DEPARTMENTAL BRIEF:

Isles of Scilly potential Special Protection Area (pSPA)

Proposal for extension to existing site and addition of new features

Natural England

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Version Control

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Authored by Alex Banks			
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Draft 3	Natural England Board members: Joe Horwood Andy Clements	Joe Horwood	February 2018
Draft 4	Wesley Smyth Area Manager Tim Hill Chief Scientist		February 2018

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SUMMARY

Isles of Scilly potential Special Protection Area (pSPA) detailed in this Departmental Brief is proposed to protect important breeding locations and areas of sea used for a variety of purposes by the qualifying features. The pSPA is an expansion of the existing Isles of Scilly SPA; the features of the existing SPA (European storm petrel *Hydrobates pelagicus*, Lesser black-backed gull *Larus fuscus graellsii*, seabird assemblage) are retained, and new qualifying features are added based on a review of current bird abundance within the pSPA boundary.

The proposed extension includes a marine area for various activities crucial to the life cycles of the features (including foraging / feeding and 'maintenance behaviours' such as loafing and preening). This extension area is identified and defined by European shag *Phalacrocorax aristotelis* distribution recorded around the islands during the breeding season. These areas add marine habitat which will be used by all features of the SPA, including birds forming part of the existing seabird assemblage.

The Isles of Scilly pSPA therefore comprises areas for breeding seabirds, both in terrestrial (nesting) and marine (feeding / foraging and 'maintenance' behaviour) habitats.

The new features proposed are European shag and great black-backed gull *Larus marinus*.

Isles of Scilly pSPA qualifies under Article 4 of the Birds Directive (2009/147/EC) for the following reasons:

- *Species listed in Annex I of the Birds Directive*: the site regularly supports more than 1% of the Great Britain population of one breeding species (Table 1). Therefore the site qualifies for SPA classification in accordance with the UK SPA selection guidelines (stage 1.1: JNCC 1999).

- *Regularly occurring migrants not listed in Annex I of the Birds Directive*: the site regularly supports more than 1% of the biogeographical populations of two breeding species (Table 1). Therefore the site qualifies for SPA classification in accordance with the UK SPA selection guidelines (stage 1.2: JNCC 1999).

- *Assemblages*: the site has a long history of supporting an assemblage of more than 20,000 individual seabirds, recognised within the original Isles of Scilly SPA classification. Therefore the site qualifies for SPA classification in accordance with the UK SPA selection guidelines (stage 1.3: JNCC 1999).

- *Species for which stage 1 guidelines cannot be applied*: the site supports one regularly occurring migratory breeding species which is not on Annex I of the Birds Directive but which cannot be selected at stage 1.2 (reaching 0.90% of the biogeographic threshold). The site is identified as supporting the largest aggregation of breeding great black-backed gulls in the UK, making a contribution to sufficiency of the SPA network (Stroud *et al*. 2016), and therefore qualifies for SPA classification in accordance with the UK SPA selection guidelines (stage 1.4: JNCC 1999).

Table 1. Summary of qualifying ornithological interest in Isles of Scilly pSPA.

Species	Count (period)	% of subspecies or population	Interest type	Selection criteria	New qualifier
In the breeding season					
European storm-petrel *Hydrobates pelagicus*	2,636 individuals[1] (2015 – 16)	5.07% of GB population	Annex 1	Stage 1.1	No
Lesser black-backed gull *Larus fuscus graellsii*	4,922 individuals[2] (2015 – 16)	1.37% of biogeographic population	Regularly occurring migrant	Stage 1.2	No
European shag *Phalacrocorax aristotelis aristotelis*	2,028 individuals[3] (2015 – 16)	1.46% of biogeographic population	Regularly occurring migrant	Stage 1.2	Yes
Great black-backed gull *Larus marinus*	1,882 individuals[4] (2015 – 16)	0.90% of biogeographic population; 5.54% of GB population	Regularly occurring migrant	Stage 1.4	Yes
Internationally important seabird assemblage of over 20,000 individuals	26,478 individuals (1999)[5]		Assemblage	Stage 1.3	No

[1] 1,318 pairs (Apparently Occupied Sites) across islands within the SPA boundary (Heaney & St Pierre 2017). The total on the citation for the existing Isles of Scilly SPA was 5,406 – 8,798 pairs, using a different method of estimating breeding numbers.
[2] 2,461 pairs (Apparently Occupied Nests) across islands within the SPA boundary (Heaney & St Pierre 2017). The total on the citation for the existing Isles of Scilly SPA was 3,608 pairs.
[3] 1,014 pairs (Apparently Occupied Nests) across islands within the SPA boundary (Heaney & St Pierre 2017).
[4] 941 pairs (Apparently Occupied Nests) across islands within the SPA boundary (Heaney & St Pierre 2017).
[5] Current estimate (2015-16) is 15,938 individuals (Heaney & St Pierre 2017).

1. Assessment against SPA Selection Guidelines

The UK SPA Selection Guidelines require that SPA identification should be determined in two stages (Stroud *et al*. 2001). The first stage is intended to identify areas that are likely to qualify for SPA status. The second stage further considers these areas using one or more of the judgements in Stage 2 to select the most suitable areas in number and size for SPA classification (Stroud *et al*. 2001).

1.1. Stage 1

Under stage 1 of the SPA selection guidelines (JNCC 1999), sites eligible for selection as a potential SPA must demonstrate one or more of the following:

Stage 1.1 an area is used regularly by 1% or more of the Great Britain (or in Northern Ireland, the all-Ireland) population of a species listed in Annex I of the Birds Directive (2009/147/EC) in any season;

Stage 1.2 an area is used regularly by 1% or more of the biogeographical population of a regularly occurring migratory species (other than those listed in Annex I) in any season;

Stage 1.3 an area is used regularly by over 20,000 waterbirds (waterbirds as defined by the Ramsar Convention) or 20,000 seabirds in any season;

Stage 1.4 an area which meets the requirements of one or more of the Stage 2 guidelines in any season, where the application of Stage 1 guidelines 1, 2 or 3 for a species does not identify an adequate suite of most suitable sites for the conservation of that species.

Isles of Scilly pSPA qualifies under stage 1.1 because it regularly supports more than 1% of the GB population of one Annex I species in the breeding season (European storm petrel). In addition, the site qualifies under stage 1.2 because it regularly supports over 1% of the biogeographical population of two regularly occurring migratory birds (lesser black-backed gull and European shag). It qualifies under stage 1.3 by regularly supporting a seabird assemblage of over 20,000 individuals. Finally, it qualifies under stage 1.4 because it supports a regularly occurring migratory species (great black-backed gull) present in numbers indicating it is the most important breeding area thus far identified for this species in the UK.

