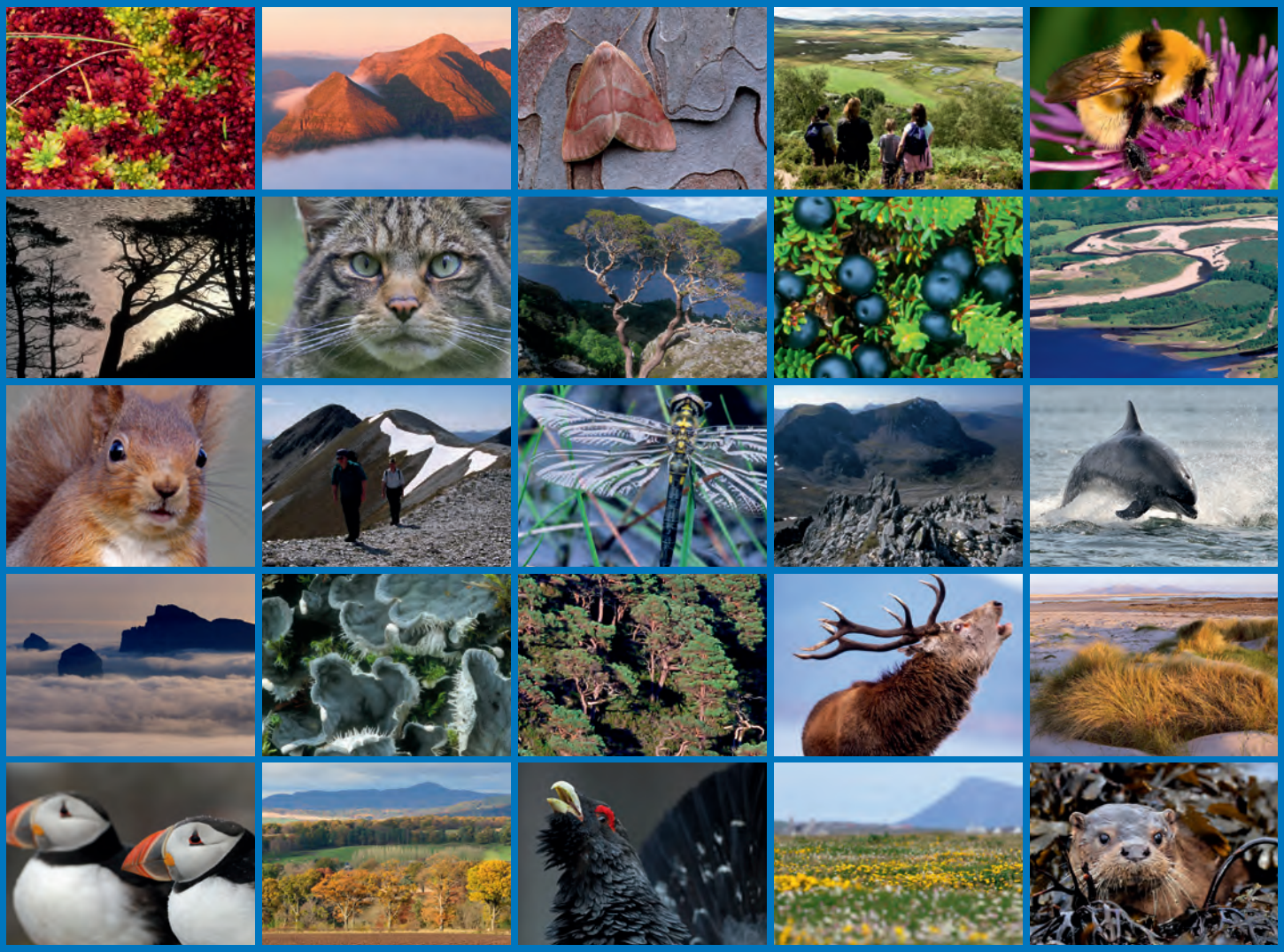
Scottish Natural Heritage
Commissioned Report No. 623

Boat and aerial survey protocols for seabirds at wave and tidal search areas in north western Scotland



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COMMISSIONED REPORT

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Boat and aerial survey protocols for seabirds at wave and tidal search areas in north western Scotland

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COMMISSIONED REPORT

Summary

Boat and aerial survey protocols for seabirds at wave and tidal search areas in north western Scotland

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Note: This report was originally completed in 2010 but not published, formally, at the time. It is being published in 2013 in recognition of the ongoing value of the research concerned but readers should note that the text has not been updated in the intervening period.

Background

In order to inform future wave and tidal leasing rounds, the Scottish Government, in 2010, identified six search areas across north western Scotland as potentially suitable for wave energy and tidal stream development. These areas hold internationally important breeding colonies of many seabird species and all contain, overlap with or are situated close to (i.e. within foraging range of certain species) existing Special Protection Areas (SPAs).

A considerable amount of information regarding seabirds in the region containing the search areas is already available. However, this is mostly limited to bird counts on land at major breeding colonies as part of long running monitoring programmes. Whilst useful in providing background information, these data do not identify key offshore areas nor do they support assessments of potential impacts of wave and tidal developments on seabird populations in the study area. Thus, more detailed information to inform the identification of key areas is required.

Main findings

This report, funded by Marine Scotland and completed in 2010, provides an overview of appropriate offshore boat and aerial survey protocols, tailored to the study area. Further, it outlines a proposed suite of surveys, over two years, that should ensure a) the collection of high quality data in a scientifically robust manner and b) inter-project consistency.

