Non-technical summary

Defining the Isles of Scilly marine pSPA (potential Special Protection Area) boundary

1. Background and overview

Natural England undertook a two-year programme of at-sea data collection to reveal areas of highest usage by breeding seabirds around the Isles of Scilly SPA. This information was used to design the proposed site boundary for the marine pSPA, which includes foraging areas at sea for birds breeding in the adjacent terrestrial SPA.

Of the seabirds classified as 'features' of the Isles of Scilly pSPA (European storm petrels *Hydrobates pelagicus*, lesser black-backed gulls *Larus fuscus*, great black-backed gulls *Larus marinus* and European shags *Phalacrocorax aristotelis*), European shags are the most suitable species to focus on for data collection to design a site boundary. This is because they tend to forage and rest in marine locations which are consistent, and the birds are large and easily detectable from boats and aircraft. By contrast, the European storm petrel is much smaller making it more difficult to detect, and the gull species tend to be opportunistic foragers, meaning their usage of marine areas is more variable and inconsistent.

Various data collection methods were considered including boat surveys with human observers (Camphuysen *et al*. 2004), tracking of individual birds using miniaturised GPS (Global Positioning System) loggers (Evans *et al*. 2015) and digital aerial surveys (DAS). DAS, involving aircraft-mounted video cameras, were chosen as the primary method as they allow a large area to be surveyed rapidly, and because data of this type are known to be of very high quality (e.g. from monitoring of marine birds in existing SPAs: Goodship *et al*. 2015). This summary describes the collection and analysis of the primary data used to define the boundary, but further information about these additional sources of data is available in the Departmental Brief.

This note summarises the survey work reported in Irwin *et al*. (2015), Webb *et al*. (2016) and the final analysis reported in McGregor *et al*. (2017) to provide an overview of the methods and data used to define the proposed site boundary.

2. Data collection

Digital aerial surveys (DAS)

Methods

Three surveys were undertaken in each of the summers of 2014 and 2015, spaced throughout the breeding season in May, June and July. Each survey involved flying an aircraft along 15 transects (pre-determined lines spaced at regular intervals) at an altitude of approx. 550 m above sea level (causing little or no disturbance to the birds surveyed). Each transect covered an area of 230-240 km^2. Surveying all of the waters around the islands was not possible due to time and financial constraints. However, it is commonplace for marine bird surveys (for example, surveys for impact assessments of offshore wind farms) to 'sample' from the wider area and use these results to characterise usage of the sea by seabirds. The surveys were designed to collect more data closer to the islands in shallower waters (up to a maximum seabed depth of 70 m) as this is where most European shags were expected to occur based on their known ecology and preference for foraging in shallower waters. Consequently, transects were spaced 2.5 km apart in these 'high intensity' study areas closer inshore, and 5 km apart in the 'low intensity' areas further offshore (Figure 1).

The aircraft carried four High Definition (2 cm Ground Sample Distance (GSD) i.e. each pixel in a resulting image equates to 2 cm in reality) video cameras which recorded continuously along survey transects. Using established processing methods (Irwin *et al*. 2015; Webb *et al*. 2016), birds within the videos were identified (with quality assurance checks) and recorded to their exact location. This gives a highly accurate and objective spatial record of bird numbers and location, and is the starting point for all analyses. Behaviour (sitting / flying) was also recorded.

