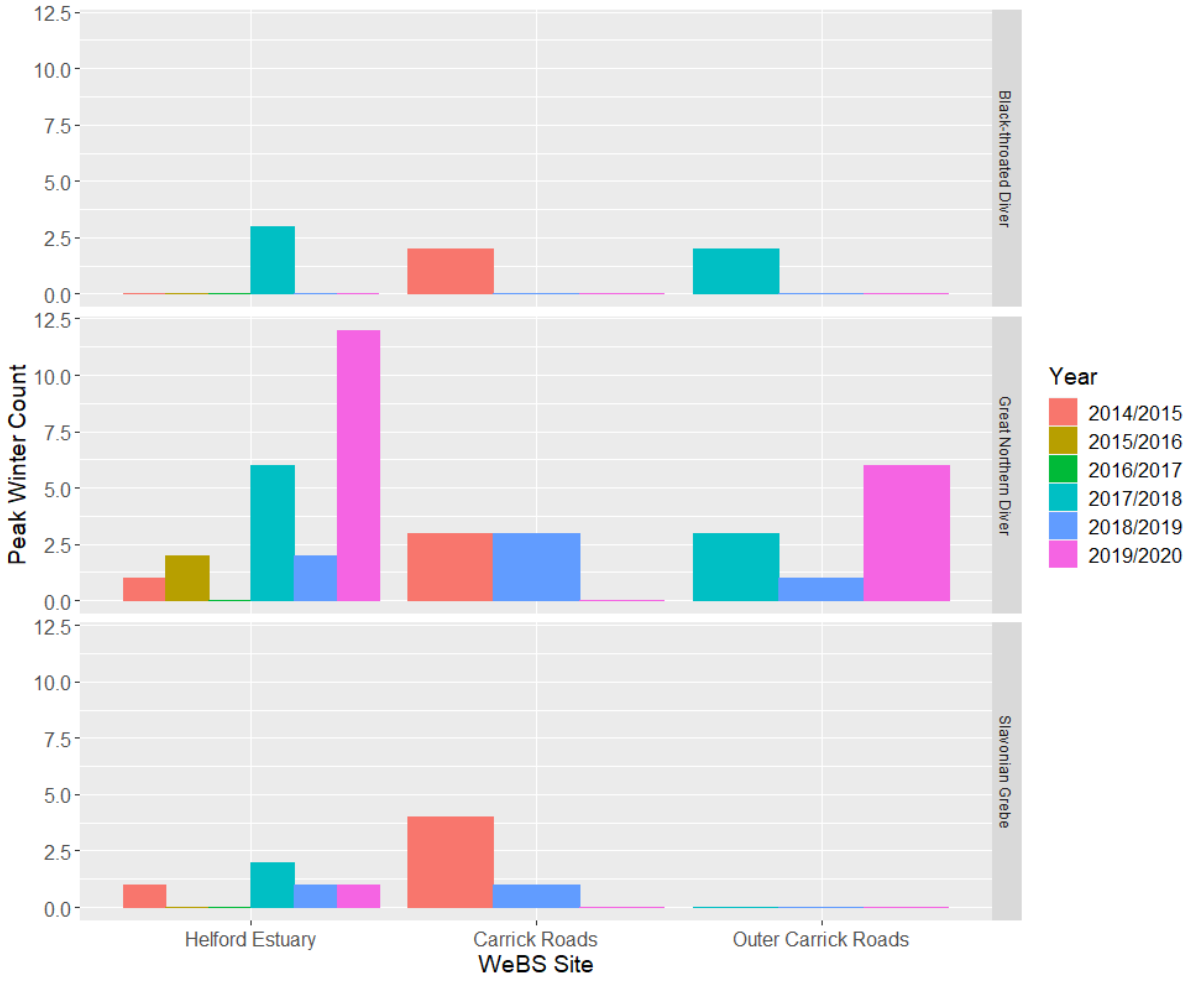


**Figure 6 Peak winter counts for the qualifying features at three WeBS sites from 2014/2015 to 2019/2020**

## 4.4 Diver Species – *Unidentified Species*

### *4.4.1 Abundance and Distribution*

Where divers could not be identified down to the species level, they were recorded as unidentified diver species. The raw counts of unidentified diver species from the two surveys are presented in **Table 8.**

No unidentified divers were recorded in flight during the February or March surveys.

The spatial distribution of unidentified diver species is presented in **Figure 7** and **Figure 8**. During the February and March surveys unidentified diver species were distributed across the Survey Area.

**Table 8 Raw counts of unidentified diver species recorded during the February and March 2021 surveys of the Survey Area.**

| Survey | Sitting | Flying | Total |
|---|---|---|---|
| February | 3 | - | 3 |
| March | 9 | - | 9 |
| ***Total Unidentified Diver Species*** | | | ***12*** |