These protocols will form the basis for an ornithological characterisation of the study area - both temporally and spatially - as well as an improved understanding of seabird distribution patterns in relation to SPAs (connectivity).

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1. BACKGROUND

1.1 Study Area

In order to inform future wave and tidal leasing rounds, the Scottish Government, in 2010, identified six search areas across north western Scotland as potentially suitable for wave energy and tidal stream development.

In this report the study area at large is considered to be the whole of north western Scotland – approximately from the Mull of Galloway in Dumfries and Galloway to Cape Wrath, Sutherland, including the coast line of Northern Ireland.

The potential development areas all fall within the overall study area and are spread across the Outer Hebrides, Inner Hebrides, Colonsay, Islay and Kintyre and are hereafter referred to as "the search areas".

Two tidal search areas have been identified: south and southwest off Islay and a third area south of the Mull of Kintyre.

Wave search areas have been identified in three locations: west of Coll and Tiree, west of Colonsay as well as along the entire west coast of the Outer Hebrides.

Figure 1 (see Appendix) provides an overview of the various wave and tidal resource areas in the study area in addition to all relevant Special Protection Areas (SPA), including any marine extensions. Search areas for wind energy developments in Scottish Territorial Waters (SWT) have been included to provide additional spatial context.

1.2 Ornithological Significance

The study area holds internationally important breeding colonies of northern fulmar *Fulmarus glacialis*, Manx shearwater *Puffinus puffinus*, northern gannet *Morus bassanus*, shag *Phalacrocorax aristotelis*, great skua *Catharacta skua*, common guillemot *Uria aalge*, razorbill *Alca torda* and black guillemot *Cepphus grylle*. Various other species are also known to breed in nationally important numbers (Barton & Pollock 2005).

The most important colonies are St. Kilda, Rum, Handa, Shiant Islands, Treshnish Isles, Priest Island, Berneray, North Uist, North Rona, Mull, Mingulay, Sula Sgeir, Lewis, Harris, Colonsay, the Flannan Isles and Ailsa Craig.

Away from breeding colonies, internationally important concentrations of great northern diver *Gavia immer*, Slavonian grebe *Podiceps auritus*, and Manx shearwaters occur within the area, and nationally important numbers of several other species are known to occur.

Key areas for great northern divers are Loch Indaal, Islay, the Sound of Gigha, west Kintyre peninsula, Loch Caolisport and Howmore, South Uist, while the Sound of Taransay holds internationally important numbers of Slavonian grebe. Large numbers of Manx shearwaters are regularly recorded passing Frenchman's Rocks, Islay on passage.

Within Northern Ireland, lesser black-backed gull *Larus fuscus*, common guillemot and razorbill breed in internationally important numbers and eight other species breed in nationally important numbers (Barton & Pollock 2005).

The most important colonies in Northern Ireland are on Rathlin Island, Sheep Island, Copeland Islands and the Causeway Coast.

Outside of the breeding season, nationally important numbers of common eider *Somateria mollissima* are recorded at Rathlin Island, with important numbers of black-legged kittiwake *Rissa tridactyla* and Arctic tern *Sterna paradisaea* recorded flying past Ramore Head.

A network of Special Protection Areas (SPA) has been established under the Birds Directive (Directive 2009/147/EC) to ensure the conservation of a variety of bird species. Several terrestrial SPAs have recently been extended to include the areas of sea adjacent to breeding colonies in recognition of the importance of these areas for the designated breeding bird species or bird assemblages.

All proposed development search areas in the study area either overlap with or are situated close to (i.e. within foraging range of certain species) existing SPAs.

1.3 Knowledge Gaps

A considerable amount of information regarding seabirds in the study area is already available. However, this is mostly limited to bird counts on land at major breeding colonies as part of long running monitoring programmes (e.g. Mitchell *et al*. 2004). Spatial and temporal data of seabird utilisation of offshore habitats, other than in the vicinity of such colonies, is scarce. Much of such existing data has been obtained and collated by JNCC through its Inshore Survey Programme. These data have been used for a range of purposes such as SPA monitoring, site condition monitoring and to determine the conservation status of key species. Currently the JNCC is analysing data to establish important offshore aggregations of seabirds with a view to explore the designation of marine SPAs.

Seabird data available through the European Seabirds At Sea (ESAS) database, albeit valuable, is acknowledged to be patchy in its coverage of UK waters. Crucially, the data is available only at a relatively coarse spatial resolution, insufficient for the level of detail required for wave and tidal developments, for which search areas are relatively small in comparison.

Whilst useful in providing background information, these data do not provide, on their own, a baseline capable of identifying key offshore areas nor of supporting assessments of potential impacts of wave and tidal developments on seabird populations in the study area. Thus, more detailed information to inform the identification of key areas is required.

Identification of offshore areas of ornithological importance alone, however, is not sufficient - the underlying ecological mechanisms as well as connectivity with protected areas need to be established. Understanding seabird associations with particular environmental features in marine areas is essential for identifying offshore bird aggregations for risk assessments of wave and tidal developments. For example, surveys of distribution and abundance alone are inadequate to determine the importance of a feeding location without also knowing which colony or colonies are the sources of feeding aggregations or which features make certain feeding locations of interest in the first place.

Ultimately, bringing together insight in distribution and abundance, as well as an understanding of the reasons behind these patterns, will support an iterative layout design process for development search areas and associated impact assessments.

Thus, overall, surveys designed to deliver ornithological characterisations of a given study area are essential in assisting in the identification of the most suitable locations for renewable energy developments as part of marine spatial plans. Furthermore, data collected during these surveys will inform the Environmental Impact Assessments or Appropriate Assessments which may be required as part of the consideration of proposed developments.