1.2. Stage 2

Isles of Scilly pSPA is assessed against Stage 2 of the SPA selection guidelines in Table 2. It should be acknowledged that in applying the SPA selection guidelines, Stroud *et al.* (2001) note that a site which meets only one of these Stage 2 judgments is not considered any less preferable than a site which meets several of them, as the factors operate independently as indicators of the various different kinds of importance that a site may have. The pSPA meets most of the Stage 2 criteria indicating the different kinds of importance the site holds.

Table 2. Assessment of the bird interest against stage 2 of the SPA selection guidelines.

Feature	Qualification	Assessment
1. Population size & density	✓	Compared to other sites in the UK, the site supports the fifth largest population of European storm petrels (and the largest in England), the sixth largest population of lesser black-backed gulls, the third largest population of European shags (and the largest in England), and the largest population of great black-backed gulls (Stroud *et al*. 2016). The seabird assemblage includes at least eight other species, including Manx shearwater, which only breeds at one other location in England.
2. Species range	✓	The pSPA is one of only two established breeding locations for European storm petrels in England. The Isles of Scilly form the south-westerly limit of distribution within the UK for all species breeding on the islands.
3. Breeding success	✓	Storm petrel productivity data are not systematically available because of the logistical issues with collection. However, observations from newly rat-free islands suggest 1.00 chicks per pair is achievable. Productivity data is also difficult to collect for shags breeding at the Isles of Scilly, but some recent estimates from Samson suggest comparability with the national average of 1.30 chicks per pair. Lesser black-backed gull productivity from Gugh was also similar to the national average of 0.53 chicks per pair (average 0.48 2013-2017). Great black-backed gull productivity data are not available: productivity is assumed to be sufficiently good to drive recent population growth, although immigration from elsewhere cannot be ruled out. (All data from Horswill & Robinson 2015; Heaney 2016).
4. History of occupancy	✓	The long history of seabird occupancy of the archipelago was first formally recognised in the early 1980s, when 26 Sites of Special Scientific Interest (SSSIs) were notified covering various islands. This was reinforced with the classification of the original SPA in the early 2000s. In reality, the Isles of Scilly have supported significant numbers of many seabird species for at least 140 years (Brown & Grice 2004) and almost certainly long before that, albeit without freely available published records.
5. Multi-species area	✓	Four features qualify in total, as well as a seabird assemblage containing at least eight other species.
6. Naturalness	N/A	No longer applicable, following ruling from the SPA & Ramsar Scientific Working Group.
7. Severe weather refuge	N/A	Does not apply to breeding features, relevant only to non-breeding features.

2. Rationale and data underpinning site classification

In 1979, the European Community adopted Council Directive 79/409/EC on the conservation of wild birds (EEC, 1979) known as the 'Birds Directive'. This has been amended subsequently as Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. This provides for protection, management and control of naturally occurring wild birds within the European Union through a range of mechanisms. One of the key provisions is the establishment of an ecologically coherent network of protected areas. Member States are required to identify and classify the most suitable territories for rare or vulnerable species listed in Annex I (Article 4.1) and for other 'regularly occurring migratory species' under Article 4.2 of the Directive. These sites are known as Special Protection Areas (SPAs). Guidelines for selecting SPAs in the UK are derived from knowledge of common international practice and based on scientific criteria (JNCC 1999).

Progress to date has largely focused on 'terrestrial' sites, which for seabirds relates mainly to habitats used for nesting (Stroud *et al*. 2016). However, seabirds also routinely use the marine environment, both to access resources and engage in other behaviours that are critical for their survival and reproduction. Johnston *et al*. (2002) describe a process consisting of three work strands by which SPAs might be identified for marine birds under the Birds Directive *i.e*. the identification of:

Strand 1: marine extensions of existing seabird breeding colony SPAs beyond the low water mark (using generic ecological information for certain species);

Strand 2: inshore feeding areas used by concentrations of birds (e.g. seaduck, grebes and divers) in the non-breeding season; and

Strand 3: offshore areas used by seabirds for feeding and other activities but also for other purposes.

Since then, a fourth strand was added to the work conducted by the Joint Nature Conservation Committee (JNCC) to address the need for:

Strand 4: other types of marine SPA http://jncc.defra.gov.uk/page-4184 identified for marine birds that may not be addressed by the above three categories and will be considered individually.

In line with the recommendations of Reid & Webb (2005), generic extensions have only been implemented at sites holding certain seabird species, none of which occur in qualifying numbers within the Isles of Scilly pSPA. Reid & Webb (2005) conclude that generic extension of colony SPAs is not appropriate for shags, gulls and storm petrels, because their 'maintenance' behaviours either do not depend upon waters immediately adjacent to the breeding sites, or are not consistent from colony to colony in the way shown by other seabird species.

Marine protection for the Isles of Scilly SPA therefore falls under **Strand 4**. Reid & Webb (2005) found that shag activity around study colonies was site-specific, necessitating an individual approach to data collection and analysis for the site.

In the process of SPA classification, Ministerial approval has to be given to undertake formal consultation on the proposals. At this stage, a site becomes a potential SPA (pSPA). Within this departmental brief, for clarity, the existing classified (Isles of Scilly SPA) site is referred to as 'SPA' as it remains fully classified. Proposed changes to the site, including new features and boundaries, are termed 'pSPA' until the new site is classified.

This Departmental Brief sets out information supporting the identification of the qualifying features of the Isles of Scilly pSPA and definition of its proposed marine boundaries. This is based upon the areas of sea identified as being most important for breeding European shags, although all qualifying features will be protected.

2.1. Data collection – reviewing the abundance of breeding seabirds in the Isles of Scilly pSPA

The size of each of the populations of seabirds nesting on islands or rocks within the Isles of Scilly pSPA, and which exceed the SPA qualifying thresholds, have been summarised from Heaney & St Pierre (2017), with reference where appropriate to Heaney *et al*. (2008) and the original SPA citation (http://publications.naturalengland.org.uk/publication/5846031572926464). These reports describe survey efforts in 2015/16 and 2006 respectively, using standardised seabird survey methods (Walsh *et al*. 1995;

Gilbert *et al*. 1998). No other comprehensive seabird surveys took place in the intervening period. Therefore, the numbers used to demonstrate site qualification are typically the most recently available from 2015/16. Although it is ideal to refer to data collected over more than one breeding season within the last five years, the lack of a survey since 2006 (likely because of the complicated logistics of counting all seabirds across 55 islands and large rocks) excludes this approach. Whilst it would be possible to take an average over a longer time period, from the surveys in 2006 and 2015/16, the time elapsed between surveys suggests the preferred approach is to use data from the most recent survey, with reference to previous surveys to demonstrate regularity of use. The original Isles of Scilly SPA classification followed the same approach (bird numbers from one breeding season only, 1999).