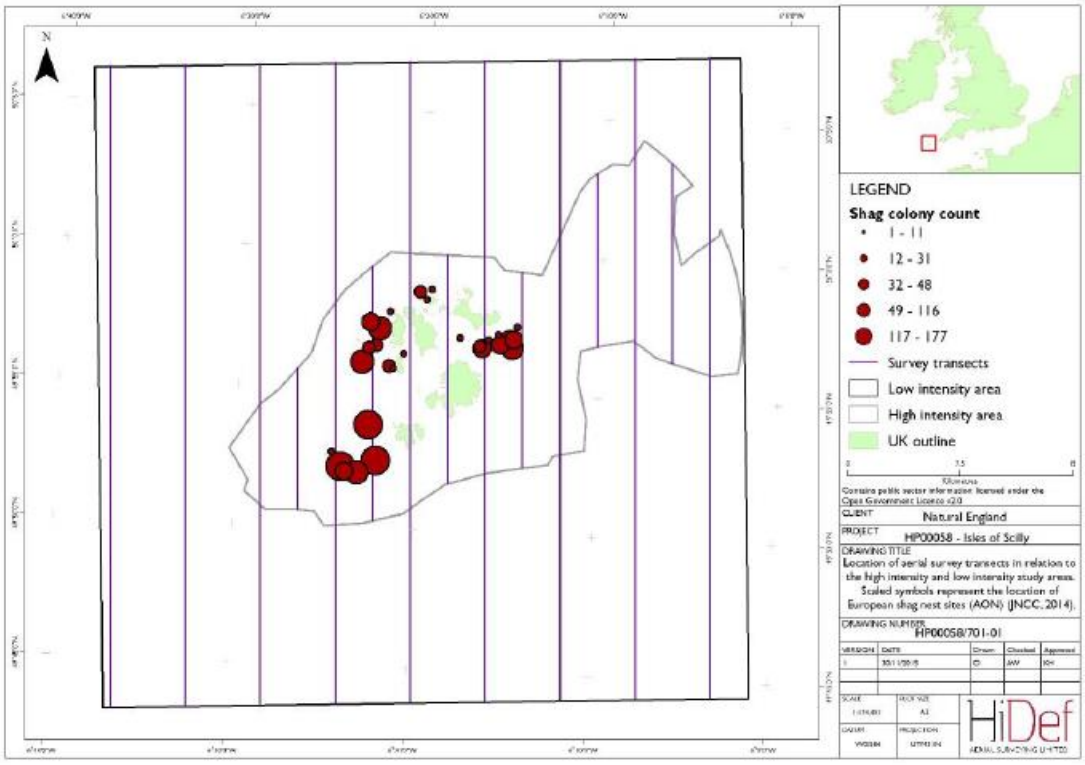

Figure 1. Aerial survey transects in relation to high and low intensity study areas. Scaled symbols show European shag nesting locations.

Results

No European shags were recorded in the low intensity area, supporting the initial expectation that birds would be found in shallow waters closer to nesting locations. Other bird features (e.g. lesser black-backed gull, great black-backed gull) were recorded across a much wider area, reflecting their larger foraging ranges, less predictable use of marine areas and generalist foraging ecology. European storm petrels were not detected anywhere, probably because of the difficulty of detection of these small birds even at 2 cm GSD.

The observational data therefore supported expectations that European shag distribution is more predictable, consistent and suitable for use in setting marine SPA boundaries (Figure 2). Figure 2 shows those birds observed to be ‘sitting’: in practice, this definition can relate to different behaviours such as resting, feeding, searching for food, preening and so on. The key thing is that the birds are using the sea in some way, as opposed to simply flying over it.