1.4 Objectives

This report aims to provide an overview of appropriate offshore boat and aerial survey protocols, tailored to the study area, to ensure the collection of high quality data in a scientifically robust manner, as well as inter-project consistency.

These protocols will form the basis for an ornithological characterisation of the study area - both temporally and spatially - as well as an improved understanding of seabird distribution patterns in relation to SPAs (connectivity).

1.5 Summary of Requirement

It is proposed that the survey programme should span a two-year period, in order to attempt to account for inter-annual variability in seabird populations in the region as well as to enable a thorough marine ornithological characterisation of the study area.

Monthly boat-based surveys are proposed for the tidal search areas off Islay and Kintyre and the wave search areas off Colonsay and Coll/Tiree. Survey design should be based on a relatively fine-scaled transect grid, providing maximum opportunity to collect behavioural data in particular.

A more limited boat-based survey effort is proposed to be undertaken at a few carefully chosen locations off the Outer Hebrides. Such locations will have to be near known seabird aggregations in the general search area, providing the best opportunity to collect behavioural data in particular.

Aerial surveys should be deployed to provide a regional context for all of the search areas including the Outer Hebrides. Given the large size of the Outer Hebrides this would be the mainstay of the survey effort for that area. It is expected, however, that this approach will provide an appropriate level of ornithological characterisation at this stage.

Both boat and aerial survey protocols should incorporate the recording of marine mammals and other mega-fauna (e.g. basking shark *Cetorhinus maximus*) encountered. Although these are of a lower priority for the current surveys, data collected will substantially contribute to existing knowledge on marine mammal distribution in the study area.

It is strongly recommended to consider e.g. remote techniques for nocturnal species, and dedicated survey effort for detailed behavioural information of all seabirds, the latter particularly at tidal sites.

Further details are provided in the methodology section.

1.6 Timescale

The initial phase of the project would be for 12 months, starting in September 2010, with a second period of 12 months starting in September 2011.

2. METHODOLOGY

2.1 Survey Timescales – Boat Surveys

In order to obtain confidence that bird activity levels throughout the annual cycle are recorded, the recommended minimum effort for boat surveys are monthly surveys over a two-year period for all search areas.

However, the recommended survey effort can be more appropriately distributed across years if informed by the ecology of the species concerned. For example, fewer surveys may be conducted in winter at sites known to be important only for breeding seabirds, or vice versa.

2.2 Study Design – Boat Surveys

Boat-based surveys should be undertaken in accordance with established COWRIE guidance (Camphuysen *et al*. 2004). It is essential that survey recommendations made by Maclean *et al*. (2009) are incorporated into study designs where relevant.

Figures 2 to 4 show indicative boat survey areas including associated buffer zones for each search area (see Annex 2-4).

It might be possible to cooperate with developers of the three STW wind farm development areas in the study area. This could potentially allow for a minimum of overlap, and thus an efficient use of boat resources, leading to a more targeted overall approach. However, this would involve the need for data compatibility as well as data sharing – the likelihood of which is as of yet unclear.

2.3 Transect Layout

It is expected that, with exception of the Outer Hebrides, all search areas will be surveyed in their entirety. Given the size of the Outer Hebrides' search area, the logistics of boat survey mobilisation and likely weather issues involved, it is proposed to spatially limit the boat-based survey effort to a few carefully chosen locations. Such locations should have either known or estimated seabird aggregations in the general search area, focussing on a range of species and providing a good opportunity to collect behavioural data in particular. SPAs such as Mingulay and Berneray might be suitable options for such targeted locations.

Proposed boat transects should be spaced at between 1 and 3.7km intervals (0.5 to 2 nautical miles). If transects are spaced further apart than this, only a very small proportion of the study area is sampled. Given the variability in count data, this scaling process can be problematic if only a small proportion of the area is sampled, largely because it becomes very likely that seabird hotspots will be missed. As with the Pentland Firth protocols, a denser transect grid (within aforementioned range) should be considered where search areas overlap with SPA marine extensions. Transect "tails" – the travel distance from the end of a transect to the start of a new transect - should not be surveyed.

Particular attention should be paid to the orientation of transects in relation to the environmental gradients present. This is usually done by situating transects parallel to the bathymetry gradient. However, it would be valuable to consider transect layout in relation to potential flight directions between known seabird colonies and known or estimated feeding sites. In some search areas it might be feasible to orientate transects perpendicular to flight directions between colonies and feeding areas to increase the likelihood of capturing connectivity data.

A transect layout should at least consist of around 20 transects in each study area to generate confident estimates of numbers (Camphuysen *et al*. 2004; Maclean *et al*. 2009).

2.4 Buffer Zones

Areas to be surveyed by boat should include a surrounding 4km buffer in order to optimise the design's capacity to detect potential displacement effects. This buffer width has recently been used in several Round 2 and Round 3 zones. Research at Danish offshore wind farms suggests that displacement effects generally extend for less than 4km (Petersen *et al*. 2004). Modelling of buffer widths in relation to displacement detection probability has shown that for more abundant species a 4km buffer is likely to be sufficient to reliably detect changes in bird density of 15% or more (Trinder 2010).

2.5 Sampling Methodology – Boat Surveys

The boat-based bird surveys should be primarily aimed at establishing the species, number, density, distribution, and behaviour of birds present within the study area and a surrounding 4km buffer zone. Survey scheduling should aim to cover a range of tidal conditions as well as providing coverage of the diurnal cycle. The former can be planned in advance, the latter can be done through varying start and end points – i.e. not continually starting at the same transect or same side of the survey area.