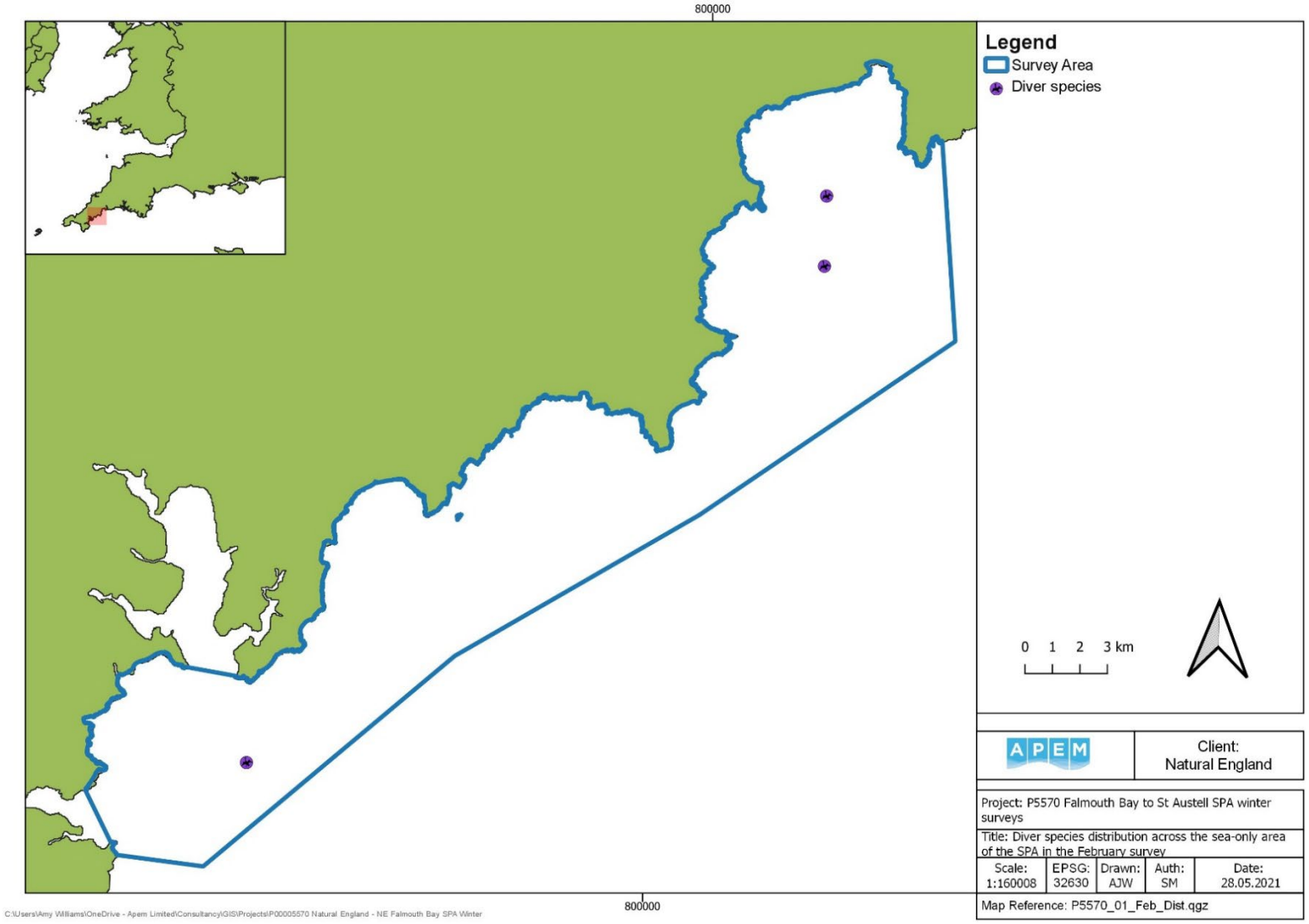


**Figure 7 Spatial distribution of unidentified diver species during the February 2021 survey.**

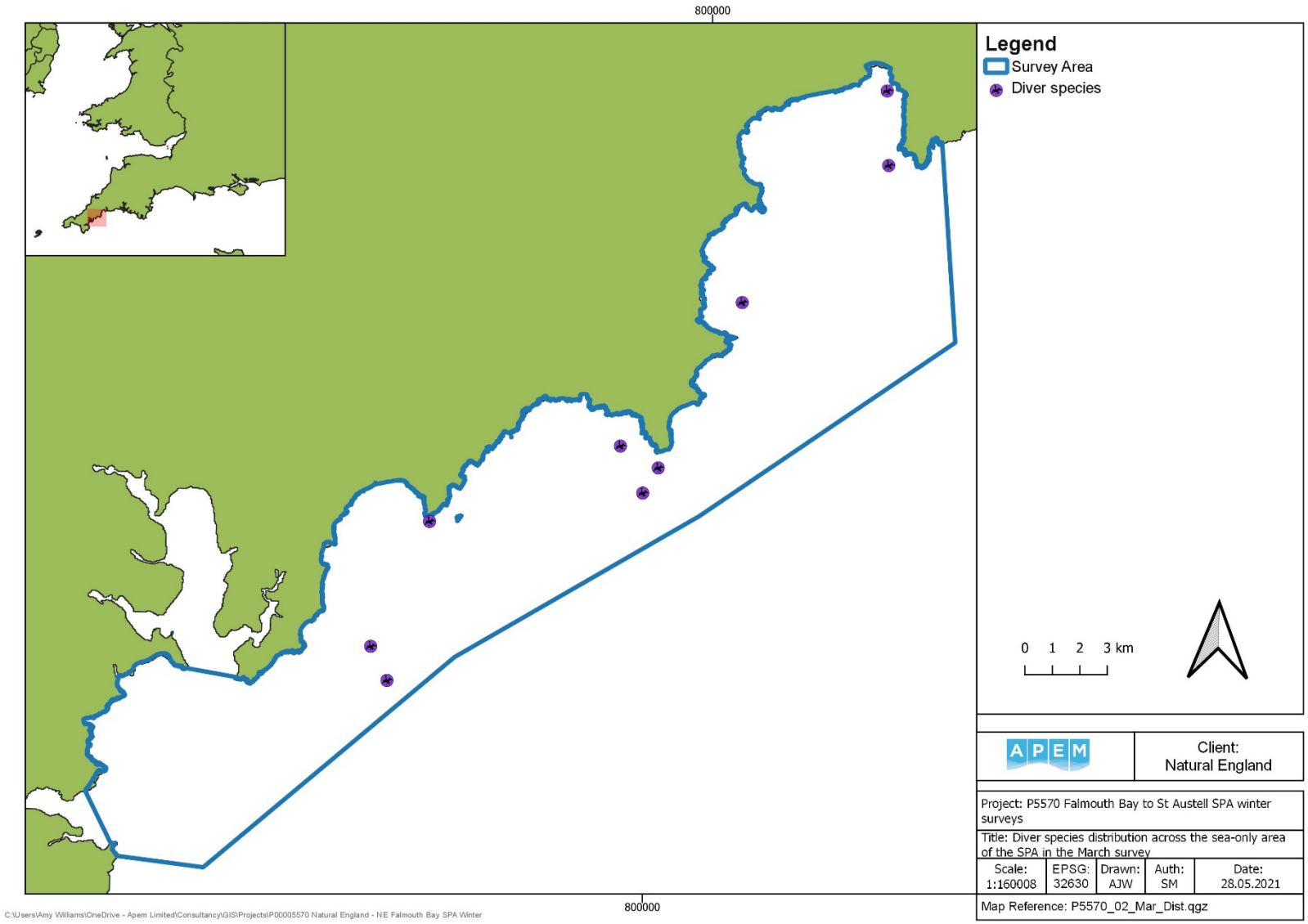


**Figure 8 Spatial distribution of unidentified diver species during the March 2021 survey.**

### *4.4.2 Design-based Population Estimates*

The peak count of nine unidentified diver species during the March survey (Survey 2) resulted in a population estimate of 13 for the Survey Area (**Table 9**).

The peak count of seven unidentified diver species from the March survey (Survey 2) in the 2 km area from the shoreline, resulted in a population estimate of 10 (**Table 9**).

**Table 9 Raw counts and abundance and density estimates (No. estimated individuals per km2) of unidentified diver species in a) Survey Area; and b) Survey Area within 2 km from shoreline.**

| a) Survey Area | | | | | | |
|---|---|---|---|---|---|---|
| **Survey** | **Raw Count** | **Population estimate** | **Lower CI** | **Upper CI** | **Precision** | **Density (bird per km$^2$)** |
| February | 3 | 4 | 3 | 12 | 0.58 | 0.02 |
| March | 9 | 13 | 9 | 22 | 0.33 | 0.05 |
| **b) Survey Area – only 2 km from shoreline** | | | | | | |
| **Survey** | **Raw Count** | **Abundance** | **Lower CI** | **Upper CI** | **Precision** | **Density** |
| February | 0 | - | - | - | - | - |
| March | 7 | 10 | 7 | 19 | 0.38 | 0.08 |

### *4.4.3 Distribution of Sightings*

Unidentified diver species in the survey area varied in their relationship with distance to shore across the two surveys (**Figure 11** and **Figure 12**). In the February survey all unidentified diver species were observed over 2 km from the shore whereas in the March survey 75% of unidentified diver species were observed less than 2 km from the shore.

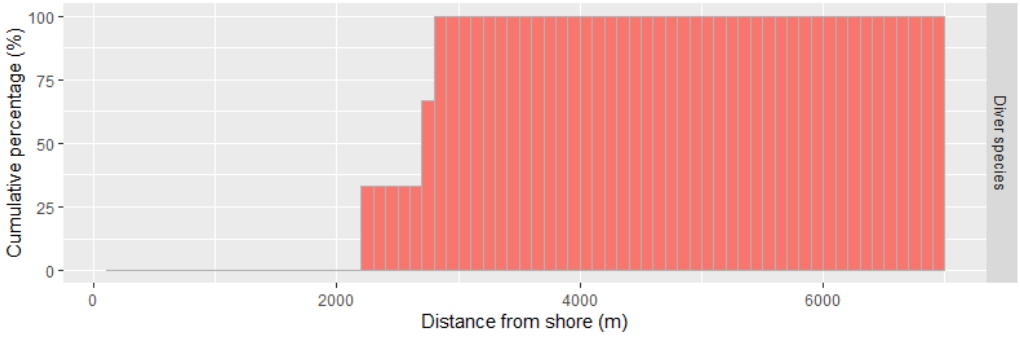


**Figure 9 Cumulative percentage of observation of unidentified diver species in relation to distance from shore in the February survey**

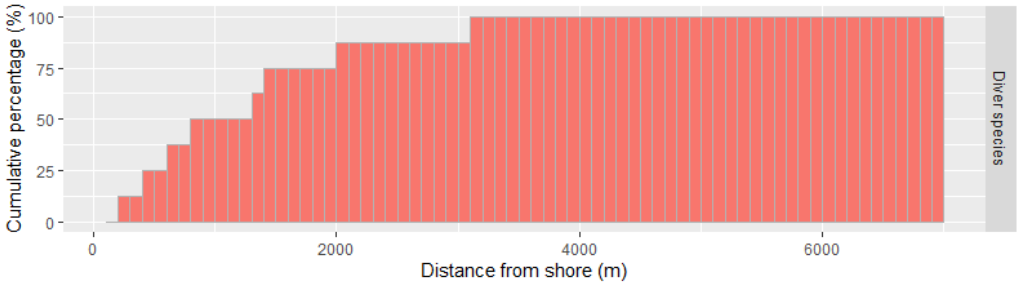


**Figure 10 Cumulative percentage of observation of unidentified diver species in relation to distance from shore in the March survey**

## 4.5 Black-throated Diver

### *4.5.1 Abundance and Distribution*

The raw counts of black-throated diver from the two surveys are presented in **Table 10**. Example snags of black-throated diver are presented in Appendix II. Individuals that could not be distinguished between black and red-throated divers were identified as black / red-throated diver. The raw counts of black / red-throated diver from the two surveys are presented in **Table 10**.

No black-throated diver or black / red-throated diver were recorded in flight during the February and March surveys.

The spatial distribution of black-throated diver is presented in **Figure 13** and **Figure 14**. In the February and March surveys the black-throated diver were observed in the center and north-east of the SPA. The spatial distribution of black / red-throated diver is presented in **Figure 15** and **Figure 16**. In the February and March surveys, the black / red-throated diver were also observed in the center and north-east of the SPA.

**Table 10 Raw counts of black-throated divers and black / red-throated divers recorded during the February and March 2021 surveys of the Survey Area.**

| Survey | Sitting | Flying | Total |
|---|---|---|---|
| February | 3 | - | 3 |
| March | 9 | - | 9 |
| ***Total black-throated diver*** | | | ***12*** |
| February | 4 | - | 4 |
| March | 6 | - | 6 |
| ***Total black / red-throated diver*** | | | ***10*** |