2.2. Defining the boundary of Isles of Scilly pSPA

The proposed adjustments to the boundary of the Isles of Scilly SPA (currently restricted to 'terrestrial' habitat above Mean High Water (MHW), used for nesting) are based on the at-sea distribution of European shags. The marine boundary encompasses the key sea areas determined to be used (which may include for foraging, resting, preening and other activities), bounded by a buffer around the colonies within which they breed to ensure flight-lines between nest sites and marine areas are contained. This buffer is set to 707 m, which is the distance from the centroid of a 1 km grid square to the corner of that square (i.e. the maximum distance a colony point location can be from the centre of a grid square identified to be important (McGregor *et al*. 2017).

3. Site Status and Boundary

3.1. Existing Boundary

The total area of the existing Isles of Scilly SPA is approximately 401.38 ha (Figure 1).

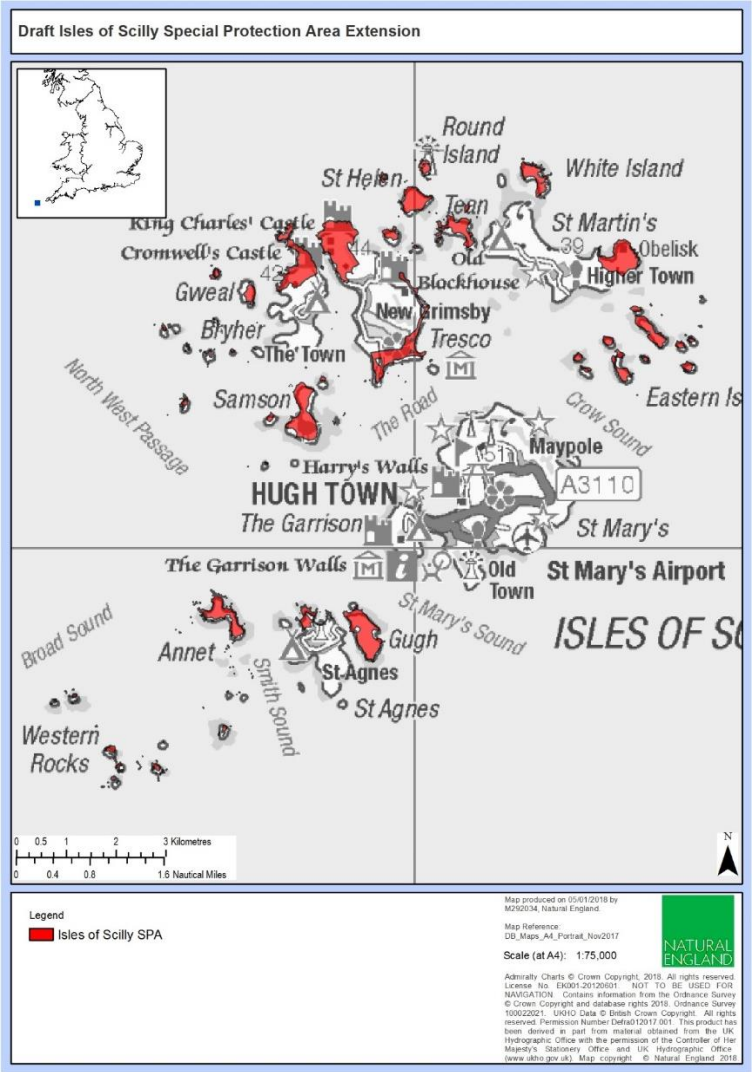

Figure 1. Existing boundary of Isles of Scilly SPA.

3.2. Isles of Scilly pSPA Boundary

The total area of the Isles of Scilly pSPA is approximately 13,332.52 ha. The new area proposed comprises an increased area of approximately 12,931.14 ha (Figure 2). The seaward boundary of the existing Isles of Scilly SPA ends at MHW, i.e. only the nesting habitat of the islands was included within the site (note: not all islands within the archipelago are included within existing SSSIs or the SPA). With the new proposed area, the boundary now includes original terrestrial areas above MHW and marine areas below MHW, for reasons outlined in section 3.3; the marine boundary encompasses the islands forming the original SPA. Where islands and / or rocks were not part of the original SPA, or where only parts of larger islands were included, the marine boundary is placed at MHW. This is consistent with boundary setting procedures at other marine SPAs, and the identification of various intertidal habitats as important to European shags (BirdLife International 2016), European storm petrels (D'Elbée & Hémery 1998), and gulls (e.g. Garthe *et al*. 1999; Ellis *et al*. 2005).