Boat-based surveys will be carried out using the established sampling methodology as outlined in Camphuysen *et al*. (2004) and reviewed in MacLean *et al*. (2009). Some aspects of these guidelines are described in some detail below; see aforementioned sources for a detailed overview.

2.6 Weather

For the purpose of maintaining data quality it is essential that weather-related survey restrictions as outlined in Camphuysen *et al*. (2004) are adhered to – i.e. that sea bird data should not be collected in sea states above 4. Weather conditions such as strong swells or high winds, which might cause the sea state to exceed 4, and thereby diminish the quality of survey data, should be avoided.

General weather conditions and changes in visibility (e.g. through appearance of rain, fog or other precipitation, or spray) should be recorded at least at the start of each new transect, and thereafter upon each change in conditions.

2.7 Navigation

The vessel's Global Positioning System (GPS) should be used to accurately follow the predefined survey route. In addition surveyors should use portable GPS to record waypoints at the end of each transect and the track of the boat at regular intervals (e.g. every 30 to 60 seconds). Such spatial and temporal information is essential for the calculation of density estimates and accurate distribution maps.

2.8 Surveyors

ESAS accredited surveyors should be used wherever possible. However, it is recognised that relatively few surveyors have this level of training and the current provisions for undergoing this training are limited. It is therefore recommended that at least one ESAS trained surveyor is present on each survey, and that otherwise only experienced surveyors are used. Thus only surveyors with a minimum of 50 hours of offshore survey in UK waters should be deployed on boat-based surveys.

2.9 Sampling Method

The sampling method adopted in this study should ideally aim to minimise inter-observer bias by deploying two surveyors on each observation platform, both counting birds at the same time, with the second observer assuming the role of scribe. Both observers scan 90 degrees to one side of the vessel. A third surveyor acts in support allowing for rotation of roles and appropriate rest breaks. In areas where divers or seaducks are expected a fourth surveyor should be present to scan ahead for these species groups. It is important that every change of roles is recorded as this will allow for the observer factor to be incorporated in subsequent data analysis. Sun glare can be avoided by changing vessel sides.

Sampling efficiency may be enhanced by operating two transects at the same time, one on each side of the ship. An advantage of this approach is that with more surface area surveyed per count, chances of recording “false zero’s” decrease, and more accurate assessments of low densities may be achieved. However, sun glare is likely to be more of an issue, as are the logistics and costs associated with a double transect approach.

2.10 Line Transects

The basic bird recording interval is 60 seconds. Within this period the surveyors record all seabirds, both on the water and in flight, on their respective side of the boat, primarily within 300m from the vessel. These zones are divided into five bands (A-E as follows: 0-50m, 50-100m, 100-200m, 200m-300m and >300m) for the purpose of distance sampling (Thomas *et al*. 2010), thereby permitting accurate density estimation. It is very important that surveyors concentrate observations on the transect line to improve the likelihood of achieving the assumption in distance sampling that all birds on the line are recorded. Focussing on the transect line is needed as well to scan ahead of the boat for species that are sensitive to flushing at long range.

Snapshots of birds in flight provide information on the density of flying birds. Snapshots should occur at predefined locations (at e.g. 300 or 500m intervals) along the boat transects, as opposed to time-based intervals which do not adequately compensate for variation in vessel speed.

Only those birds seen flying during a “snapshot” count, or first recorded upon the sea, within the 300 m band transect should be included in the density and abundance estimates.

Behavioural data, recorded in categories as described in Camphuysen *et al*. (2004), are essential and should always be gathered during surveys. In particular, where feeding or loafing behaviour is observed this should be recorded. Similarly, other factors which may assist in interpreting bird distributions, such as whether the birds are carrying prey, associations with other birds or ships and the presence of fishing and commercial vessels should be recorded.

2.11 Point Counts

For tidal search areas in particular it would be extremely valuable to gather behavioural data through a dedicated effort as opposed to line transects, where such data is of secondary interest. This could for example be done by combining line transects with stationary point counts at predefined locations.

At each stationary point the boat would have to maintain its position, through mooring or the use of its engine, for a set amount of time.

During this period, observers could for example select target individuals (diving birds on the sea, or quartering birds in the air) and record their behaviour. Data should include species, age, feeding behaviour, dive duration and frequency.

2.12 Incidental Observations

Whilst birds are the primary survey target, incidental observations of marine mammals and other species (e.g. basking shark), including as much detailed information as possible, should also be recorded.

2.13 Oceanographic Data

It is strongly recommended to log oceanographic information during every survey (e.g. salinity, temperature, depth). Such units are relatively cheap and will provide valuable information to further our understanding of seabird distribution patterns.

2.14 Survey Time Scale – Aerial Surveys

In order to obtain confidence that bird activity levels throughout the annual cycle are recorded, the recommended minimum effort for aerial surveys is eight surveys per year over a two year period for all search areas (WWT 2005, Maclean *et al*. 2009).

2.15 Study Design – Aerial Surveys

Study design for aerial surveys should be in accordance with COWRIE guidelines (Camphuysen *et al*. 2004, Maclean *et al*. 2009). Survey areas should be large enough to provide an ornithological context appropriate for a given development site but not too large to become unworkable. It may be possible to cover certain areas in a single survey flight.

Figures 2 to 4 show indicative aerial survey areas for each search area (see Appendix).