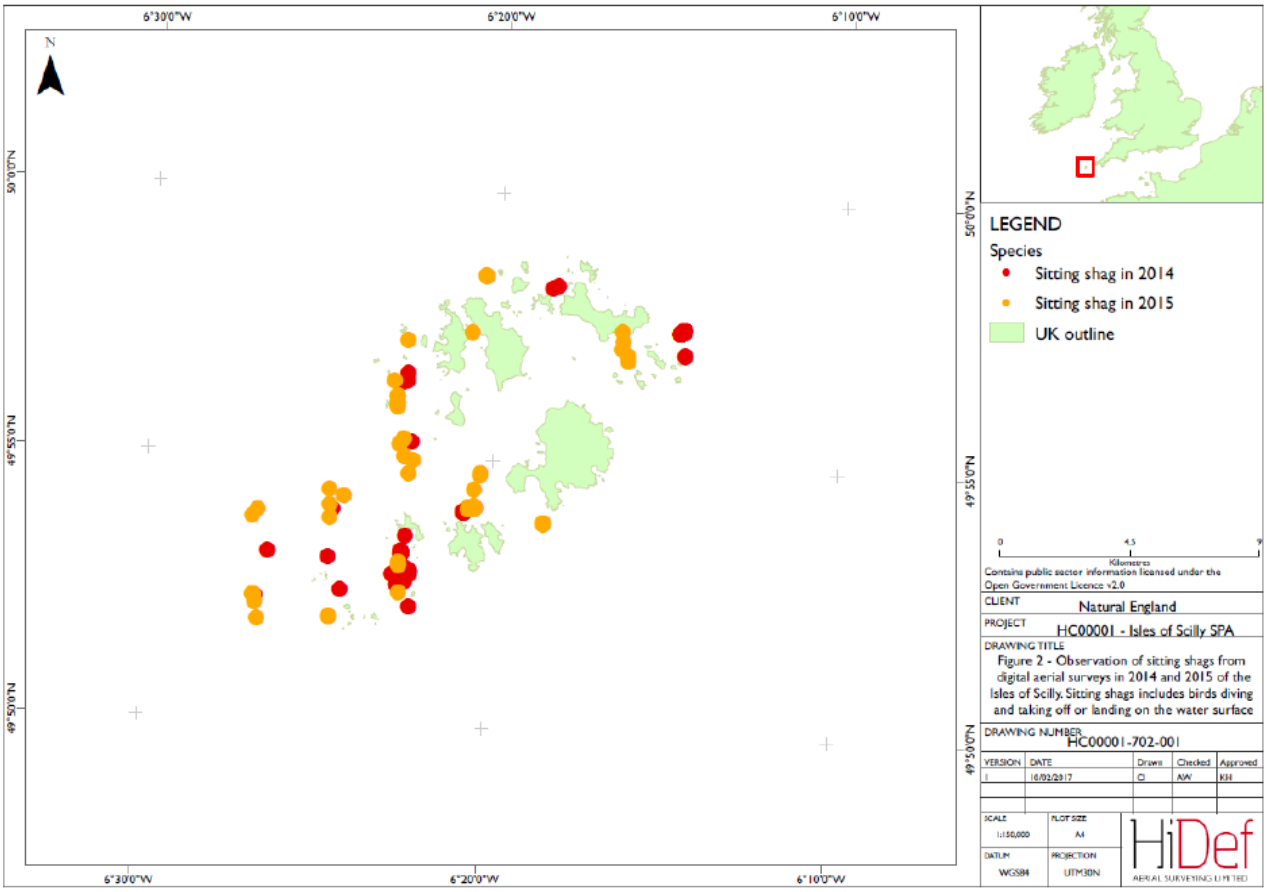

Figure 2. Location of observations of European shags (2014-2015).

3. Data analysis

<u>European shag distribution</u>

Digital aerial survey models

Modelling was used to extrapolate from the collected digital aerial survey data to predict European shag distribution in areas which were not surveyed i.e. between transects. Modelling as defined here is a term covering several different mathematical methods of making predictions about bird usage of marine areas. This is standard practice for marine bird surveys, as the scale of habitat is usually prohibitively large to survey in full (e.g. Camphuysen *et al*. 2004; Goodship *et al*. 2015). Surveys (transects) covered approximately 20% of the high intensity area. Data from the low intensity area were not considered as no European shags were detected here. Models are usually based on the relationships between birds and environmental variables. For the Isles of Scilly marine pSPA, the wider marine area was divided into grid cells 1 km x 1 km, and predictions were made at this scale.

The particular type of 'habitat association model' used for the pSPA boundary is called 'Density Surface Modelling' (DSM). DSM has been applied to SPA selection before (e.g. Northumberland Marine SPA; Morecambe Bay & Duddon Estuary SPA) and DSMs are also routinely applied to model bird data for a variety of other purposes (e.g. Bradbury *et al*. 2014; Goodship *et al*. 2015; Long 2017).

4. Boundary delineation

After recording and predicting European shag distribution across the whole survey area, the next stage was to use the resulting data to show which areas of sea should be included within a marine extension to the existing terrestrial site.