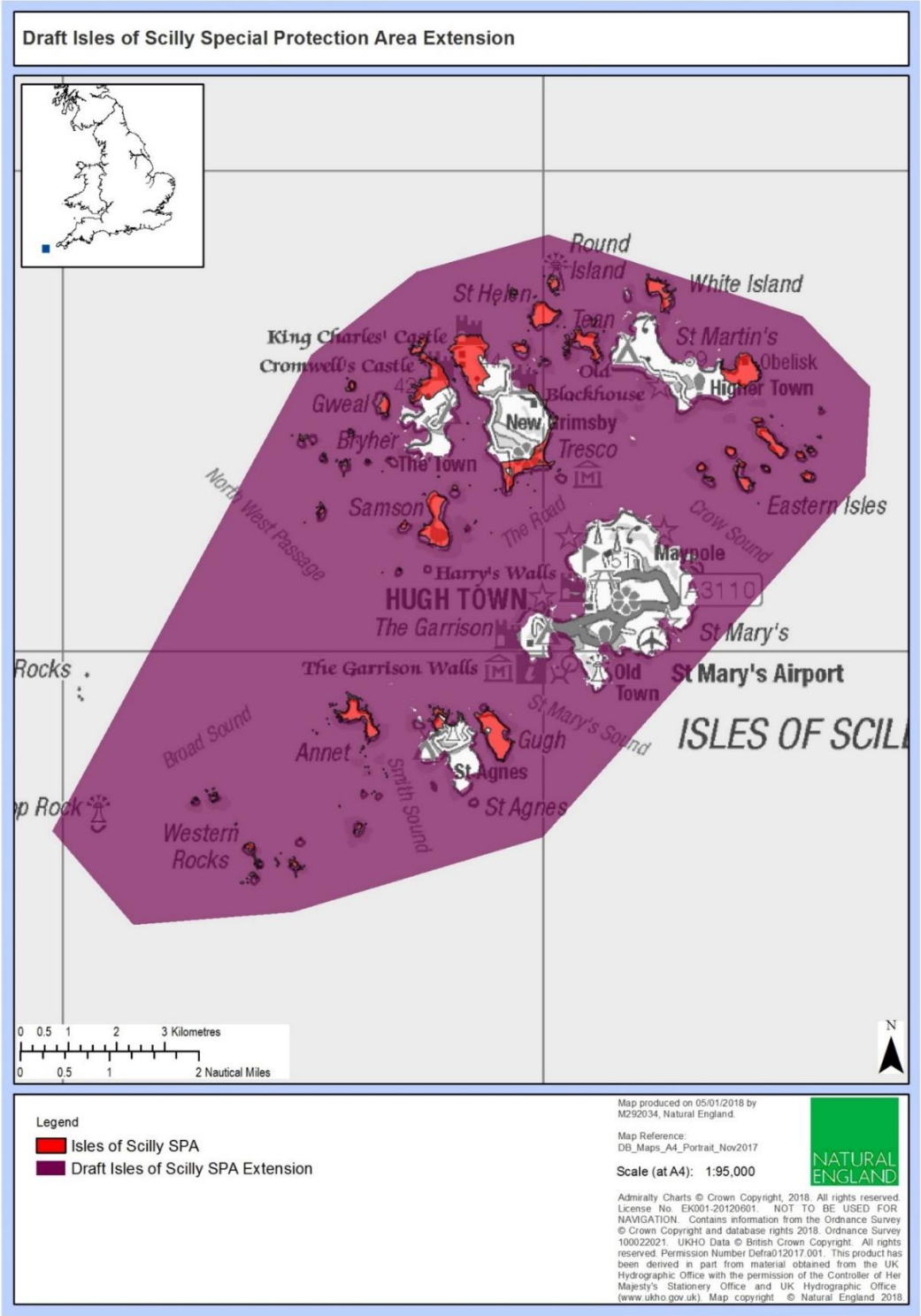

Figure 2. Isles of Scilly pSPA (original site and proposed extension areas).

3.3. Seaward boundary of the pSPA

At some existing SPAs classified for breeding seabirds, it has been possible to extend the site beyond MHW into the sea over a generic distance (e.g. parts of Northumberland Marine SPA). This is possible based on research to investigate areas within which 'maintenance behaviours' consistently take place for some species across UK colonies studied (McSorely *et al*. 2003; 2005; 2006; Reid & Webb 2005). However, none of the species for which these generic marine areas have been developed are qualifying features of the Isles of Scilly pSPA in their own right. Instead, it has been necessary to collect bespoke site-specific data on seabird distribution around the islands supporting breeding seabirds.

The feasibility of using data from each qualifying feature was considered in turn.

European storm petrels spend all day at sea, foraging over wide areas (>65 km; Thaxter *et al*. 2012) perhaps somewhat opportunistically (Brown & Grice 2004). There is some evidence of nocturnal foraging (D'Elbée & Hémery 1998). These ecological characteristics, coupled with the difficulties of detection of a very small bird (length: 16 cm https://app.bto.org/birdfacts/results/bob520.htm) from 'traditional' survey platforms (boats and aircraft), present considerable obstacles to reliably defining important marine areas around breeding sites.

Lesser black-backed gulls are opportunistic feeders with very large foraging ranges (mean maximum 141 km; Thaxter *et al*. 2012) and established relationships with anthropogenic activity (e.g. Camphuysen 1995). Great black-backed gulls are similarly opportunistic (BirdLife International 2016), but also much more dependent on terrestrial prey (Brown & Grice 2004). It is therefore unlikely that data from either of these species could be meaningfully used to define a marine SPA boundary.

By contrast, breeding European shags are known to favour shallow, sandy sediments or rocky substrates for foraging (Daunt *et al*. 2015; Michelot *et al*. 2017), indicating a greater likelihood of consistently used marine areas by this species. This hypothesis is supported by data from tracking of individual shags at the Isles of Scilly (Evans *et al*. 2015).

As a result, the proposed boundary for the marine SPA is based on distribution of shags at sea during the breeding season, determined by data from digital aerial surveys (DAS) designed specifically for this purpose and the application of predictive density surface models (section 3.3.1; McGregor *et al*. 2017).

The resulting seaward boundary of the Isles of Scilly pSPA includes some marine areas, particularly between islands, where thresholds of importance derived from Maximum Curvature (O'Brien *et al*. 2012) were not exceeded (Figure 3). However, supplementary information from alternative models based on tracking data and observations of foraging rafts suggest that European shags do use these areas (Evans *et al*. 2015; Figure 4), supporting their inclusion and providing continuous protection around breeding colonies.

3.3.1. Identification of important areas for European shags

The mean foraging range of European shags is 5.9 km, the mean of recorded maxima is 14.5 km and the maximum recorded is 17 km (Thaxter *et al.* 2012). This informed the survey area which was covered by digital aerial surveys; these involved aircraft-mounted High Definition video cameras to record seabirds present in marine areas, with survey transects spaced 2.5 km apart (McGregor *et al*. 2017).

Data were collected over six surveys spanning two breeding seasons (May – July 2014, 2015) around the Isles of Scilly. Because of the consistent patterns observed between seasons, supported by supplementary information from tracking data from European shags (Evans *et al*. 2015), data collected were considered sufficient to meet the criteria for 'regularity of use' (JNCC 1999); that is, regular usage of marine areas could be demonstrated using the same survey method in at least two seasons, with consistent supporting information from a different method in an additional three seasons.

Surveys reported 1,094 European shag detections, with 57% of these birds on the water (the remaining birds in flight were not used in analysis). Associations with environmental variables were determined within a density surface model package known as MRSea (Mackenzie *et al*. 2013), which is routinely used for assessments of seabird distribution within marine industry casework. These associations then informed predictions of European shag density across areas not surveyed, divided into grid cells of 1 km x 1 km. Maximum Curvature was applied to these grid cells to identify the point of 'diminishing returns' (i.e. when addition of increasing numbers of grid cells stops producing proportional increases in numbers of birds included within the boundary).

Data from GPS tracking of 13 European shags breeding on three islands (Annet, Great Ganinick, Samson) between 2010 and 2012 were also analysed. Because the data generated are not compatible with data from DAS, it was not possible to compile a single model from the two data types. Instead, different boundaries were recommended based on the two methods (McGregor *et al*. 2017).

It is proposed that the option based on DAS data is used to inform the pSPA boundary, with the alternate boundary based on tracking data considered to provide important supplementary evidence. This is because the tracking data, although very high quality, reflect habitat choices of just 13 birds, from an estimated Isles of Scilly breeding population of 2,028 individuals (i.e. 0.64%). Whilst foraging areas for these individuals are revealed, we cannot be sure how representative of the wider population they are (though the similarities between the suggested resulting boundary and the DAS data boundary indicate they match very well).

Conversely, the DAS data includes European shags wherever they are captured in images, regardless of source breeding colony, and so should represent wider marine habitat use with greater confidence.

Further information on these methods are in McGregor *et al*. (2017) and Annex 4.