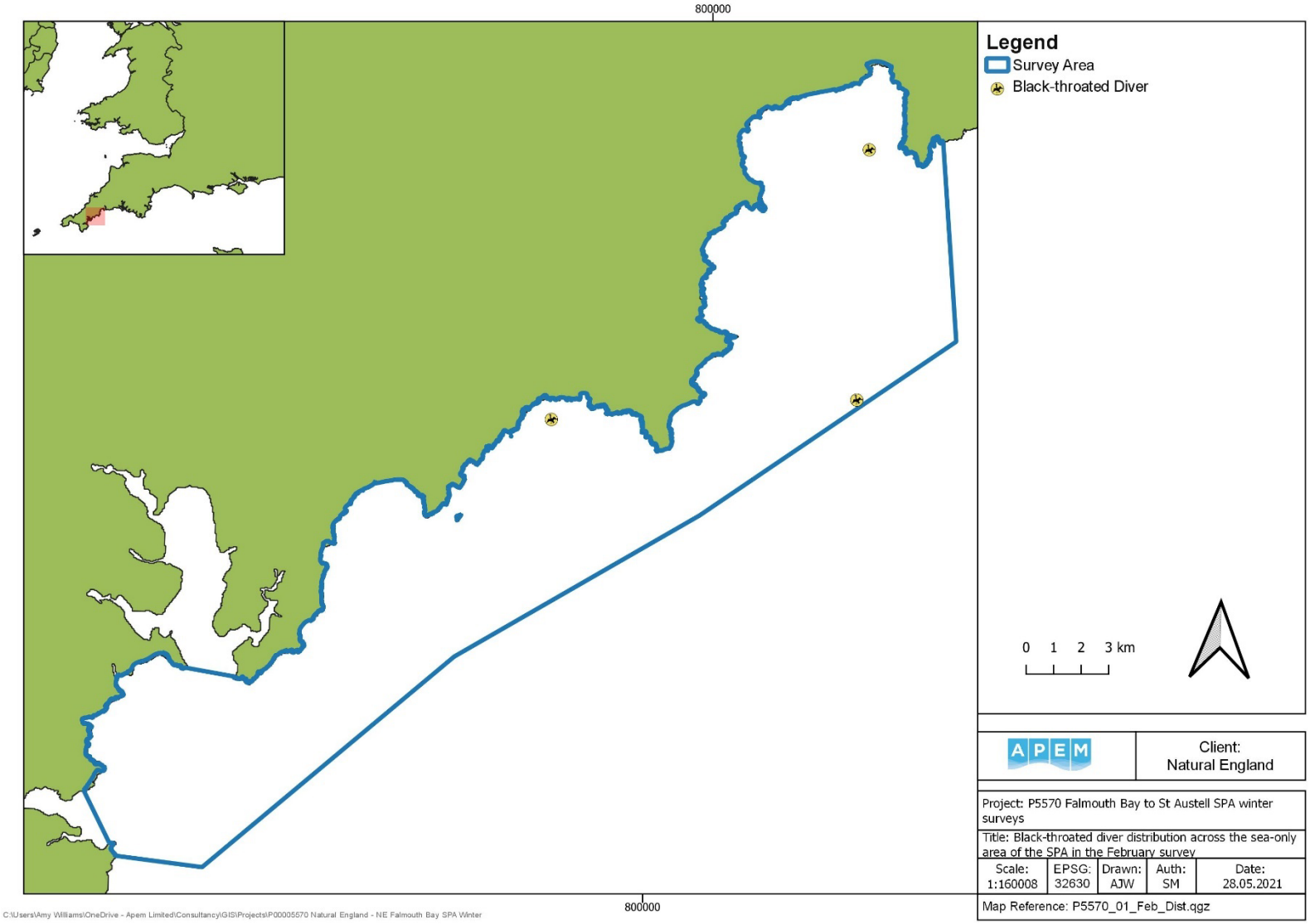


**Figure 11 Spatial distribution of the black-throated diver during the February 2021 survey.**

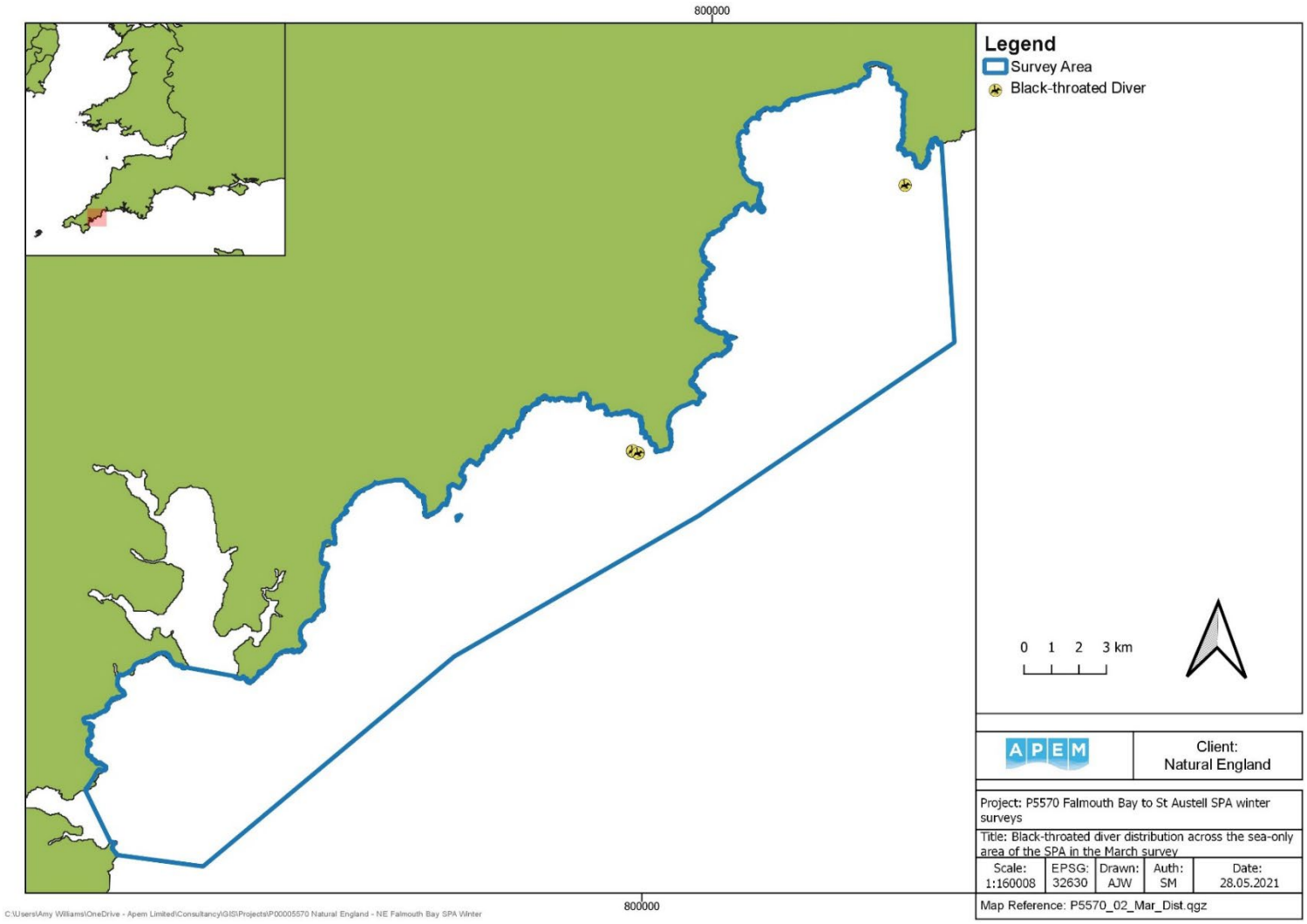


**Figure 12 Spatial distribution of the black-throated diver during the March 2021 survey.**

Figure Note: Individuals may appear to overlap if they are in close proximity to each other.