2.16 Transect Layout

It is expected that any aerial surveys deployed for the Islay, Kintyre and Colonsay search areas will have a transect spacing of 2km intervals, and transect orientation running from the coastline into deeper water -parallel to the bathymetry gradient.

For the Outer Hebrides as well as the Coll/Tiree search areas it is recommended for aerial surveys to use the same transect layout as deployed by the JNCC in its Inshore Survey Programme (Lewis *et al*. 2008, Söhle *et al*. 2009). This would allow a comparison with existing data to allow improved characterisation of the ornithology within the study area.

It would be of interest to consider value added data that could be extracted from aerial survey data collected using digital imaging (either stills or video). In particular it may be possible to determine (or suggest) connectivity between feeding sites and seabird colonies by analysing flight directions captured by aerial digital imaging methods, as seabirds tend to fly directly back to colonies once foraging is completed.

2.17 Sampling Methodology – Aerial Surveys

For aerial surveys the methods to be applied should follow standard COWRIE protocols (Camphuysen *et al*. 2004, WWT 2005 & Maclean *et al*. 2009). HiDef or APEM digital imaging aerial surveys may also be suitable. Many of the specific aerial survey methods (e.g. flight height, plane type, etc.) are dependent on which of the above approaches is adopted, thus only common features are discussed here.

2.18 Weather

For the purpose of maintaining data quality it is essential that weather-related survey restrictions as outlined in Camphuysen *et al*. (2004) are adhered to – i.e. that sea bird data should not be collected in sea states above three. Weather conditions such as strong swells or high winds, which might cause the sea state to exceed three, and thereby diminish the quality of survey data, should be avoided.

General weather conditions and changes in visibility (e.g. through appearance of rain, fog or other precipitation, or spray) should be recorded at least at the start of each new transect, and thereafter upon each change in conditions.

2.19 Navigation

The plane's Global Positioning System (GPS) should be used to accurately follow the predefined survey route. The GPS should record waypoints at the end of each transect and the track of the plane at regular intervals (every five seconds). Such spatial and temporal information is essential for the calculation of density estimates and accurate distribution maps.

2.20 Surveyors

If surveys are conducted using human observers, only experienced (preferably WWT) trained surveyors should be used. Camphuysen *et al*. (2004) suggest that a minimum of 30 hours' flying time, depending on individual skills, would be sufficient for most observers, accompanied and assessed by an experienced, qualified surveyor.

In case of HiDef or APEM surveys only experienced ornithologists with a proven track record should be used for image identification.

2.21 Sampling

Regular aerial surveys should involve two surveyors, each recording on their respective side of the plane. For purposes of distance sampling it is expected that the established distance bands are used (A = 44-162m, B = 163-282m, C = 283-426m and D = 427-1000m). Further details on JNCC aerial surveys are described in Lewis *et al.* (2008).

All birds, cetaceans and human activity detected should be recorded, along with positional information (e.g. time-referenced observations which can be linked to a GPS record). All records should be recorded to the nearest second.

Whilst birds are the primary target for surveying, incidental observations of marine mammals and other species (e.g. basking shark) should also be recorded.

2.22 Other Survey Techniques

2.22.1 Remote Sensing Techniques

In expanding our understanding of nocturnal seabird utilisation of the study area, it would be of interest to undertake survey trials with remote techniques such as thermal imaging. This is currently being tested in the Bristol Channel and would be of particular interest in areas where Manx shearwater and storm petrel *Hydrobates pelagicus* are likely to occur (e.g. Coll/Tiree due to the proximity to the Rum and the Treshnish Isles SPAs or Islay/Kintyre due to the proximity to the Copeland Isles SPA and the Sanda Island SSSI).

2.22.2 Land-based Observations

Where search areas lie close to the coast in shallow water, it would be worthwhile to combine boat and aerial survey work with a monthly land-based vantage point effort.

The primary aim of such vantage point surveys would be to collect data on the distributions of diving seabirds, and to collect representative behavioural observations. Only data collected in sea state four or less should be used for analysis for seabird data.

As a starting point it is suggested to undertake a 6-hour monthly effort from each vantage point, with a single survey lasting one hour. The timing of such surveys should be linked to the tidal cycle, in order that any relationships between bird behaviour and the tidal cycle can be identified.

Each 1-hour survey period could be split between different activities: a set time period to record the positions of all birds on the water; another period to record behavioural observations; and a third period to record snapshots of birds in flight.

2.22.3 Distance Sampling

The main effect on the detection of birds or groups of birds is increasing distance – i.e. detectability decreases with increasing distance. Other factors that affect the detection probability are wind speed, sea state, visibility factors such as fog, sun glare and time of day, as well as behaviour, group size, whether birds are on the water or in flight, the height of the viewing platform, and differences between observers.

When considering the effects of distance on detectability, it will be important to determine if the age of birds with cryptic non-adult plumages (e.g. gannet, large gulls) has an influence on detectability. Thus for those species with age-dimorphic plumages, the age (adult or juvenile) should be recorded by observers. These data should either be analysed separately, or the effect of age should be included as a covariate.

To correct for biases in detection due to these factors, density and population estimates should be calculated using analytical methods such as Distance sampling (Thomas *et al*. 2010), which explicitly allow for the inclusion of covariates in detection. However, such methods require a minimum amount of data in order to provide reliable results. For species encountered at low rates, standard correction figures (e.g. Stone *et al*. 1995) can be used. This is a less desirable approach and should only be used where more robust methods (i.e. Distance) are not suitable.