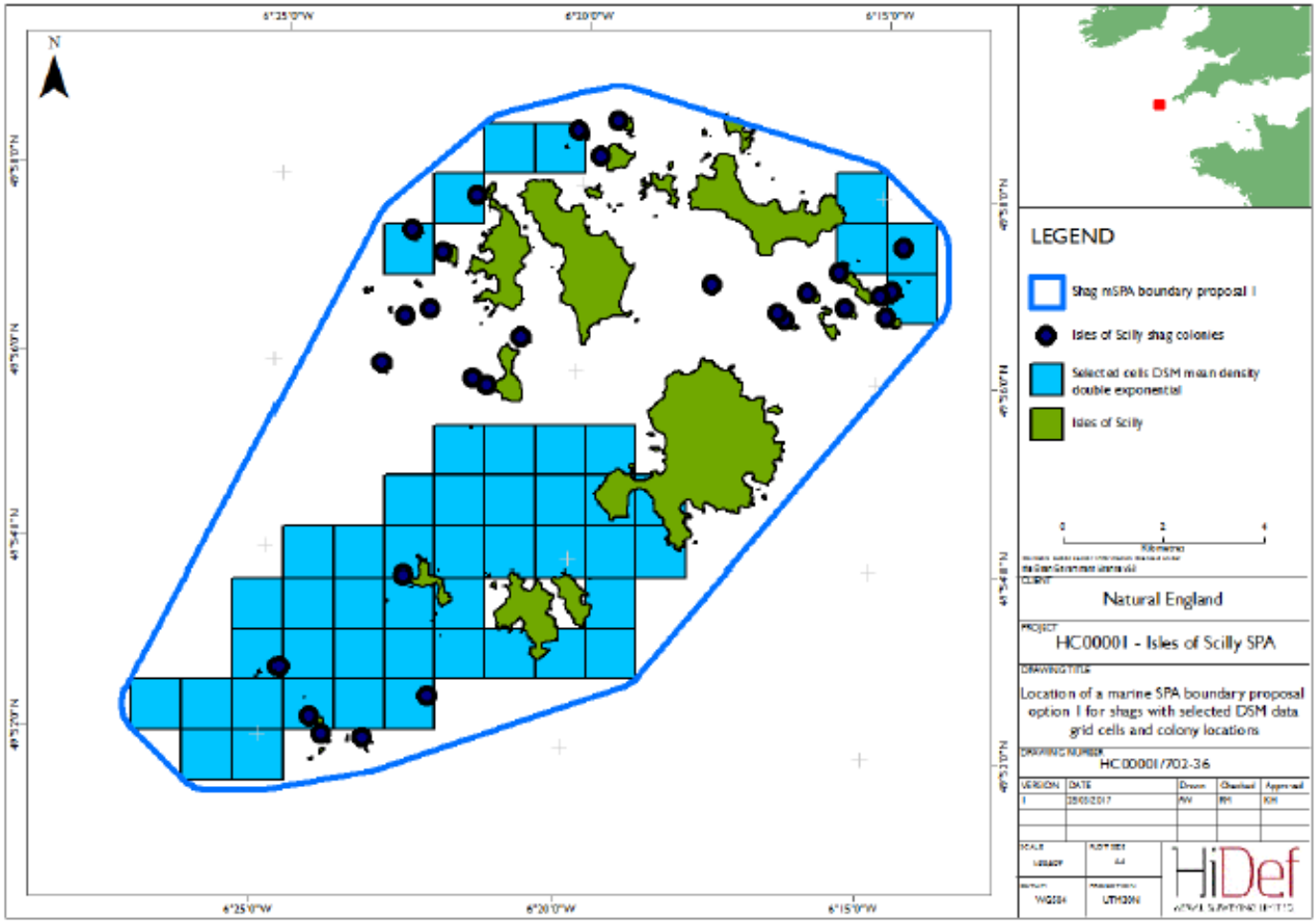

Figure 3. Important areas for European shags breeding at the Isles of Scilly SPA, as defined by DAS Density Surface Models and Maximum Curvature (McGregor *et al*. 2017).

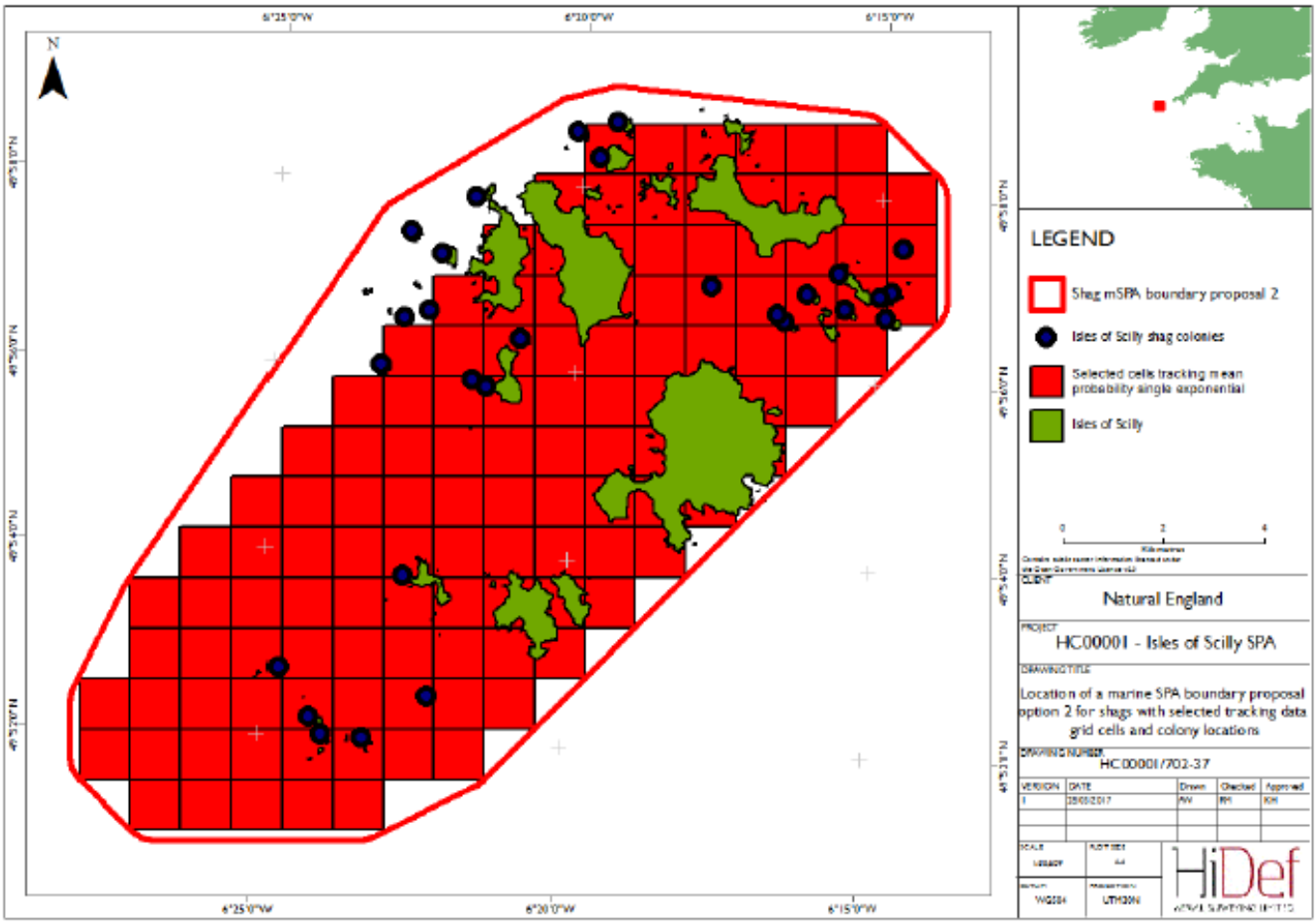

Figure 4. Important areas for European shags breeding at the Isles of Scilly SPA, as defined by GPS tracking models and Maximum Curvature (McGregor *et al*. 2017).