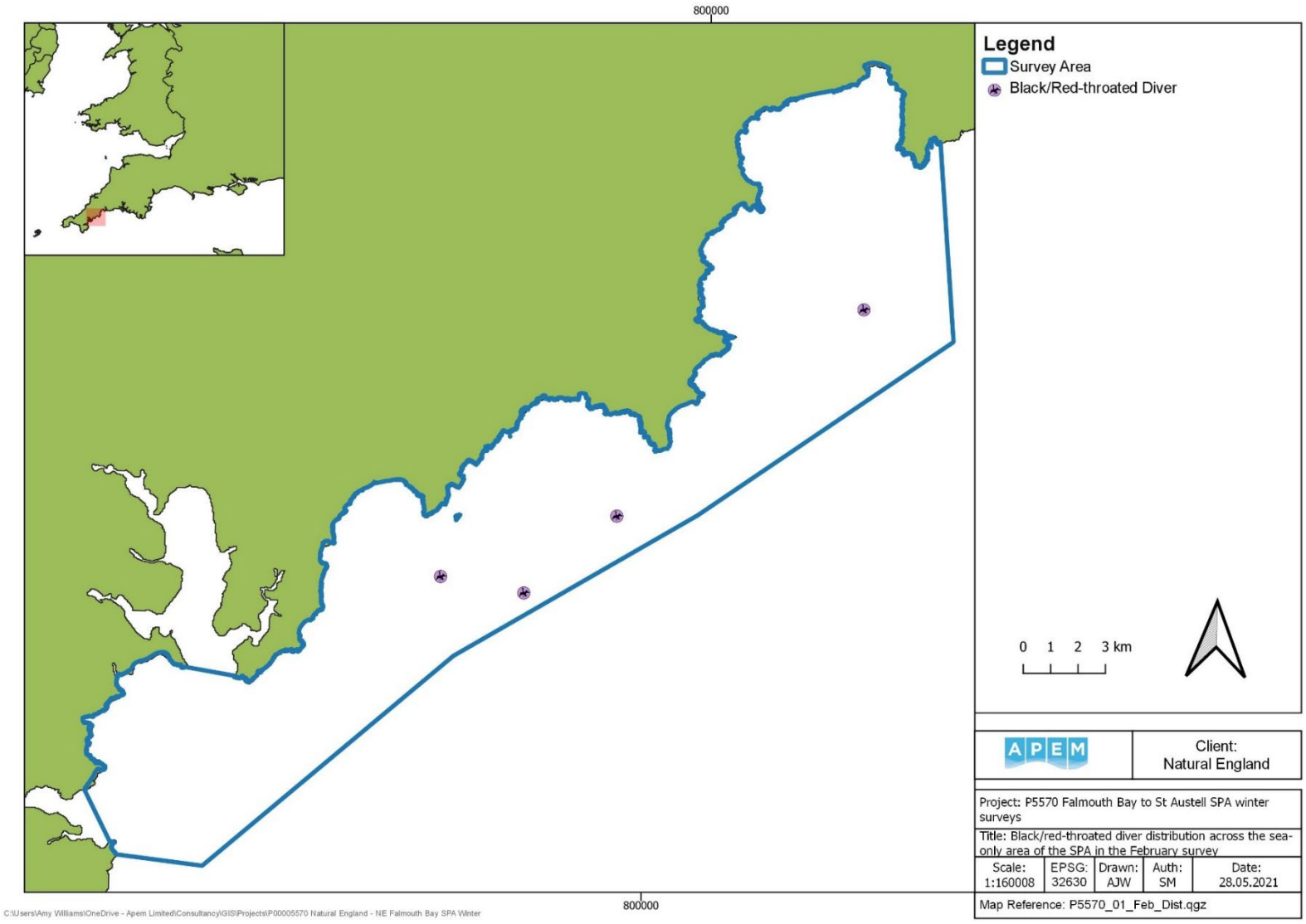


**Figure 13 Spatial distribution of the black / red-throated diver during the February 2021 survey.**

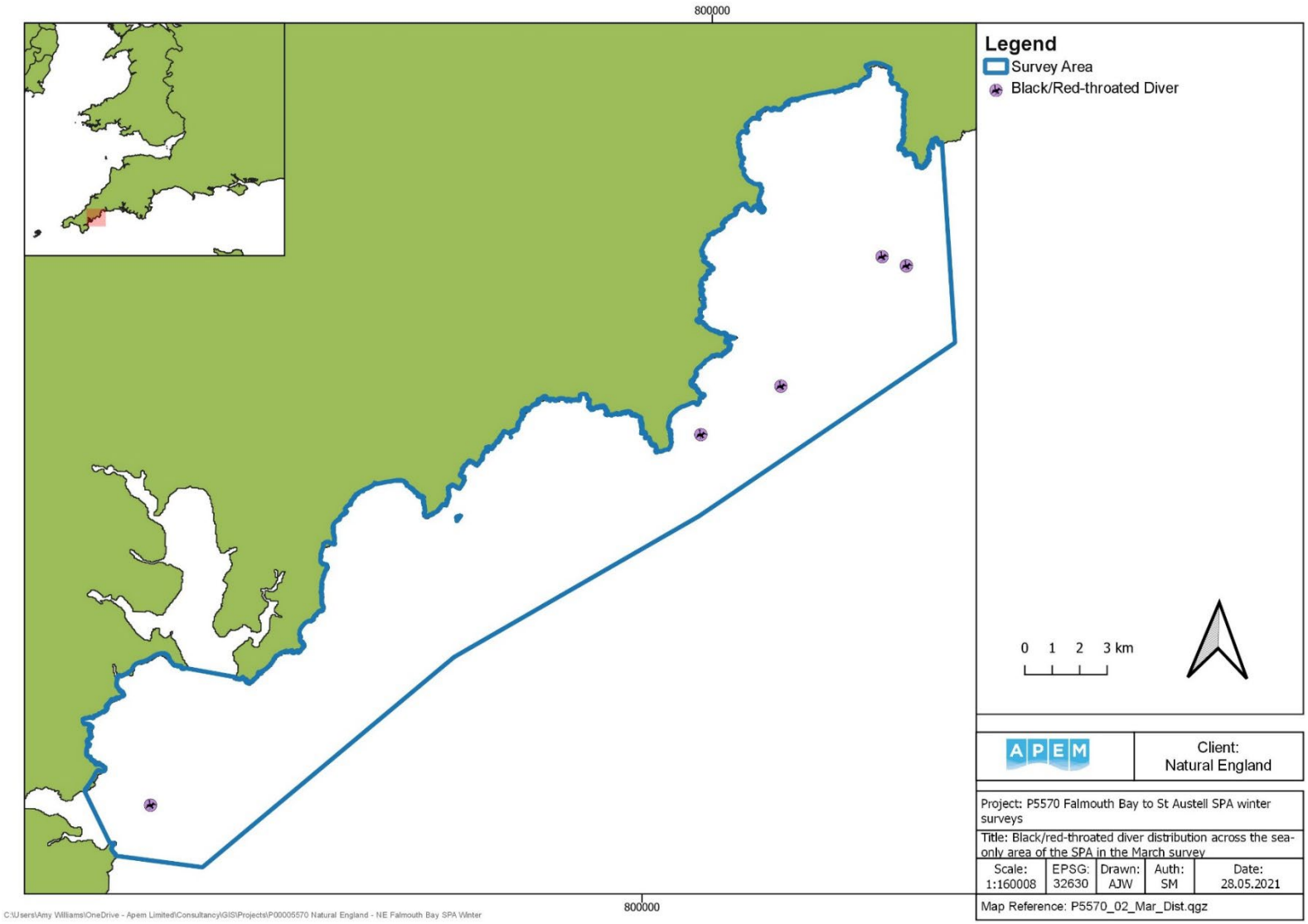


**Figure 14 Spatial distribution of the black / red-throated diver during the March 2021 survey.**

### *4.5.2 Design-based Population Estimates*

The peak count of nine black-throated diver during the March survey resulted in a population estimate of 13 for the Survey Area (**Table 11**). All black-throated divers were observed in the area within 2 km from the shoreline (**Table 11**).

**Table 11** **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black-throated diver in: a) Survey Area; and b) Survey Area within 2 km from shoreline.**

| a) Survey Area | | | | | | |
|---|---|---|---|---|---|---|
| **Survey** | **Raw Count** | **Population estimate** | **Lower CI** | **Upper CI** | **Precision** | **Density (bird per km$^2$)** |
| February | 3 | 4 | 3 | 12 | 0.58 | 0.02 |
| March | 9 | 13 | 9 | 38 | 0.33 | 0.05 |
| **b) Survey Area – only 2 km from shoreline** | | | | | | |
| **Survey** | **Raw Count** | **Abundance** | **Lower CI** | **Upper CI** | **Precision** | **Density** |
| February | 2 | 3 | 2 | 7 | 0.7 | 0.02 |
| March | 9 | 13 | 9 | 38 | 0.33 | 0.1 |

The peak count of six black / red-throated divers during the March survey resulted in a population estimate of nine for the Survey Area (**Table 12**). The majority of black / red-throated divers were observed in the area within 2 km from the shoreline (**Table 12**).

**Table 12** **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black / red-throated diver in: a) Survey Area; and b) Survey Area within 2 km from shoreline.**

| a) Survey Area | | | | | | |
|---|---|---|---|---|---|---|
| **Survey** | **Raw Count** | **Population estimate** | **Lower CI** | **Upper CI** | **Precision** | **Density (bird per km$^2$)** |
| February | 4 | 6 | 4 | 12 | 0.5 | 0.02 |
| March | 6 | 9 | 6 | 18 | 0.41 | 0.04 |
| **b) Survey Area – only 2 km from shoreline** | | | | | | |
| **Survey** | **Raw Count** | **Abundance** | **Lower CI** | **Upper CI** | **Precision** | **Density** |
| February | 0 | - | - | - | - | - |
| March | 2 | 3 | 2 | 7 | 0.71 | 0.02 |

The apportionment of unidentified diver species abundance and the black / red-throated divers abundance (**Table 13**) across the Survey Area results in a revised population estimate of 5 black-throated divers in February survey and 20 black-throated divers in the March survey.

**Table 13** **Apportioned unidentified diver species and black / red-throated diver population estimates for black-throated divers, and revised population estimate for black-throated diver.**

| Survey | Apportioned population estimates | | Black-throated diver | |
|---|---|---|---|---|
| | Unidentified diver species | Black / red-throated diver | Population estimate | Revised population estimate |
| February | 0.039 | 0.89 | 4 | 4.94 |
| March | 0.56 | 6.10 | 13 | 19.67 |

The peak revised estimate of 20 black-throated divers from the March survey combined with the total of seven estimated from WeBS counts, results in a population estimate of 27 black-throated divers for the entire SPA.

### *4.5.3 Distribution of Sightings*

In the February survey, two individuals were less than 2 km from the shore, with one individual 4.8 km from the shore (**Figure 17**). In the March survey, all black-throated diver were observed under 1 km from the shoreline (**Figure 18**).

For black / red-throated divers the majority of individuals were located over 2 km from the shore (**Figure 19** and **Figure 20**), approximately 75% of individuals were over 2 km from the shore.

The estimated total of black-throated diver from the WeBS data, 7, for the estuarine / creek areas of SPA was 58% of the raw count observations of black-throated diver in the February survey, whereas it was 26% of the black-throated diver raw count observations in the March survey.

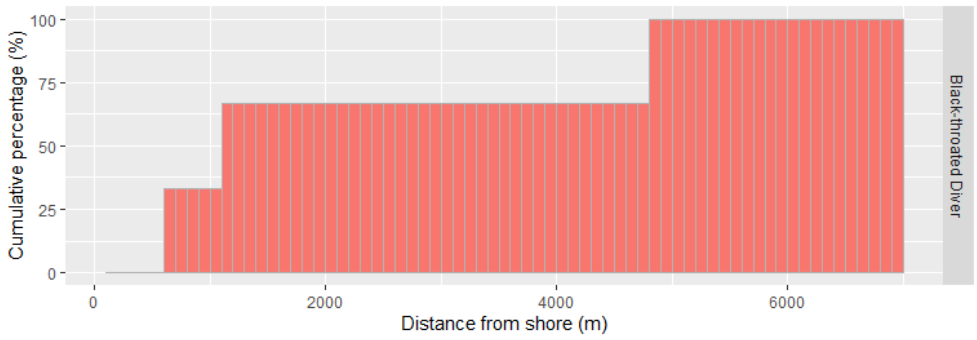


**Figure 15 Cumulative percentage of observation of black-throated diver in relation to distance from shore in the February survey**

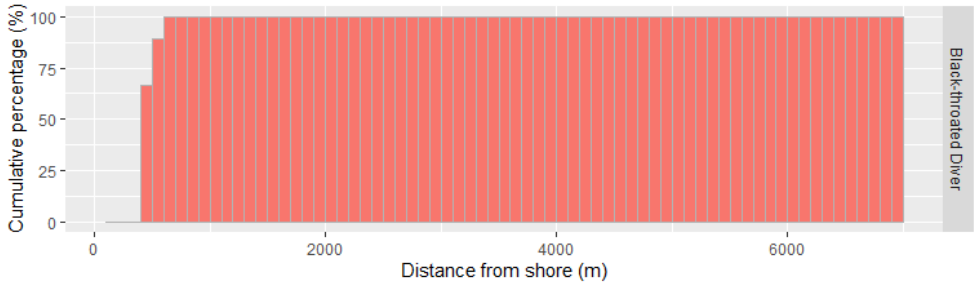


**Figure 16 Cumulative percentage of observation of black-throated diver in relation to distance from shore in the March survey**

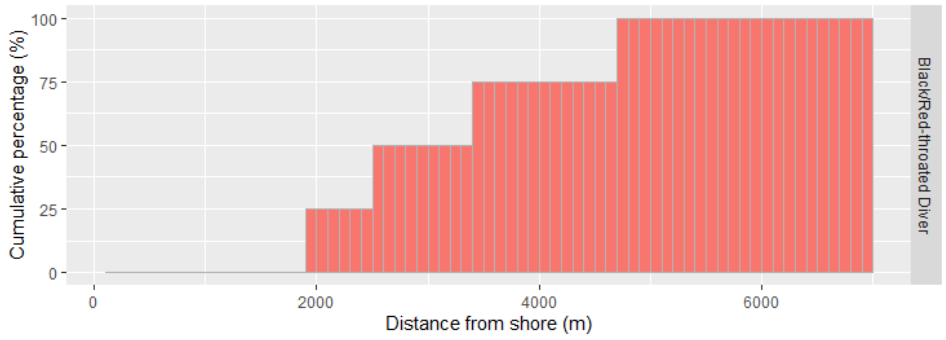


**Figure 17 Cumulative percentage of observation of black / red-throated diver in relation to distance from shore in the February survey**

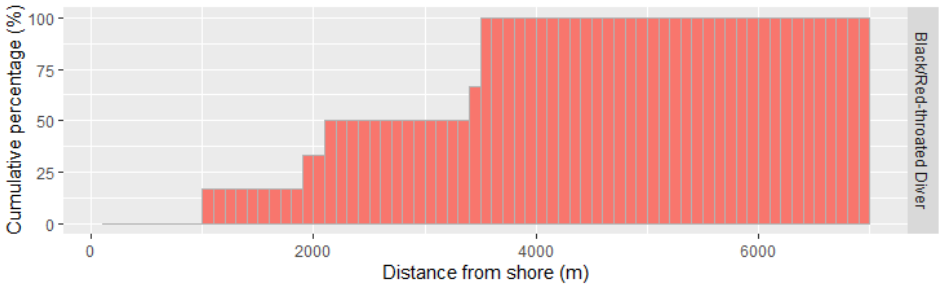


**Figure 18 Cumulative percentage of observation of black / red-throated diver in relation to distance from shore in the March survey**

## 4.6 Great Northern Diver

### *4.6.1 Abundance and Distribution*

The raw counts of great northern diver from the two surveys are presented in **Table 14**. Example snags of great northern diver are presented in Appendix II.

One great northern diver was recorded in flight during the March survey.