Maximum curvature

Maximum curvature is a mathematical technique to establish the point of diminishing returns. It was first used in marine SPA boundary selection by O'Brien *et al*. (2012), and has been a cornerstone of the UK's SPA programme ever since, used to select over ten marine boundaries in England alone. It has mainly been applied to establish the relationship with increasing habitat and decreasing bird abundance (as for this site), though has been used for other relationships (abundance and depth). In other words, it is a technique that can tell you when adding more habitat/sea area into the boundary of a site ceases to give additional benefit in terms of protecting more birds. This allows setting of an efficient site boundary that offers maximum protection to seabirds whilst minimising sea area included.

Figure 3 below shows the results of the analysis for this site – plotting the cumulative number of European shags against the cumulative habitat area (black line). Because the line levels off quickly, this reveals most of the birds were predicted to occur in relatively few of the 1 km grid cells. The blue and red lines represent different models tested (called 'exponential' and 'double exponential'). The grid cells falling below the maximum curvature threshold established in Figure 3 are those that were used to define the pSPA boundary (i.e. those that are selected before the law of diminishing returns applies: these are shown in Figure 4).

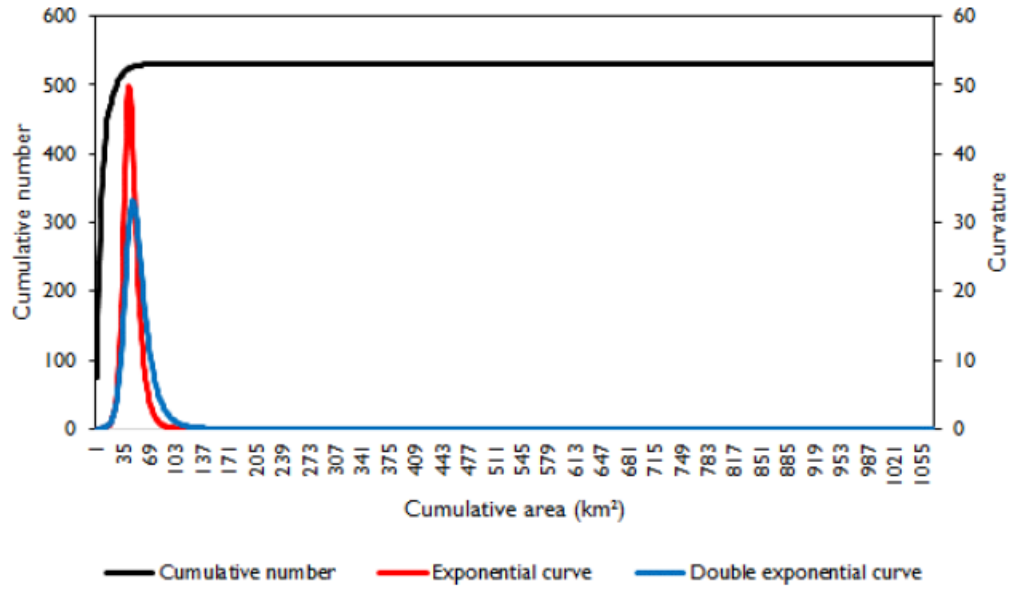

Figure 3. Cumulative number of shags against cumulative area of habitat, with maximum curvature from two models, based on DSM of sitting shags from DAS.