3.4. Landward boundary of the pSPA

Where entire islands are part of the existing SPA, no landward boundary will exist; the pSPA boundary will encompass these islands in full with continuous protection from land to sea. Where whole islands are not part of the existing SPA (e.g. St Mary's), or where only part of an island is within the SPA (e.g. St Martin's), it is proposed that the landward boundary of the pSPA will be set at MHW. This will ensure the marine habitat is within the site boundary, but the boundary will not include terrestrial areas not already identified as important for breeding seabirds.

4. Location and Habitats

The Isles of Scilly lie approximately 45 km (28 miles) offshore from Land's End. They are a collection of over 200 granite islands and rocks, and represent Britain's only oceanic island archipelago. Wind and wave exposure around the islands can be considerable due to their offshore location, and bathymetry drops quickly from shallow waters within the islands to depths of 60-90 m further offshore. The tidal rates and range of flow around the islands are variable, with a mean tidal range for spring tides of 4-5 m and tidal flows varying in speed from 0.26 to 1.25 m per second across the spring-neap cycle. Seawater temperatures for the Isles of Scilly are affected by the up-welling of cold oceanic water that is noticeable during the summer months when water temperature is typically lower than the adjacent mainland (15-17C). In winter however, seawater temperature around the islands is higher than the mainland (10-12C). The waters surrounding the islands are fully saline.

The islands hold a number of important national and international designations due to the unique mix of marine communities found there. These communities have derived from variations in exposure to Atlantic storms and currents as well as the south-westerly position of the islands which has led to the presence of some warm water species living at the northern extremes of their range. The proposed pSPA marine

boundary therefore overlaps a number of other existing designations in the marine environment. The Isles of Scilly Complex Special Area of Conservation (SAC) was designated in 2005 to protect subtidal sediment and subtidal rock features as well as grey seals *Halichoerus grypus* and shore dock *Rumex rupestris*. Subtidal sediments around the islands are classified as mainly sand and gravelly sand, and there are also spectacular subtidal rocky reef areas around the islands with many nationally rare and scarce marine species present. Some of the most extensive seagrass beds in the country can be found in the sheltered waters in between the islands, and the Isles of Scilly are one of only two locations in south west England protected for their breeding population of grey seals. Coastal habitats around the islands include intertidal rock habitats, such as the rocky shores and underboulder habitats found around the coastline of St. Mary's and St. Agnes, as well as intertidal sandflats such as the extensive sandflats found at St. Martin's (and protected by the SAC).

In 2013 the 11 Isles of Scilly Marine Conservation Zones (MCZs) were designated. These cover a variety of intertidal and subtidal habitats around the islands and in the waters immediately offshore. Some species are also protected by the Isles of Scilly MCZs such as the spiny lobster, pink sea fan and various species of stalked jellyfish found in the intertidal and shallow subtidal. Although 10 of the 11 MCZs overlap with the SAC area they are designated to protect a different suite of features.

5. Assessment of Ornithological Interest

5.1. Survey Information and Summary

In most cases, up-to-date data (for surveys at sea during summer, between 2014 and 2015; for nesting surveys, between 2015 and 2016) have been used to inform the new classification[6]. All proposed features breed within the archipelago.

UK SPA site selection guidelines (JNCC 1999) have been applied to the most up to date information for the site. Citation values for the original qualifiers of the Isles of Scilly SPA (storm petrels and lesser black-backed gulls) have been updated to reflect new information (Heaney & St Pierre 2017). To ensure the original ambition of the Isles of Scilly SPA is preserved, data from the original SPA citation are used to select the seabird assemblage, following declines in component species in the intervening period. This is consistent with other SPAs with declining features recently updated (e.g. Morecambe Bay & Duddon Estuary SPA).

Counts of breeding seabirds at the colonies across the existing SPA (the only feasible origin of birds within the marine foraging areas of the pSPA, with the exception of the small number of seabirds nesting on islands not within the existing SPA boundary; Heaney & St Pierre 2017) are accessible from the national Seabird Monitoring Programme (SMP) database. Methods followed the standard (Walsh *et al*. 1995; Gilbert *et al*. 1998) with further details in Heaney & St Pierre (2017).

Details of the work carried out to characterise the marine areas used by breeding European shags within the Isles of Scilly pSPA are in section 3 and Annex 4.

5.2. Annex I species

5.2.1. European storm petrel *Hydrobates pelagicus*

European storm petrels were a feature of the original Isles of Scilly SPA and remain a feature for the pSPA.

The breeding population of European storm petrels in the UK is estimated to be 26,000 pairs (21,000 – 33,000: Musgrove *et al*. 2013), representing about 5.5% of the European breeding population (438,000 – 514,000 pairs: BirdLife International 2015). Breeding occurs along much of the west coast of Britain, from the north of Scotland to (and including) the Isles of Scilly (Mitchell *et al.* 2004), though Lundy Island, Devon, is believed to be the only other consistently occupied breeding location in England. The greater part of the population occurs in western Ireland (Mitchell *et al.* 2004). The species nests in burrows, crevices, amongst boulders and in stone walls (Brown & Grice 2004).

Within the Isles of Scilly, European storm petrels have been confirmed breeding on 14 separate islands during the most recent survey (Heaney & St Pierre 2017), with 58% of the population on Annet. All-island surveys in 2015 and 2016 returned a total of 1,335 breeding pairs, with 1,318 at sites within the SPA, equating to

[6] One feature, the seabird assemblage, uses data from the original SPA citation.

5.07% of the GB total of 26,000 pairs. Although the marine boundary is not based on European storm petrel distribution, it is likely that some foraging will occur within it, and that other behaviours might also be supported closer to the colony (e.g. http://birdlifemalta.org/wp-content/uploads/2015/01/Malta-Seabird-Project-Laymans-Report-ENG.pdf). The pSPA is therefore expected to offer at least some protection at sea to the significant proportion of the Great Britain total breeding at the Isles of Scilly SPA. . It is hoped that the recent eradication of rats on St Agnes and Gugh islands may see recent declines in abundance begin to reverse (Table 1).

Table 1. European storm petrel abundance within the Isles of Scilly SPA (Apparently Occupied Sites, equivalent to pairs).