The spatial distribution of great northern diver is presented in **Figure 21** and **Figure 22**. During the February and March surveys great northern diver were distributed across the Survey Area with concentrations close to the coastline and at the top north-east of the SPA.

**Table 14 Raw counts of great northern divers recorded during the February and March 2021 surveys of the Survey Area.**

| Survey | Sitting | Flying | Total |
|---|---|---|---|
| February | 255 | - | 255 |
| March | 183 | 1 | 184 |
| ***Total Great Northern Diver*** | | | ***434*** |

### *4.6.2 Density Maps*

The maps showing density of great northern diver across the Survey Area for the February and March surveys are presented in **Figure 23** and **Figure 24**.

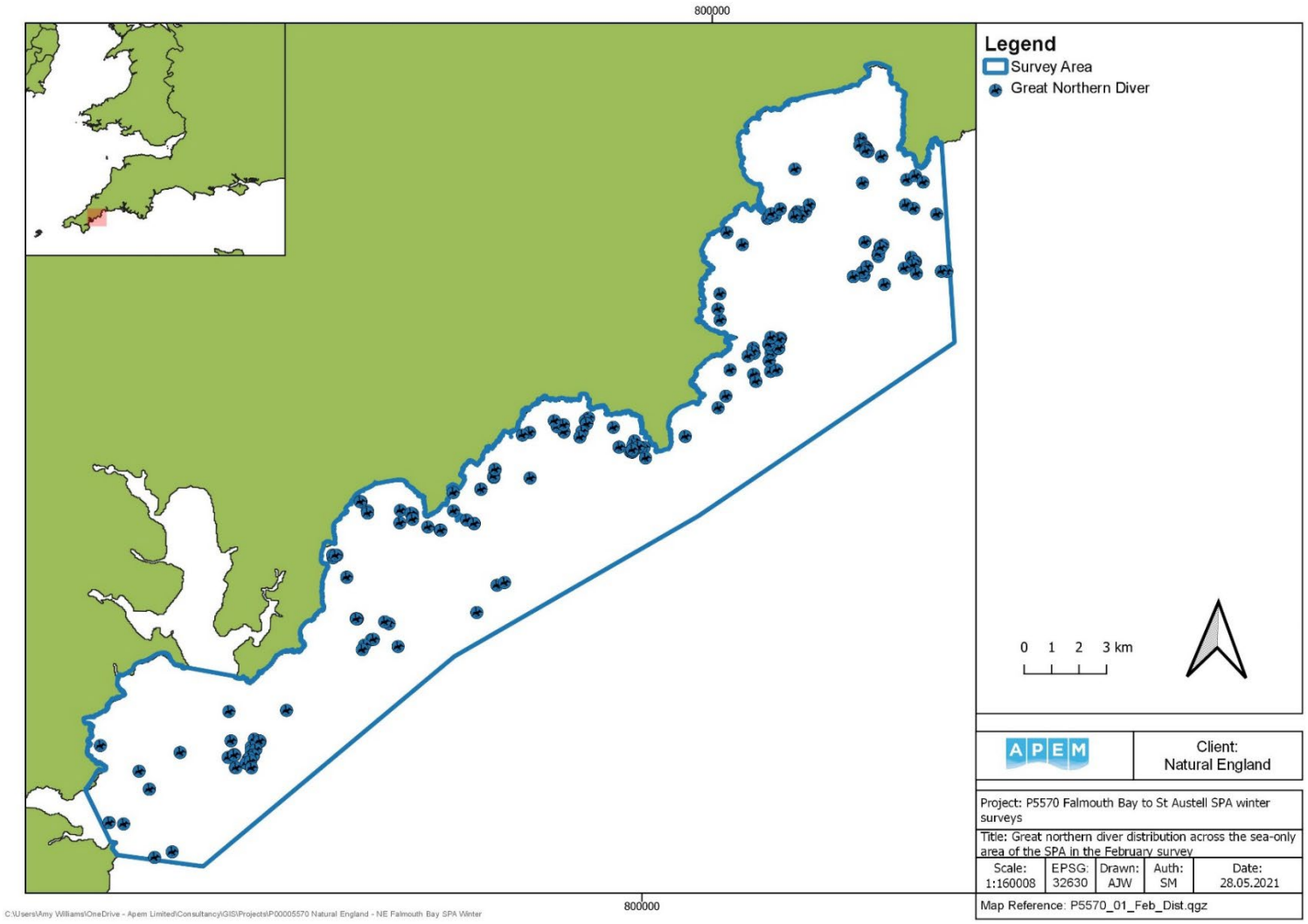


**Figure 19 Spatial distribution of the great northern diver during the February 2021 survey.**

Figure Note: Individuals may appear to overlap if they are in close proximity to each other.

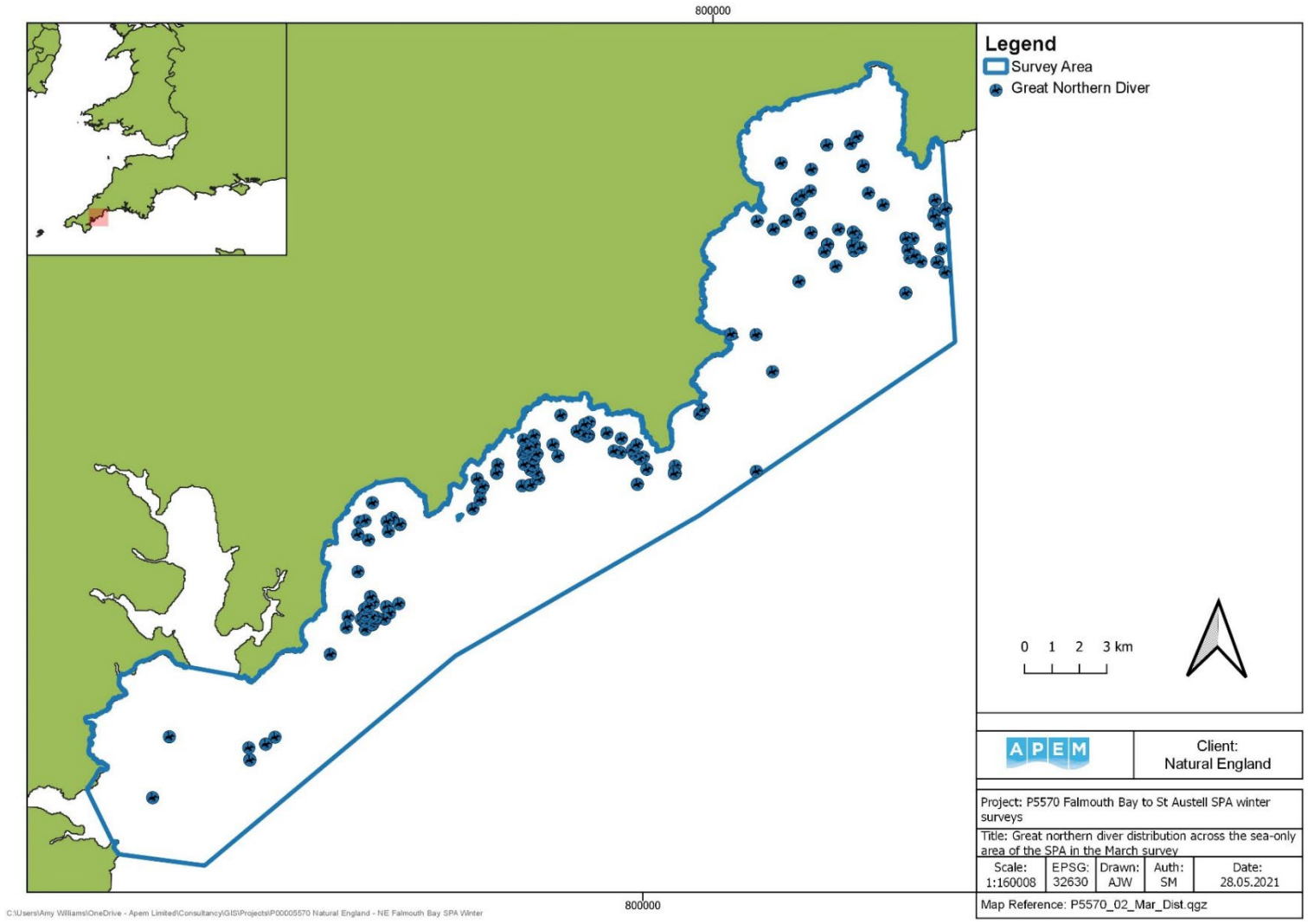


**Figure 20 Spatial distribution of the great northern diver during the March 2021 survey.**

Figure Note: Individuals may appear to overlap if they are in close proximity to each other.