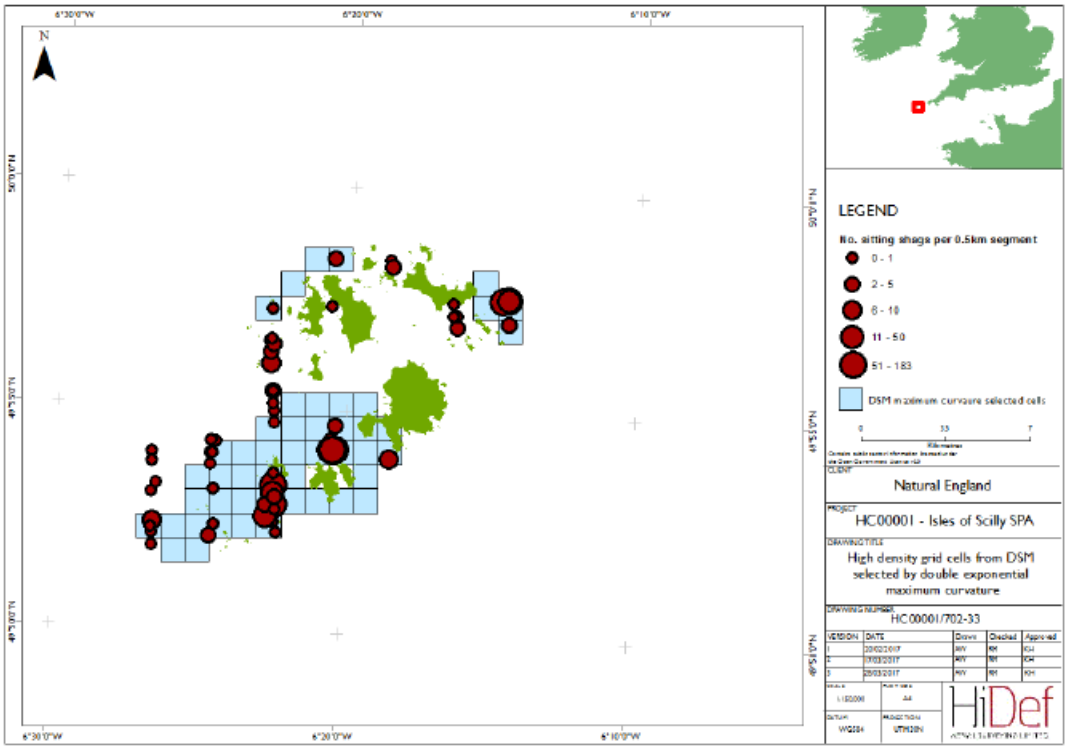

Figure 4. Grid cells identified as falling below (double exponential) maximum curvature threshold from DAS DSM, and therefore within the 'diminishing returns' cut-off, with original observations of European shags shown.

Recommended boundary

Finally, the last stage was to draw an appropriate boundary for the proposed site, encompassing all the areas of sea identified as important by the maximum curvature analysis.

This was achieved by drawing a 'convex hull' polygon. This technique aims to contain all points of interest within the smallest area possible (as if a rubber band is stretched around the points), thereby producing the most efficient boundary. The final polygon included the areas of sea identified by maximum curvature (with a buffer), as well as the known breeding locations of European shags (Heaney & St Pierre 2017). Including the latter is important to ensure that flight-lines between nest locations and marine areas are contained within the boundary, as these form part of the 'territory' we are aiming to protect. The area defined within the boundary is supported by parallel data analysis from tracks of European shags fitted with miniaturised GPS loggers (McGregor *et al*. 2017) and from studies of locations of 'rafts' of the same species in the sea around the islands (Evans *et al*. 2015). Both demonstrated the areas within the boundary, especially between Tresco, St. Martin's and St. Mary's, were used by European shags. Finally, the boundary was set to the nearest lines of longitude and latitude, as recommended by Johnston *et al*. (2002) to ensure it is straightforward for sea users to be able to locate the SPA (Figure 5).