Year	Abundance
2000	1,458
2006	1,378
2015/16	1,318

5.3. Regularly occurring migratory species

5.3.1. Lesser black-backed gull *Larus fuscus graellsii*

Lesser black-backed gulls were a feature of the existing Isles of Scilly SPA, and remain a feature for the pSPA.

The breeding population of lesser black-backed gulls in the UK is estimated to be 110,000 pairs (Musgrove *et al*. 2013), representing about 61.5% of the European breeding population of the *graellsii* race (179,000 pairs: Stroud *et al*. 2016). Breeding is widespread throughout several natural and man-made habitats (Mitchell *et al*. 2004; Balmer *et al*. 2013), though there are relatively few aggregations large enough to qualify as SPAs in England (five, including the Isles of Scilly). The species nests on coastal habitats including cliff slopes, islands, and sand dunes, and inland in upland areas (Brown & Grice 2004). Increasingly, it nests on buildings and other human constructions (Ross-Smith *et al*. 2014).

Within the Isles of Scilly, lesser black-backed gulls breed on over 30 separate islands (Heaney & St Pierre 2017), the main colony being on Samson. All-island surveys in 2015 and 2016 returned a total of 2,485 breeding pairs, with 2,461 at sites within the SPA, equating to 1.37% of the biogeographic total of 179,000 pairs. It is hoped that the recent eradication of rats on St Agnes and Gugh islands may enable declining populations of lesser black-backed gulls to recover (Table 2).

Table 2. Lesser black-backed gull abundance within the Isles of Scilly SPA (Apparently Occupied Nests, equivalent to pairs).

Year	Abundance
2000	3,604
2006	3,326
2015/16	2,461

5.3.2. European shag *Phalacrocorax aristotelis*

European shags are a new proposed feature of the Isles of Scilly pSPA. They were a ‘main component’ (>2,000 individuals and / or >1% of GB population) of the seabird assemblage feature of the original SPA, meeting both criteria. They now qualify as features in their own right; despite some declines at the islands within the SPA, the wider population has declined more rapidly, meaning the Isles of Scilly pSPA has proportionally increased in importance.

Stroud *et al*. (2016) consider European shags breeding at the Isles of Scilly SPA to contribute to the sufficiency of the UK SPA network, by virtue of their assemblage component status. However, now that they meet the stage 1.2 SPA selection guideline (JNCC 1999), the proposal is to formalise their status as distinct qualifying features.

The breeding population of European shags in the UK is estimated to be 27,000 pairs (Musgrove *et al*. 2013), representing about 38.8% of the north east Atlantic *aristotelis* subspecies breeding population (69,500 pairs: Stroud *et al*. 2016). Breeding is widespread throughout cliff and rocky habitats (Mitchell *et al*. 2004; Balmer *et al*. 2013), though there are relatively few aggregations large enough to qualify as SPAs in England (two, including the Isles of Scilly, with 11 others in Scotland: Stroud *et al*. 2016). The species nests on steep ledges of cliffs, on islets and stacks, in sea caves and amongst boulders (Brown & Grice 2004).

Within the Isles of Scilly, European shags breed on over 30 separate islands (Heaney & St Pierre 2017), the main colony being in the Western Rocks island group. All-island surveys in 2015 and 2016 returned a total of 1,025 breeding pairs, with 1,014 at sites within the SPA, equating to 1.46% of the biogeographic total of 69,500 pairs. SPA abundance has varied over time, peaking in 2006, but is similar to the level at time of original classification (Table 3).

Table 3. European shag abundance within the Isles of Scilly SPA (Apparently Occupied Nests, equivalent to pairs).

Year	Abundance
2000	1,025
2006	1,193
2015/16	1,014

5.3.3. Great black-backed gull *Larus marinus*

Great black-backed gulls are a new proposed feature of the Isles of Scilly pSPA. They were a 'main component' (>2,000 individuals and / or >1% of GB population) of the seabird assemblage feature of the original SPA, meeting the latter criterion. They are now proposed as a feature in their own right.

Stroud *et al*. (2016) consider great black-backed gulls breeding at the Isles of Scilly SPA to contribute to the sufficiency of the UK SPA network, by virtue of their assemblage component status. However, the proposal is to formalise their status as distinct qualifying features under stage 1.4 of the SPA selection guidelines (JNCC 1999), for the following (non-exhaustive) reasons. Firstly, changing the status of great black-backed gulls at the pSPA would allow conservation objectives to be drafted specifically for the feature, allowing clear articulation of requirements for site integrity for the species. Secondly, the Isles of Scilly SPA is the most important site for the species in the UK (i.e. the site makes the greatest contribution to SPA network sufficiency: section 6). Thirdly, recent increases at the SPA are contrary to declines of 11% recorded across the UK as a whole (JNCC 2016), indicating increasing relative importance of the site.

The breeding population of great black-backed gulls in the UK is estimated to be 17,000 pairs (Musgrove *et al*. 2013), representing about 16.2% of the European breeding population (105,000 pairs: Stroud *et al*. 2016). Breeding is widespread mainly on the west coast of Britain (Mitchell *et al*. 2004; Balmer *et al*. 2013), though there are relatively few aggregations large enough to qualify as SPAs in England (just the Isles of Scilly, with five in Scotland: Stroud *et al*. 2016). The species nests on small islands, cliffs and stacks, often at the top of colonies (Brown & Grice 2004).

Within the Isles of Scilly, great black-backed gulls breed on 45 separate islands (Heaney & St Pierre 2017), the main colony being in the Eastern Isles island group. All-island surveys in 2015 and 2016 returned a total of 984 breeding pairs, with 941 at sites within the SPA, equating to 0.90% of the biogeographic total of 105,000 pairs. SPA abundance has increased since the time of original classification (Table 4), though prior to classification numbers were even greater (Heaney & St Pierre 2017).

Table 4. Great black-backed gull abundance within the Isles of Scilly SPA (Apparently Occupied Nests, equivalent to pairs).

Year	Abundance
2000	743
2006	835
2015/16	941

5.4. Seabird assemblage

The original Isles of Scilly SPA citation included a breeding seabird assemblage feature, as the site supported numbers of breeding seabirds of international importance (26,478 individuals, exceeding the stage 1.3 SPA selection threshold of >20,000 individual birds: JNCC 1999).

Declines in seabirds breeding at the site, and recent changes in survey methods for European storm petrels[7], mean that the 20,000 threshold is no longer reached. Heaney & St Pierre (2017) reported a current total of 15,938 individual breeding seabirds. However, in line with Defra policy reflected by other new SPAs where declines have meant that features were retained from earlier, superseded, SPAs (e.g. Morecambe Bay & Duddon Estuary SPA: common tern, Sandwich tern, herring gull, seabird assemblage), the seabird assemblage feature is retained based on information from 1999. This was the best data available at that time and has been through public consultation.