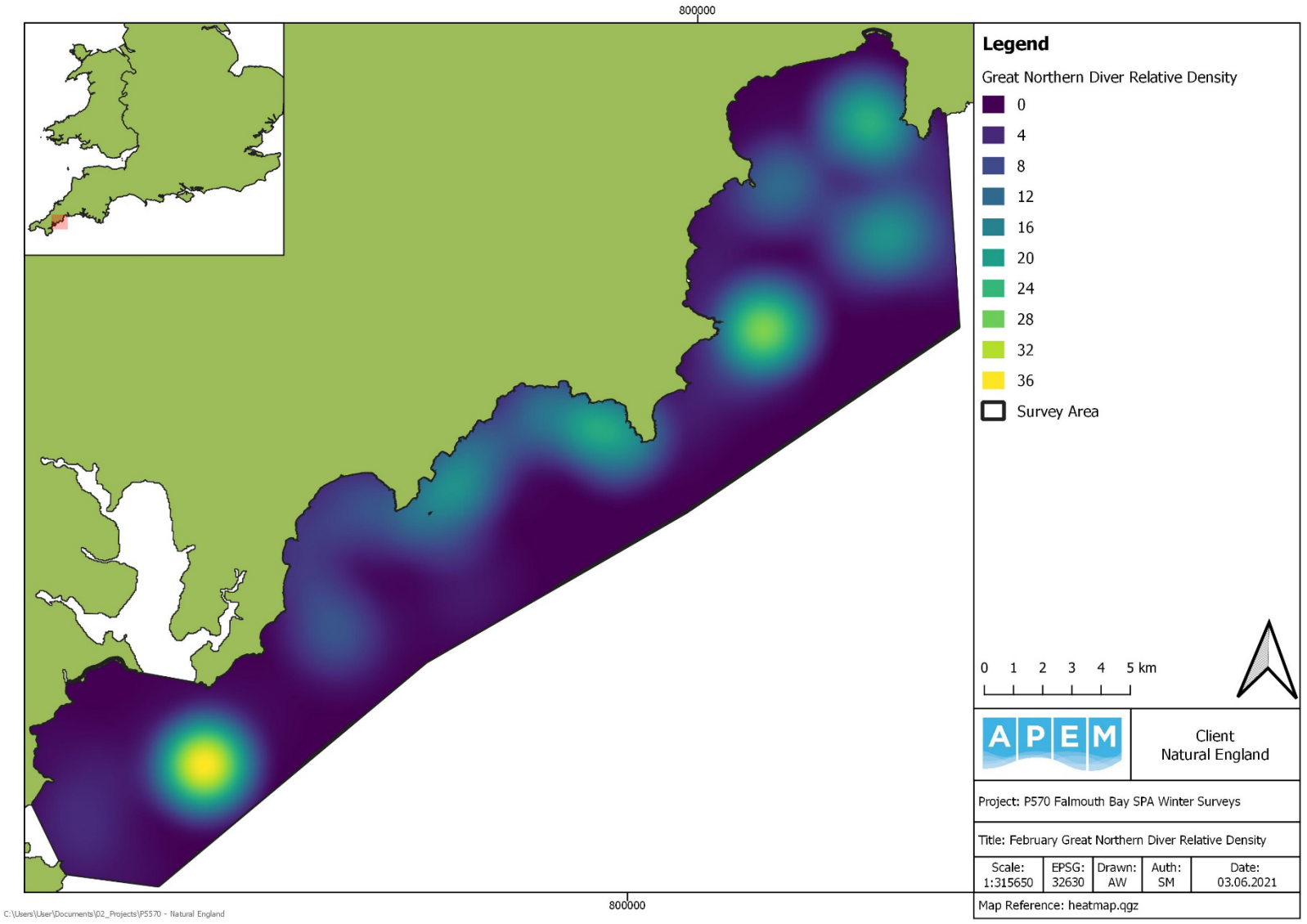


**Figure 21 Density of the great northern diver during the February 2021 survey.**

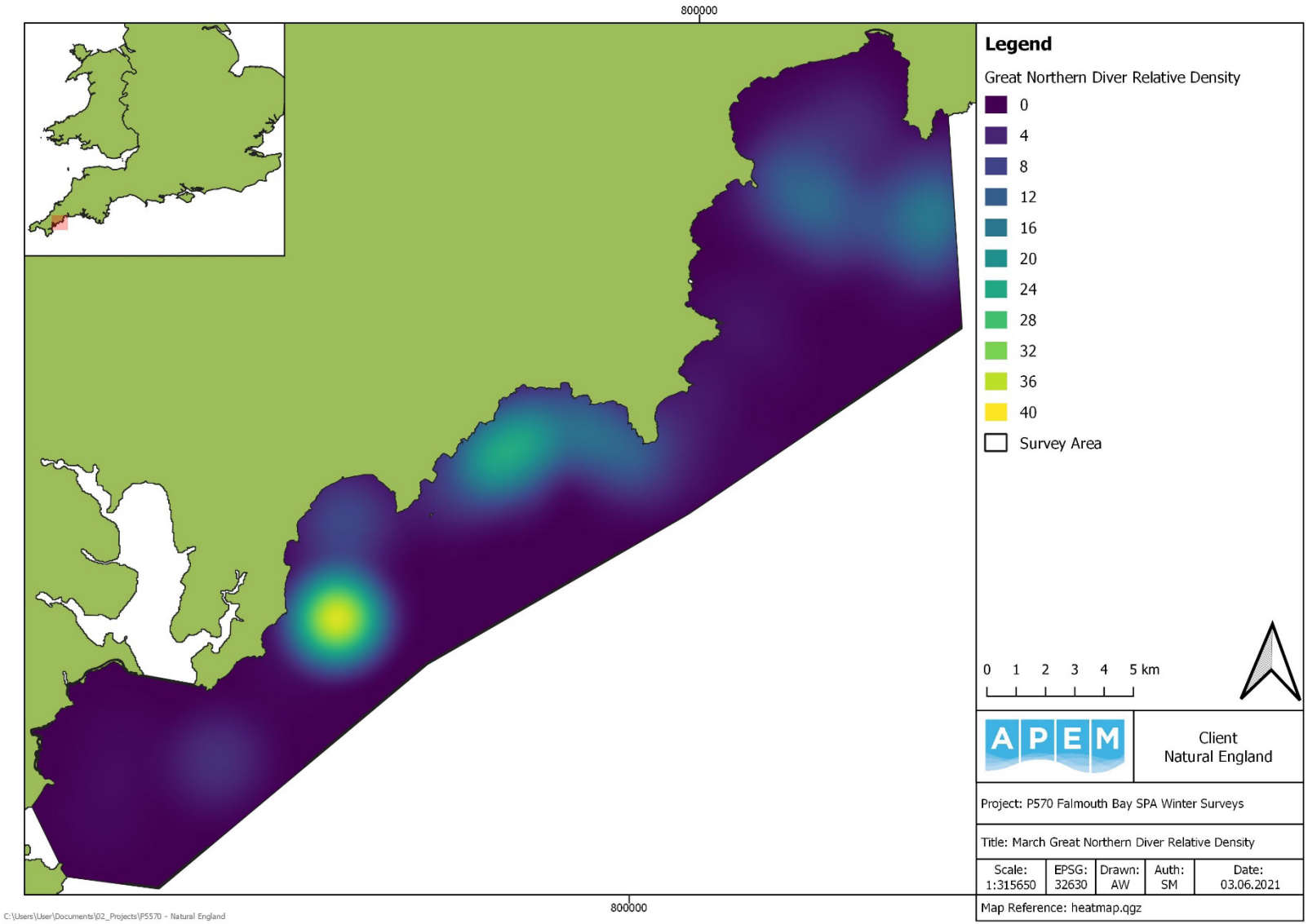


**Figure 22 Density of the great northern diver during the March 2021 survey.**

### *4.6.3 Design-based Population Estimates*

The peak count of 255 great northern diver during the February survey resulted in a population estimate of 370 for the Survey Area (**Table 15**).

The peak count of 183 great northern diver from the February survey in the 2 km area from the shoreline, resulted in a population estimate of 266 (**Table 15**).

**Table 15** **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great northern diver in a) Survey Area; and b) Survey Area within 2 km from shoreline.**

| a) Survey Area | | | | | | |
|---|---|---|---|---|---|---|
| **Survey** | **Raw Count** | **Population estimate** | **Lower CI** | **Upper CI** | **Precision** | **Density (bird per km$^2$)** |
| February | 255 | 370 | 255 | 507 | 0.06 | 1.53 |
| March | 184 | 271 | 184 | 412 | 0.07 | 1.12 |
| **b) Survey Area – only 2 km from shoreline** | | | | | | |
| **Survey** | **Raw Count** | **Abundance** | **Lower CI** | **Upper CI** | **Precision** | **Density** |
| February | 183 | 266 | 183 | 379 | 0.07 | 2.1 |
| March | 142 | 210 | 142 | 361 | 0.08 | 1.66 |

The apportionment of unidentified diver species population estimates (**Table 16**) across the Survey Area results in a revised population estimate of 374 great northern divers in February survey and 283 great northern divers in the March survey.

**Table 16** **Apportioned unidentified diver species population estimate for great northern divers, and revised population estimate for great northern diver.**

| **Survey** | **Apportioned estimates** | **Great northern diver** | |
|---|---|---|---|
| | **Unidentified diver species** | **Population estimate** | **Revised population estimate** |
| February | 3.67 | 370 | **373.67** |
| March | 11.74 | 271 | **282.74** |

The revised peak estimate of 374 great northern diver from the February survey combined with the total of 21 estimated from WeBS counts, resulted in a population estimate of 395 great northern divers for the entire SPA.

### *4.6.4 Distribution of Sightings*

All great northern diver in the survey area, in both surveys, were observed under 5 km from the shoreline (**Figure 25** and **Figure 26**). In both surveys, approximately 75% of the individuals were less than 2 km from the shoreline. With very few (~1%) over 4 km from the shoreline.

The estimated total of great northern diver from the WeBS data, 21, for the estuarine/creek areas of SPA was 5% of the raw count observations of great northern diver in the February survey, and was 7% of the great northern diver raw count observations in the March survey.

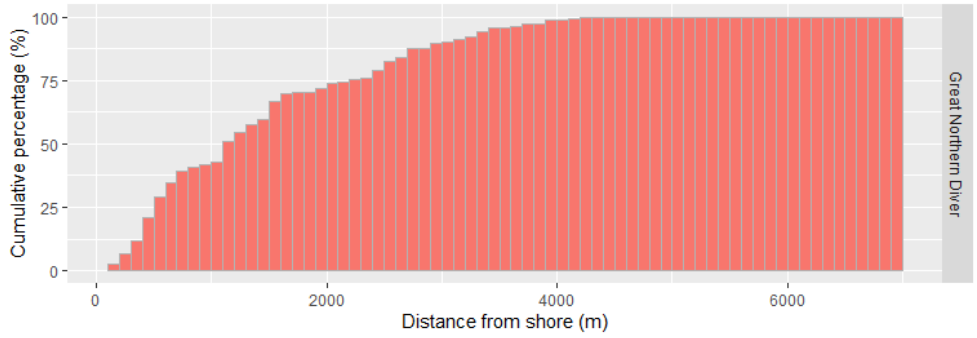


**Figure 23 Cumulative percentage of observation of great northern diver in relation to distance from shore in the February survey**

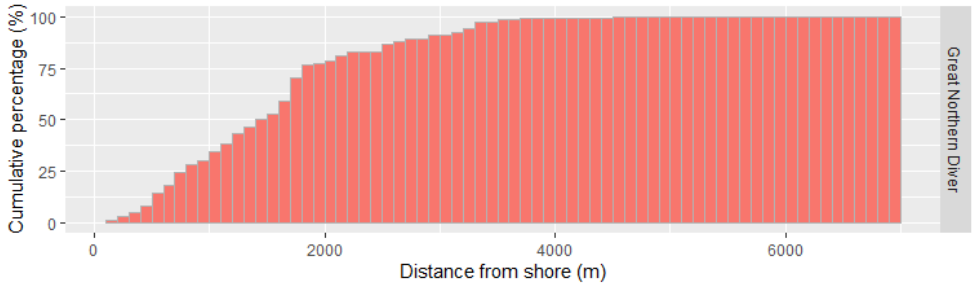


**Figure 24 Cumulative percentage of observation of great northern diver in relation to distance from shore in the March survey**

## 4.7 Slavonian Grebe

### *4.7.1 Abundance and Distribution*

In the February survey, Slavonian grebe could not be differentiated from black-necked grebe and five Slavonian / black-necked grebes were recorded (**Table 17**). No individuals were recorded as flying. Example snags of Slavonian / black-necked grebes are presented in Appendix II.