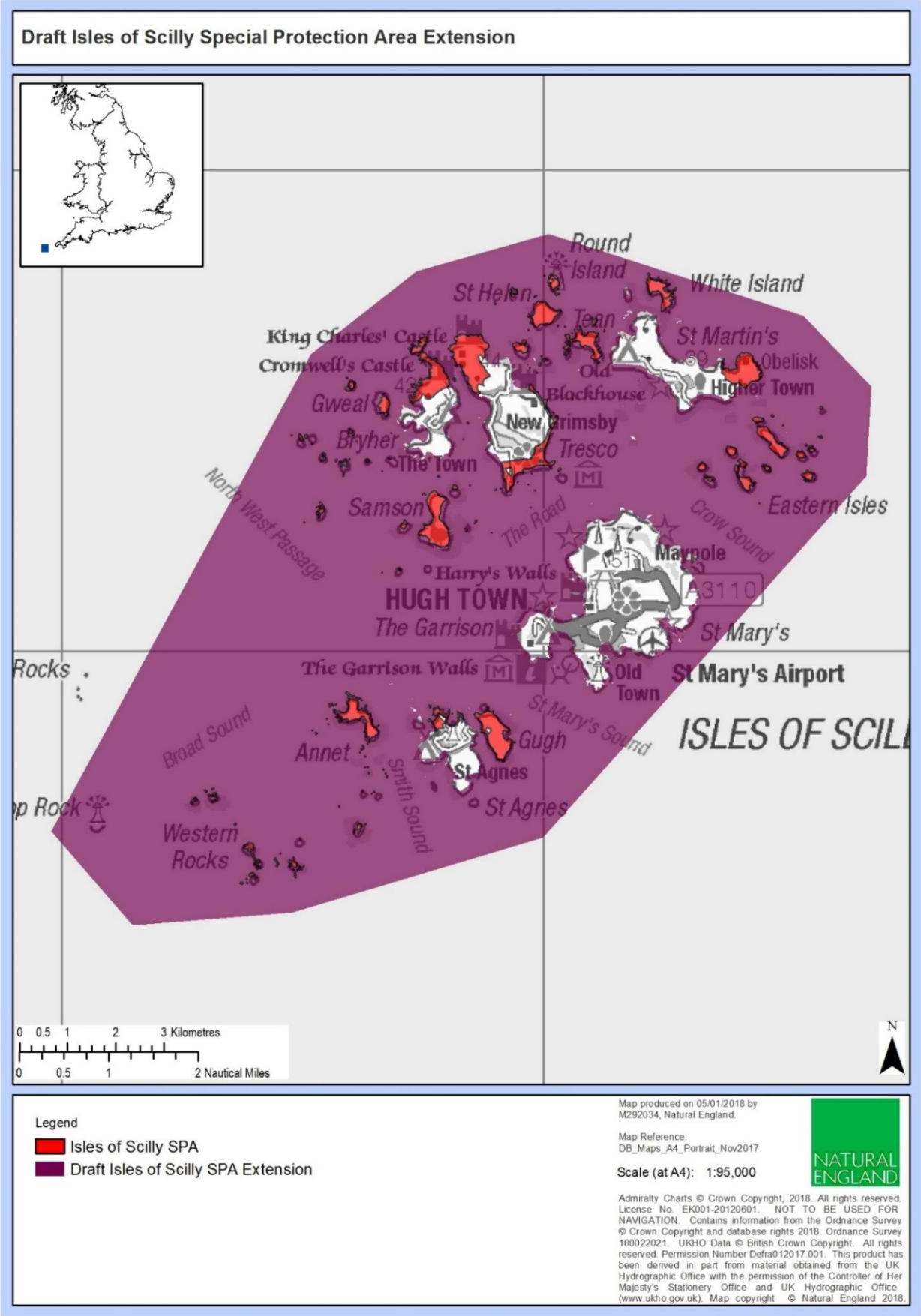

Figure 5. Recommended pSPA boundary, based on maximum curvature applied to DAS DSM data and snapped to lines of latitude and longitude.

5. Conclusion

In line with Natural England Quality Assurance Standards, the final boundary recommendation report was peer-reviewed by two independent experts. The experts were Dr Julie Black, JNCC (involved in the UK's marine SPA programme for many years, with much direct experience of boundary setting methods) and Dr Steve Votier, University of Exeter (involved in myriad seabird research programmes including work on European shags at the Isles of Scilly). Both reviewers had minor challenges, responded to by the authors, but both were happy the report was scientifically sound and appropriate for the purpose intended.

Natural England is therefore satisfied that the boundary recommended in this Departmental Brief is based on high quality data, robust and established scientific analyses, and independent external verification.

6. References

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