3. OUTPUTS

The outputs required for the initial 12-month period are:

1. Detailed monthly (boat) and approximately bi-monthly (aerial) survey reports, including track, weather, bird and marine mammal data;
2. Progress reports at 6-monthly intervals, highlighting information collected, as well as observed distribution patterns and any recommendations for adjustments to existing protocols;
3. A final report at the cessation of surveys (i.e. after one year), summarising methodology, results, data analysis including density and population estimates, as well as distribution maps. All raw data should be provided both in tabulated form (e.g. Excel spreadsheets) and GIS format (shapefiles, including appropriate metadata). Full insight in every aspect of survey and analysis methodology should be provided;
4. A second year of monitoring should involve the same package of deliverables.

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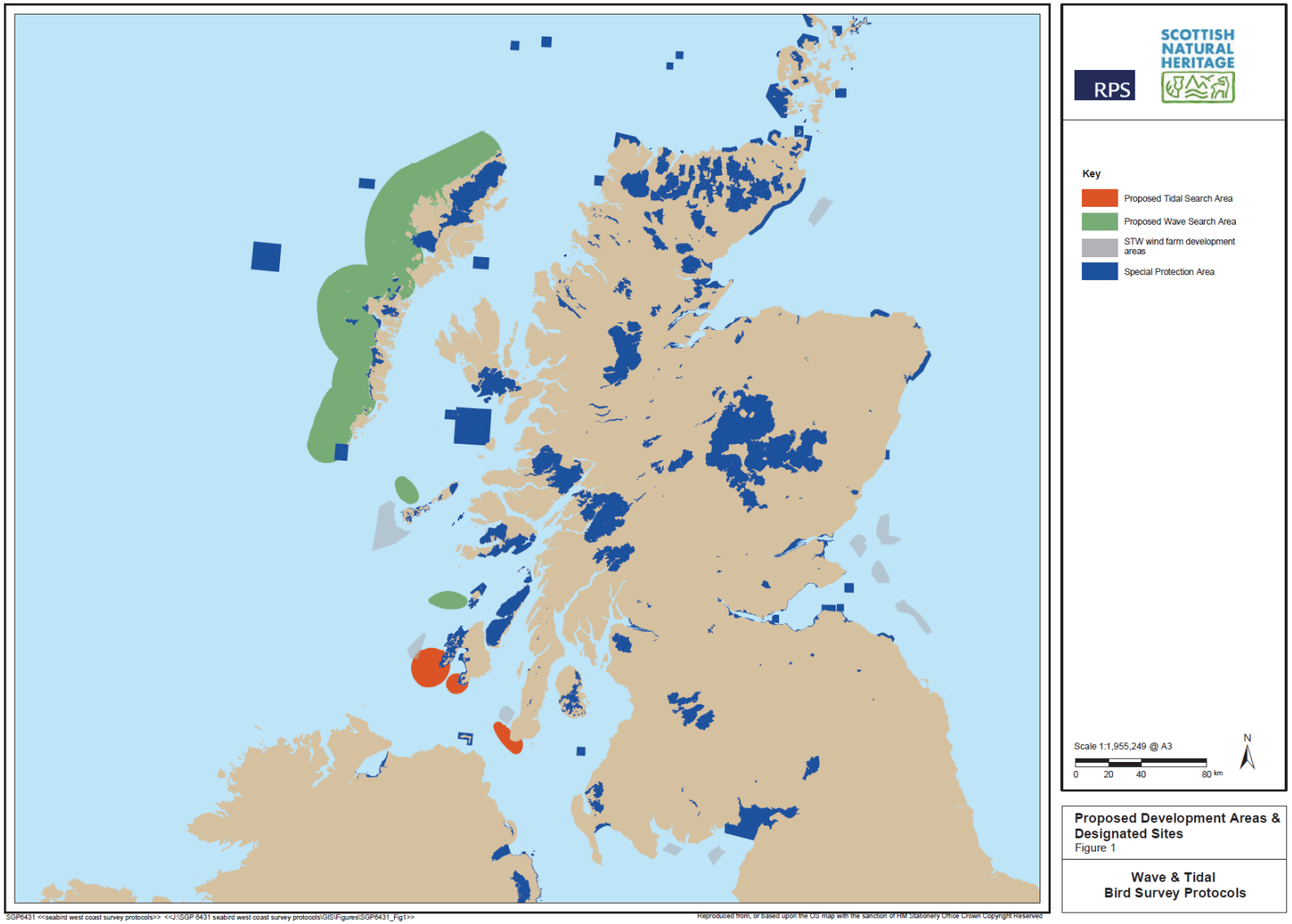
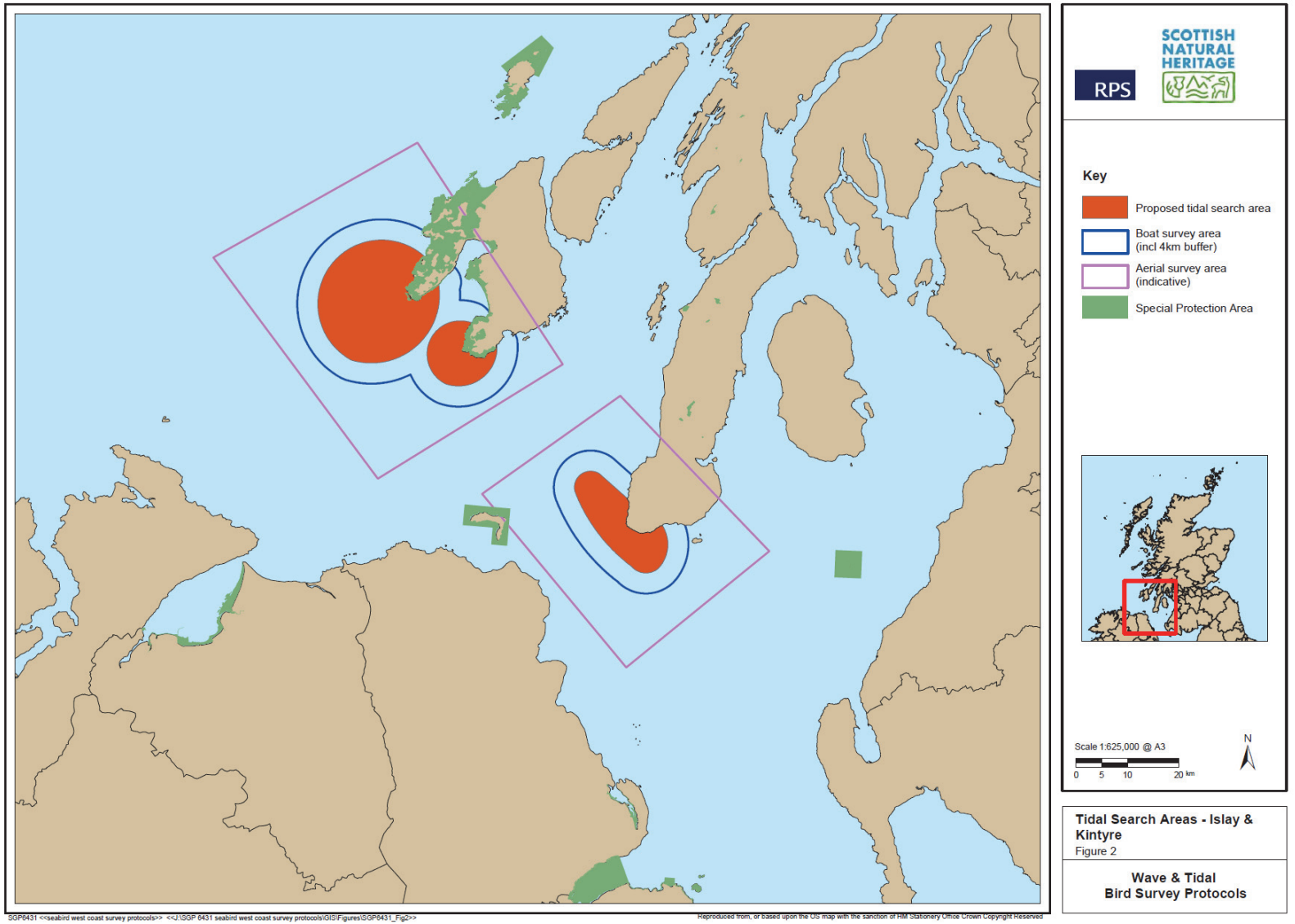
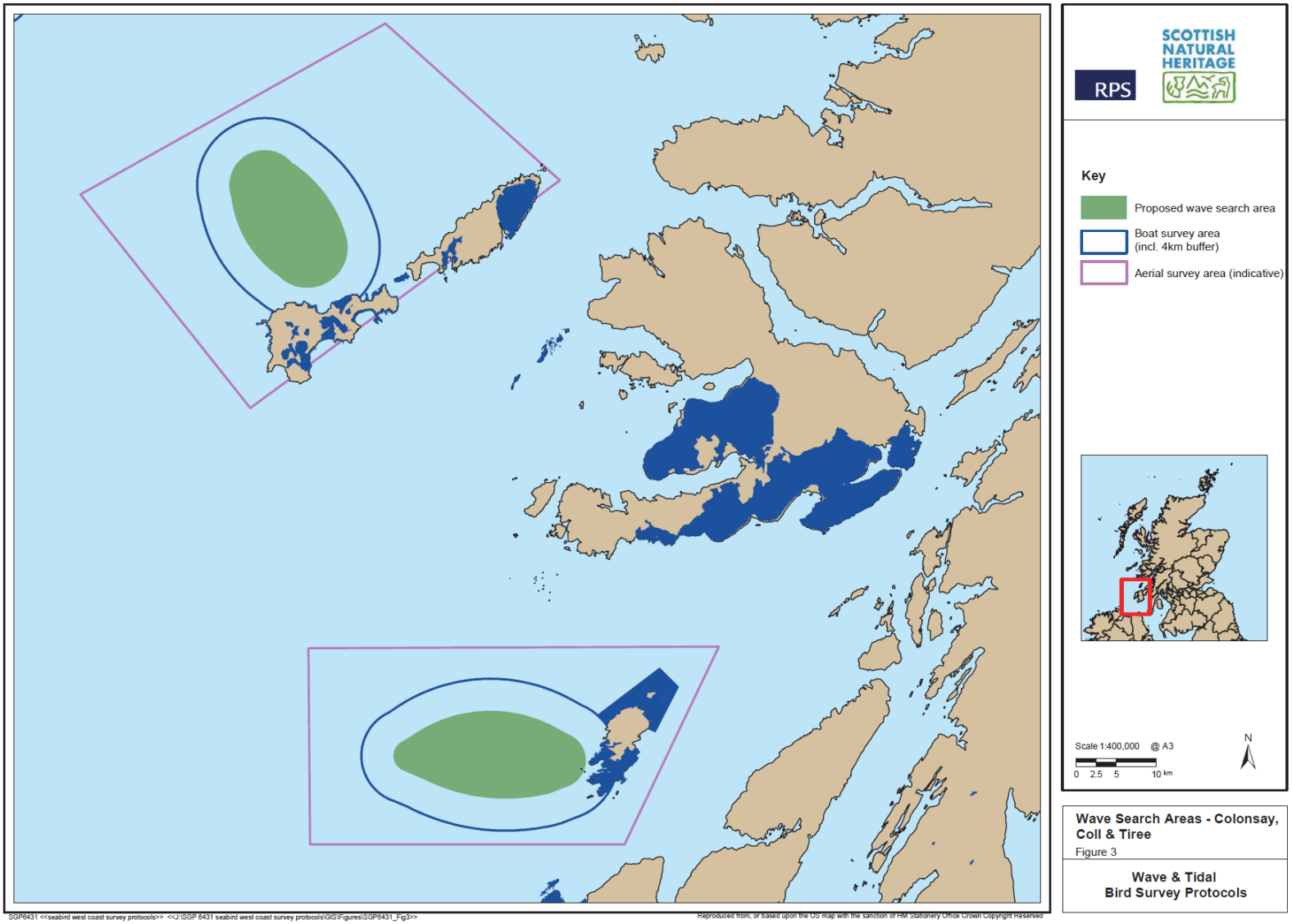
ANNEX 1: FIGURE 1 – PROPOSED DEVELOPMENT AREAS & DESIGNATED SITES