During the February survey the Slavonian / black-necked grebes were distributed across the Survey Area with one individual outside of the Survey Area boundary in the north-east (**Figure 27**). No Slavonian grebes or black-necked grebes were recorded in the March survey.

**Table 17 Raw counts of Slavonian grebe / black-necked grebe recorded during the February and March 2021 surveys of the Survey Area.**

| Survey | Sitting | Flying | Total |
|---|---|---|---|
| February | 5 | - | **5** |
| March | - | - | 0 |
| ***Total Slavonian / black-necked grebes*** | | | ***5*** |

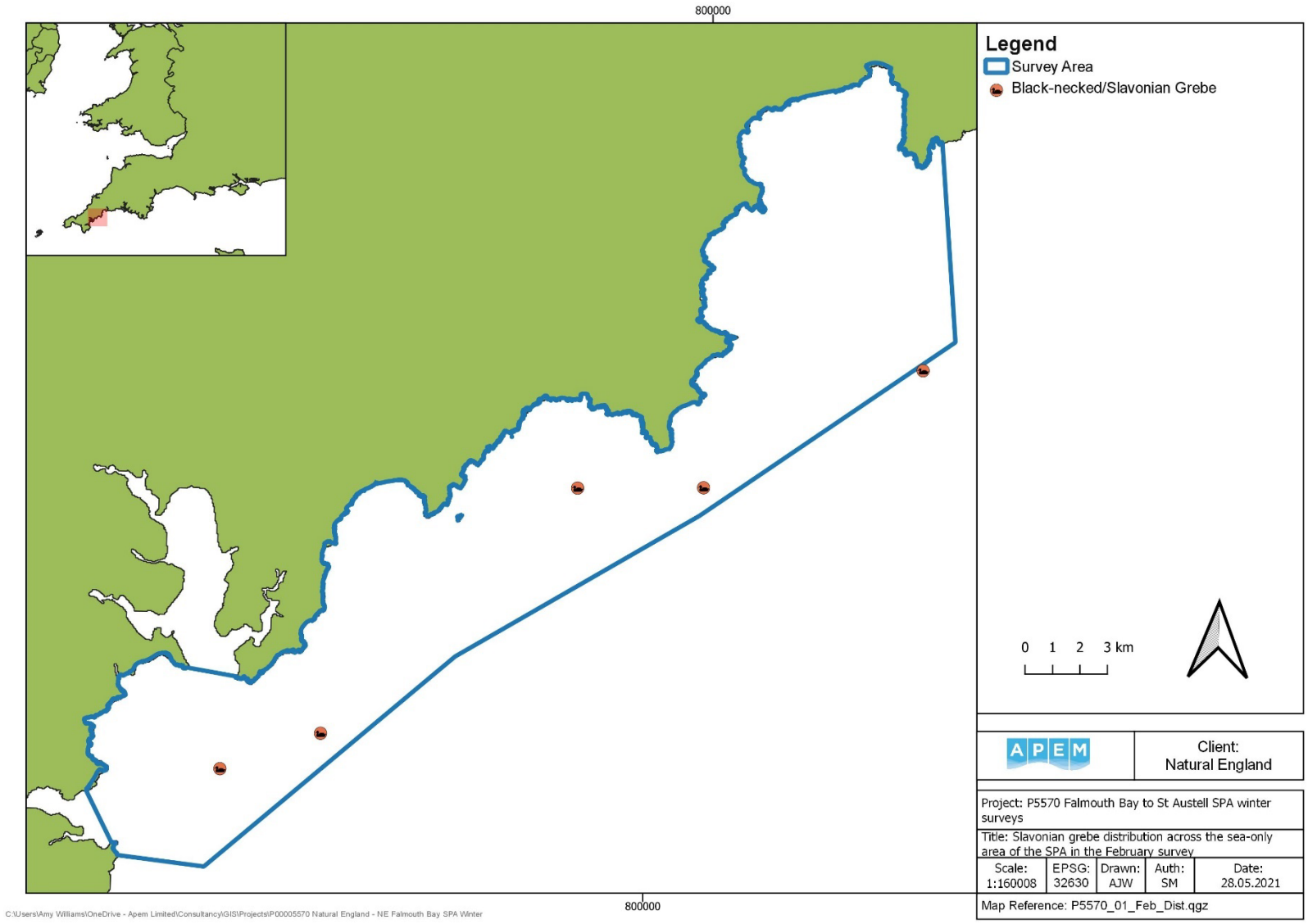


**Figure 25 Spatial distribution of the Slavonian grebe / Black-necked grebe during the February 2021 survey**

### *4.7.2 Design-based Population Estimates*

The peak count of four Slavonian / black-necked grebes inside the Survey Area boundary during the February survey resulted in a population estimate of six for the Survey Area (**Table 18**).

The peak count of one Slavonian / black-necked grebe from the February survey in the 2 km area from the shoreline, resulted in a population estimate of 1 (**Table 18**).

**Table 18** **Raw counts and abundance and density estimates (No. estimated individuals per km2) of Slavonian grebe / black-necked grebe in a) Survey Area; and b) Survey Area within 2 km from shoreline.**

| a) Survey Area | | | | | | |
|---|---|---|---|---|---|---|
| **Survey** | **Raw Count** | **Population estimate** | **Lower CI** | **Upper CI** | **Precision** | **Density (bird per km$^2$)** |
| February | 4 | 6 | 4 | 12 | 0.5 | 0.02 |
| **b) Survey Area – only 2 km from shoreline** | | | | | | |
| **Survey** | **Raw Count** | **Abundance** | **Lower CI** | **Upper CI** | **Precision** | **Density** |
| February | 1 | 1 | 1 | 4 | 1 | 0.01 |

The peak estimate of six Slavonian / black-necked grebes from the February aerial survey combined with the total of six estimated from WeBS counts, resulted in a population estimate of 12 Slavonian / black-necked grebes for the entire SPA.

### *4.7.3 Distribution of Sightings*

The Slavonian / black-necked grebes in the Survey Area, in the February survey, were observed from 1.7 to 3.1 km from the shoreline (**Figure 28**). One individual was observed just outside of the Survey Area on the seaward boundary of the SPA (not included in the peak counts or abundance estimates) at 6.8 km from the coastline.

The estimated total of Slavonian grebe from the WeBS data, six, for the estuarine/creek areas of SPA was 60% of the raw count observations of Slavonian / black-necked grebes within the Survey Area (n=4) in the February survey.

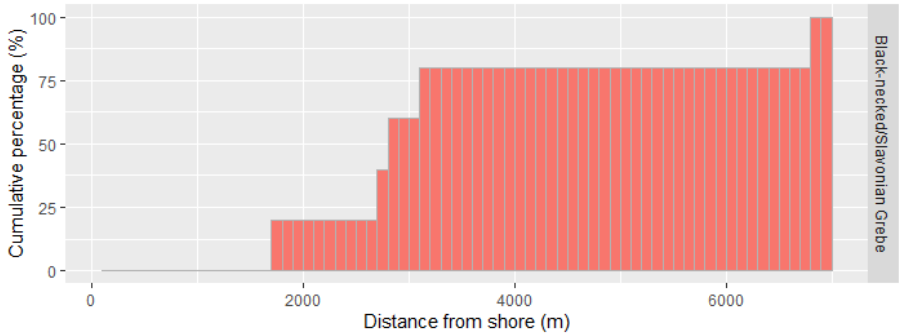


**Figure 26 Cumulative percentage of observation of Slavonian grebe in relation to distance from shore during both winter surveys.**

# 5. Discussion

This report has provided raw counts and population estimates for the three qualifying features of the Falmouth Bay to St Austell Bay SPA in the 2020/21 winter. Previous monitoring projects of these species have been undertaken from land-based surveys. At the time of classification, the site regularly supported more than 1% of the Great Britain wintering population estimate of the three qualifying features (NE 2013).

## 5.1 Black-throated Diver

In this study the peak black-throated diver population estimate across the whole SPA was 27 individuals in the March. The population estimate of 27 is a reduction from the two-year peak mean of 115 in 2009/10 and 2010/11 from JNCC shore-based counts (NE 2013) and from the maximum count of 185 (maximum count at each vantage point summed across visits) from Liley *et al.* (2014). The predicted population of 27 black-throated diver in the SPA is below the minimum required for SPA site selection (O'Brien *et al.* 2014).

Black-throated diver abundance has been shown to be variable between surveys in the same season; Liley *et al.* (2014) reported that counts for black-throated diver were higher in January than during surveys in late January and mid-March, with the late January and mid-March surveys providing low counts under 20 individuals. In the Departmental Brief for the SPA (NE, 2013), low counts were recorded in the December surveys (2009/10 and 2010/11), 16 and 53, with higher counts of 127 and 102 in the February surveys of the same season (2009/10 and 2010/11). In addition, the variability of counts for black-throated diver can be seen in the WeBS count data for the Gerrans Bay site (WeBS sector 10486) which is within the open sea area of the SPA and within the area covered by the aerial digital surveys. From 2012/13 to 2019/20, four winter seasons had surveys undertaken each month, three of these years (2012/13, 2013/14 and 2016/17) had peak counts in March (62, 79 and 77) whereas in 2015/16 the count in March was 26 with the peak in April of 112. These results suggest peaks of black-throated diver between late January and March, therefore it was predicted the peak abundance would be observed in the February and March 2021 aerial survey. However, there is variability within seasons and an earlier survey in January or a later survey in April might have observed the peak abundance in 2021.

The distribution of black-throated diver across the open sea area of the SPA were scattered from the center to north-east of the SPA with 28-56% of observations predicted to be in the estuarine / creek areas of the SPA from the WeBS count data. All black-throated diver were within 2 km of the shoreline, except for one individual which was 4.8 km from the shoreline, suggesting that the majority of black-throated diver were captured by previous land-based surveys.

## 5.2 Great Northern Diver

Great northern diver has a peak population estimate of 395 individuals across the whole SPA from the February survey. In contrast to the black-throated diver observations, this is a large increase in individuals compared to the two-year peak mean of 74 in 2009/10 and 2010/11 from JNCC shore-based counts (NE 2013) and the maximum counts of 90 from the Liley *et al.* (2014) study. Previous studies have not focused on the offshore distribution and abundance of the qualifying features, and this may have resulted in differences between this study and

previous studies for this species which had over 25% of observations over 2 km from the shoreline.

In previous studies the great northern diver counts were highest in February and early March and lowest in December and late January (NE, 2013; Liley *et al.*, 2014). The WeBS count data from Gerrans Bay site (within the open sea area of the SPA) suggests that peak counts are often observed in March (2012/13, 2013/14 and 2016/17) however in 2015/16 the peak count was observed in December. The aerial surveys in February and March 2021 were able to capture the peak winter abundance of great northern diver.

Great northern diver were scattered across the full length of the SPA with only 5-7% of predicted observations in the estuarine / creek areas of the SPA and approximately 75% of the population observed within 2 km from the shore. The range of great northern diver overlapped with the black-throated diver distribution as shown by Liley *et al.* (2014).

## 5.3 Slavonian Grebe

Slavonian grebe could not be differentiated from black-necked grebe in this study and was only observed in the February survey, the peak population estimate for the SPA was 12. This is comparable to the mean peak count of 15 from WeBS counts from 2007/08 – 2011/12 (NE 2013) and the maximum counts of 17 from the Liley *et al.* (2014) study.

Liley *et al.* (2014) reported the highest Slavonian grebe count in late January although counts were only recorded on six of the 12 surveys throughout the season. The WeBS count data from Gerrans Bay site (within the open sea area of the SPA) show that peak counts are variable throughout the season, with peak counts observed in October, November, December and March across the different years. Therefore, Slavonian grebe are observed in low numbers and observations are variable across the winter season.

Slavonian / black-necked grebes recorded in the February survey were distributed widely across the SPA; predicted observations in the estuarine / creek areas were 60% of the observations. In addition, Slavonian / black-necked grebes were distributed from 1.7 to 6.8 km from the shoreline with only 20 % of observations within 2 km from the shore; the distribution overlapped with great northern diver.

## 5.4 Conclusions

The results of this study, in combination with previous land-based surveys, suggest that the late February and March aerial survey observed the peak great northern diver population and recorded the highest population estimate for this species; the peak black-throated diver population was missed by the timings of the aerial surveys; Slavonian grebe are generally observed in very low numbers across the SPA and the counts are variable within seasons and between years. Therefore, it would be beneficial to undertake aerial surveys across the winter months, from December to March, to be able to capture the peak populations for black-throated diver and to understand the full variation of Slavonian grebe population within the SPA.

The great northern diver and Slavonian / black-throated grebe observations indicate that previous understanding of species distributions was constrained by using land-based observations. With 25% and 80% of observations, respectively, being missed if only areas within 2 km from the shoreline were surveyed. However, for black-throated diver the majority

were observed with 2 km from the shoreline. The future use of digital aerial surveys will allow for more accurate population estimates for these species to be available for multiple years.

The observations from this project suggest that the boundary of the SPA is sufficient to protect the areas used most by these two qualifying features. One black-throated diver and one great northern diver were close to the seaward limit (**Figure 13** and **Figure 22**) and one Slavonian / black-necked grebe was observed outside of the seaward limit, 6.8 km from the shore, suggesting that this qualifying species could be using deeper areas of water.

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# Appendix I Survey Conditions

**Table A Minimum weather conditions to undertake digital aerial survey**

| Condition | Minimum Survey Requirement |
|---|---|
| Visibility (kilometres) | >10 |
| Cloud Cover (metres) | >549 |
| Wind (knots) | <30 |
| Sea State | <4 |

During the Survey an APEM Camera Technician was stationed within the aircraft to oversee data collection. The technician also recorded observational data, such as vessels, large marine mammals and weather data. Windspeed, wind direction and air temperature are all observed from instruments within the aircraft. Visibility was determined by how far the observer could see out the aircraft. Sea State was recorded using the Beaufort Sea State (see below), cloud cover recordings were based on Okta (see below).

**Sea State Scale**

0 - Calm

1 - Rippled

2 - Smooth (Small wavelets)

3 - Slightly moderate (large wavelets, some white caps)

4 - No Surveys conducted in these conditions (small waves (breaking), frequent whitecaps)

**Cloud Cover Scale**

0 % - Clear

1–10% - Few

11–50% - Scattered

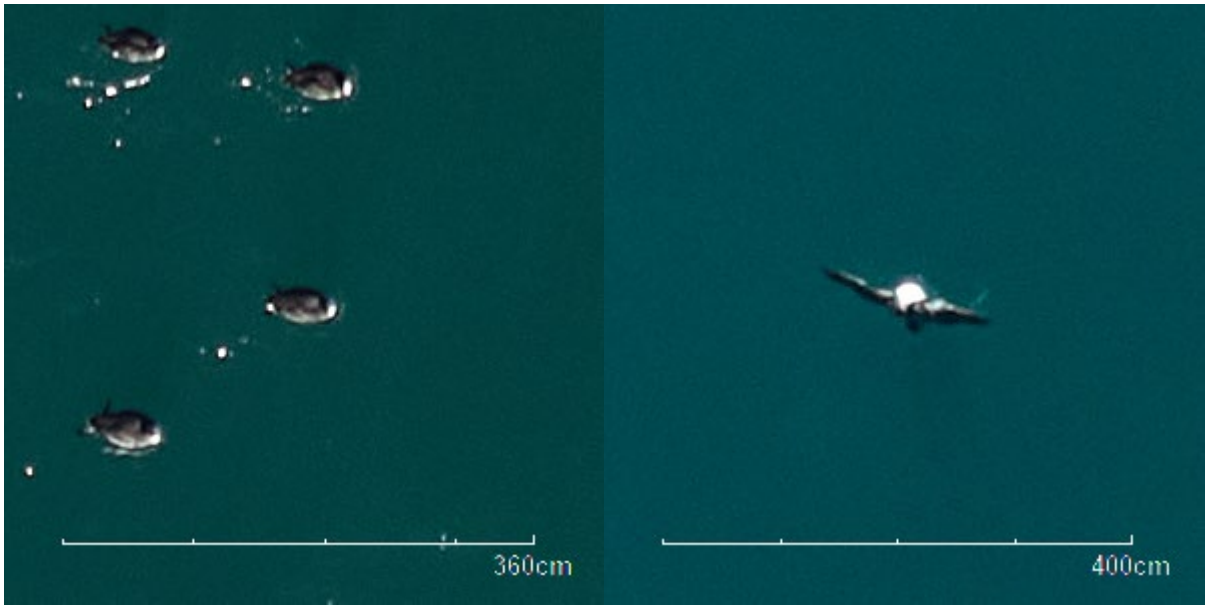
51–95% - Broken

96–100% - Overcast

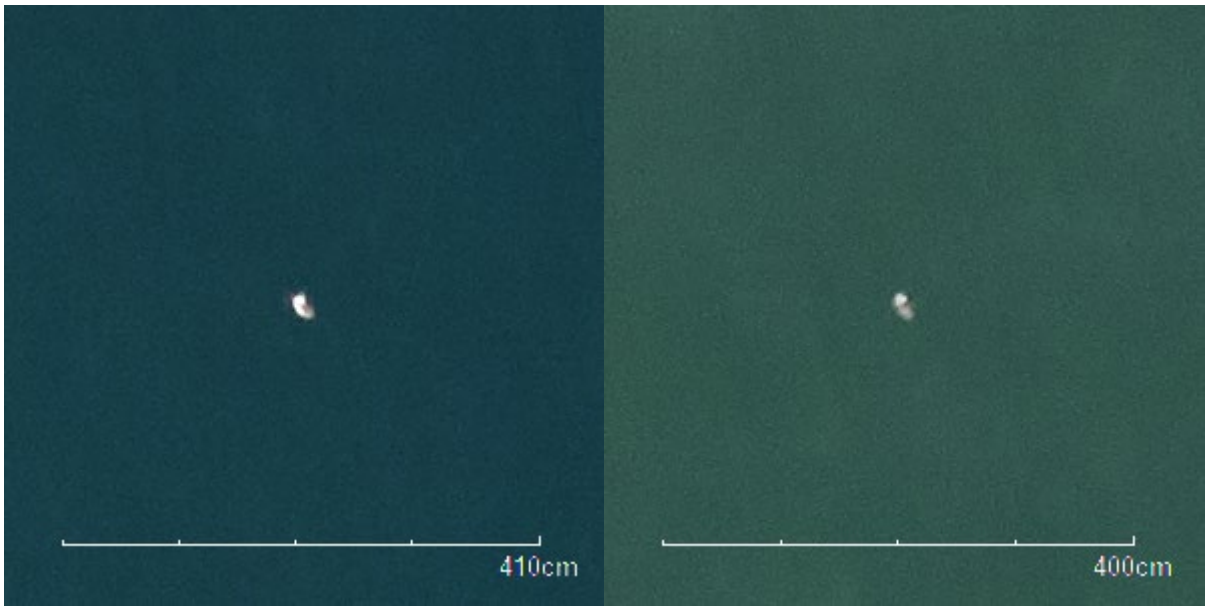
# Appendix II Example Snags of the Qualifying Features

*Black-throated Diver*


*Great Northern Diver*



*Slavonian / Black-necked grebe*



# Appendix III Scientific Names of Birds and Marine Megafauna

| Common Name | Scientific Name |
|---|---|
| Oystercatcher | *Haematopus ostralegus* |
| Kittiwake | *Rissa tridactyla* |
| Black-headed Gull | *Chroicocephalus ridibundus* |
| Mediterranean Gull | *Ichthyaetus melanocephalus* |
| Common Gull | *Larus canus* |
| Great Black-backed Gull | *Larus marinus* |
| Herring Gull | *Larus argentatus* |
| Lesser Black-backed Gull | *Larus fuscus* |
| Great Skua | *Stercorarius skua* |
| Pomarine Skua | *Stercorarius pomarinus* |
| Razorbill | *Alca torda* |
| Puffin | *Fratercula arctica* |
| Red-throated Diver | *Gavia stellata* |
| Black-throated Diver | *Gavia arctica* |
| Great Northern Diver | *Gavia immer* |
| Fulmar | *Fulmarus glacialis* |
| Gannet | *Morus bassanus* |
| Cormorant | *Phalacrocorax carbo* |
| Shag | *Phalacrocorax aristotelis* |
| Little Egret | *Egretta garzetta* |
| Carrion Crow | *Corvus corone* |

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