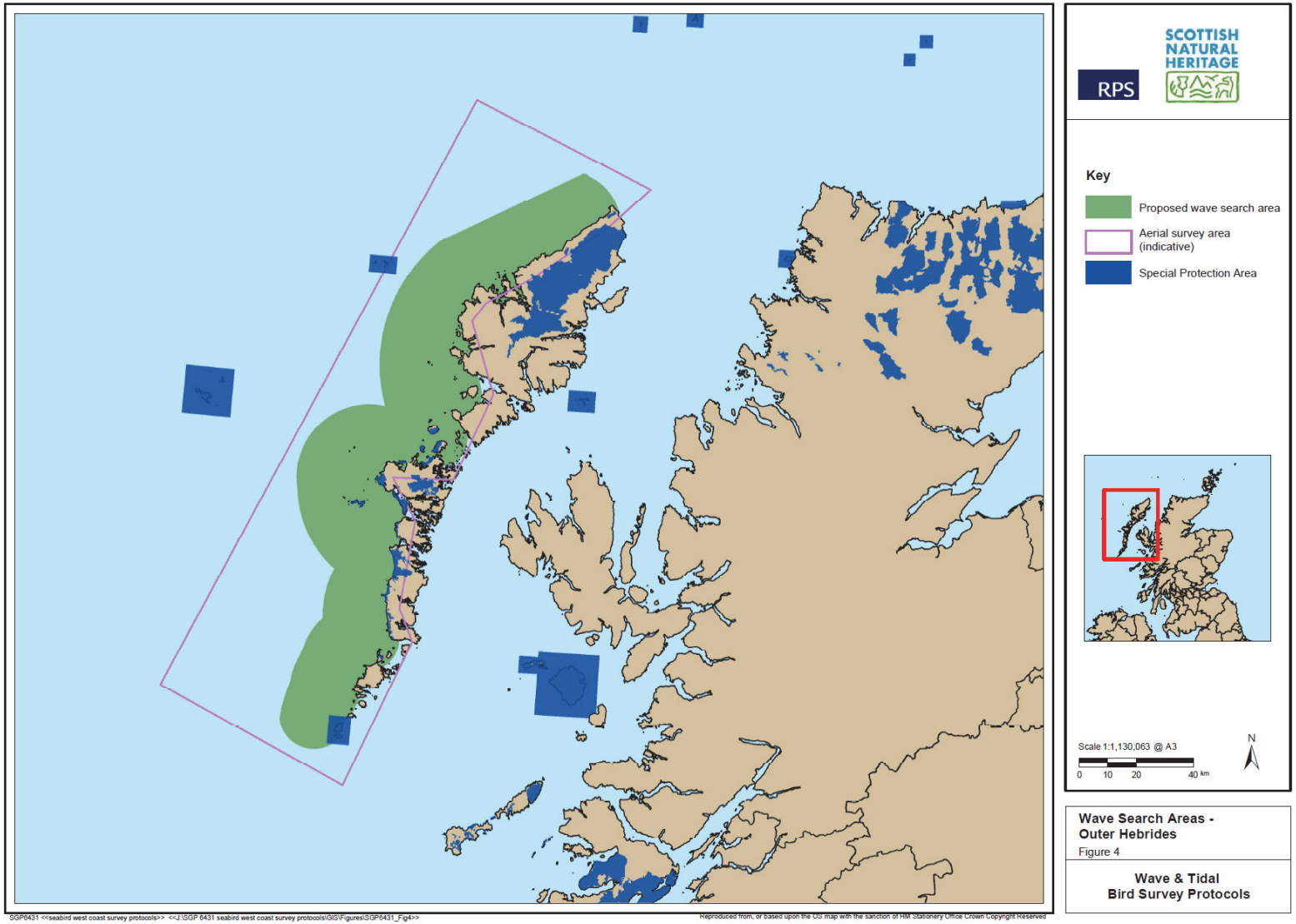
ANNEX 2: FIGURE 2 – TIDAL SEARCH AREAS – ISLAY & KINTYRE



ANNEX 3: FIGURE 3 – WAVE SEARCH AREAS – COLONSAY, COLL & TIREE



ANNEX 4: FIGURE 4 – WAVE SEARCH AREAS – OUTER HEBRIDES



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