There is a long history of importance for seabirds at the Isles of Scilly. Heaney & St Pierre (2017) document around 10,000 pairs (20,000 individuals) breeding on the islands between 1969 and the late 1980s (Figure 5). Prior to the modern era, Heaney *et al*. (2008) indicate archaeological evidence of seabird occupancy. It is therefore considered appropriate to retain the seabird assemblage, especially following recent successful efforts to eradicate rats from some seabird islands within the archipelago; numbers of some species might reasonably be expected to increase in coming years now that predation pressure is relieved.

Table 5. Seabird assemblage abundance within the Isles of Scilly SPA (individuals).

Year	Abundance
2000	18,512
2006	17,484
2015/16	15,938

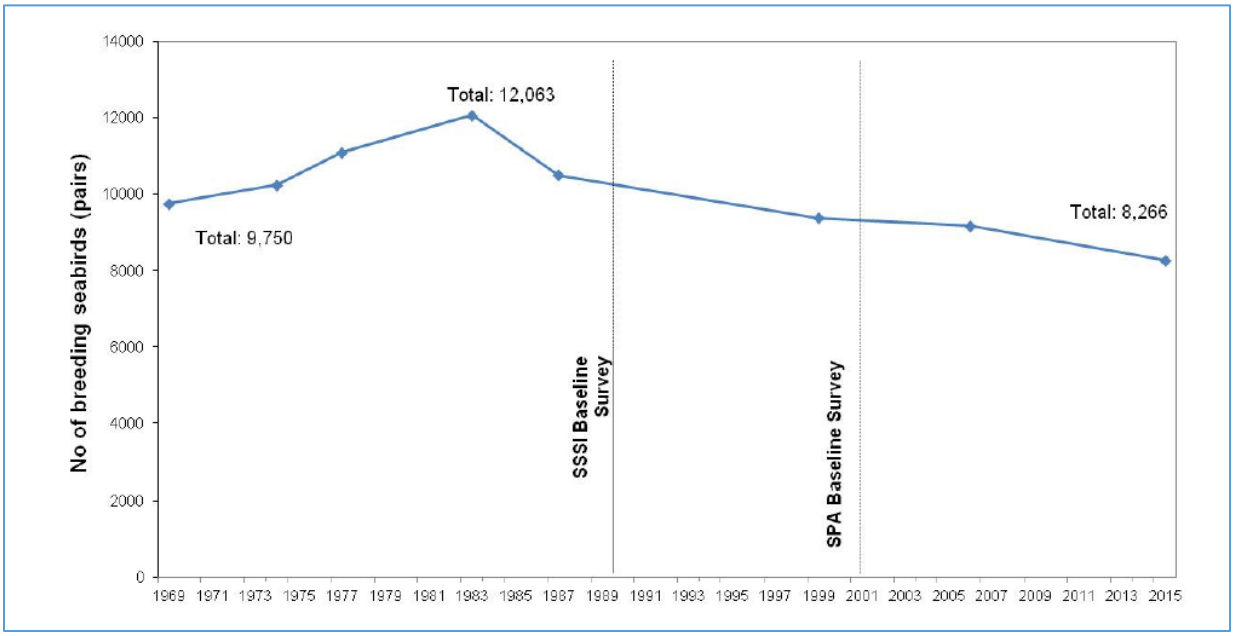

Figure 5. Cumulative seabird abundance from all-island surveys of the Isles of Scilly. From Heaney & St Pierre (2017).

6. Comparison with other sites in the UK

To indicate the relative importance of the Isles of Scilly pSPA in a national context a comparison of the

[7] The 1999 citation was based on estimates of at least 5,406 pairs of European storm petrel made by Robinson (1999). Repeat surveys in 2000, using newly standardised tape playback survey methods, estimated 1,475 pairs (Heaney *et al*. 2002).

numbers of birds within the site was made with other SPAs for the relevant species.

Table 6 shows that the pSPA is highly significant nationally for the new proposed features, being the most important site in the UK for great black-backed gull and the 3rd most important site in the UK (and most important in England) for European shag.

It is important to note that although these comparisons are made with the best available evidence, they compare contemporary data from the Isles of Scilly pSPA with a list produced for the 2016 SPA review where the data are sometimes up to 17 years older. It is likely that interim declines in European shags and lesser black-backed gulls at other sites mean the importance of the Isles of Scilly is underestimated for those features.

Table 6. Comparison of the numbers of individuals (pairs) of seabirds in the Isles of Scilly pSPA (2015/16) with those at other SPAs identified (Stroud *et al*. 2016) as supporting those features.

Species	**Individuals (pairs)[8]**	**Rank[9]**	**Comments**
European storm petrel	2,636 (1,318)	5th of 9	#1: Mousa (11,781 pairs in 2008); #9: Sule Skerry & Sule Stack (309 pairs in 2001).
Lesser black-backed gull	4,922 (2,461)	6th of 8	#1: Skomer & Skokholm (12,650 pairs in 2011); #8: Ailsa Craig (183 pairs in 2010).
European shag	2,028 (1,014)	3rd of 13	#1: Foula (2,300 pairs in 2000); #13: Hermaness (82 pairs in 1999).
Great black-backed gull	1,882 (941)	1st of 6	#2: Calf of Eday (675 pairs in 2000); #6: East Caithness Cliffs (175 pairs in 1999).

7. Conclusion

The evidence presented in this departmental brief sets out the scientific case for SPA classification, based on at site survey data and peer-reviewed models of European shag marine distribution. The proposed boundary encompasses the islands upon which the features breed, as well as the marine habitats shown to be important for at least one feature. In all likelihood, the other features (including the seabird assemblage) will also make use of those marine areas for some activities.

The pSPA is internationally important for three species, with a fourth proposed to include formal protection at its most important UK site. It is the most abundant site in the UK for great black-backed gulls, (at least) the third most abundant for European shags, the fifth most abundant for European storm petrels (one of only two breeding locations in England), and (at least) the sixth most abundant for lesser black-backed gulls. There is a long history of seabird occupancy, reflected by the seabird assemblage feature, and recent conservation efforts mean there is a reasonable expectation of recovery of this feature to previous abundance levels. All of these features are at the edge of their UK range given the remote location of the island archipelago.

In conclusion, the site qualifies as per the original Isles of Scilly SPA, with the addition of European shag and great black-backed gull, to protect both terrestrial breeding habitat and the marine areas used by birds breeding on the islands and rocks within the pSPA.

[8] Stroud *et al*. (2016) note: "*Most seabird data (71% of seabird interest features) were derived from the Seabird Monitoring Programme, i.e. from 2003 or later. However the remaining (totalling 90, or 29% of seabird interest features) assessments for 18 species derive from Seabird 2000* [the last national census of seabirds]*. These relate mostly to remoter seabird colonies especially in northern and western Scotland*."

[9] These rankings should only be considered indicative of the relative importance of the pSPA as contemporaneous data are not available for all sites.

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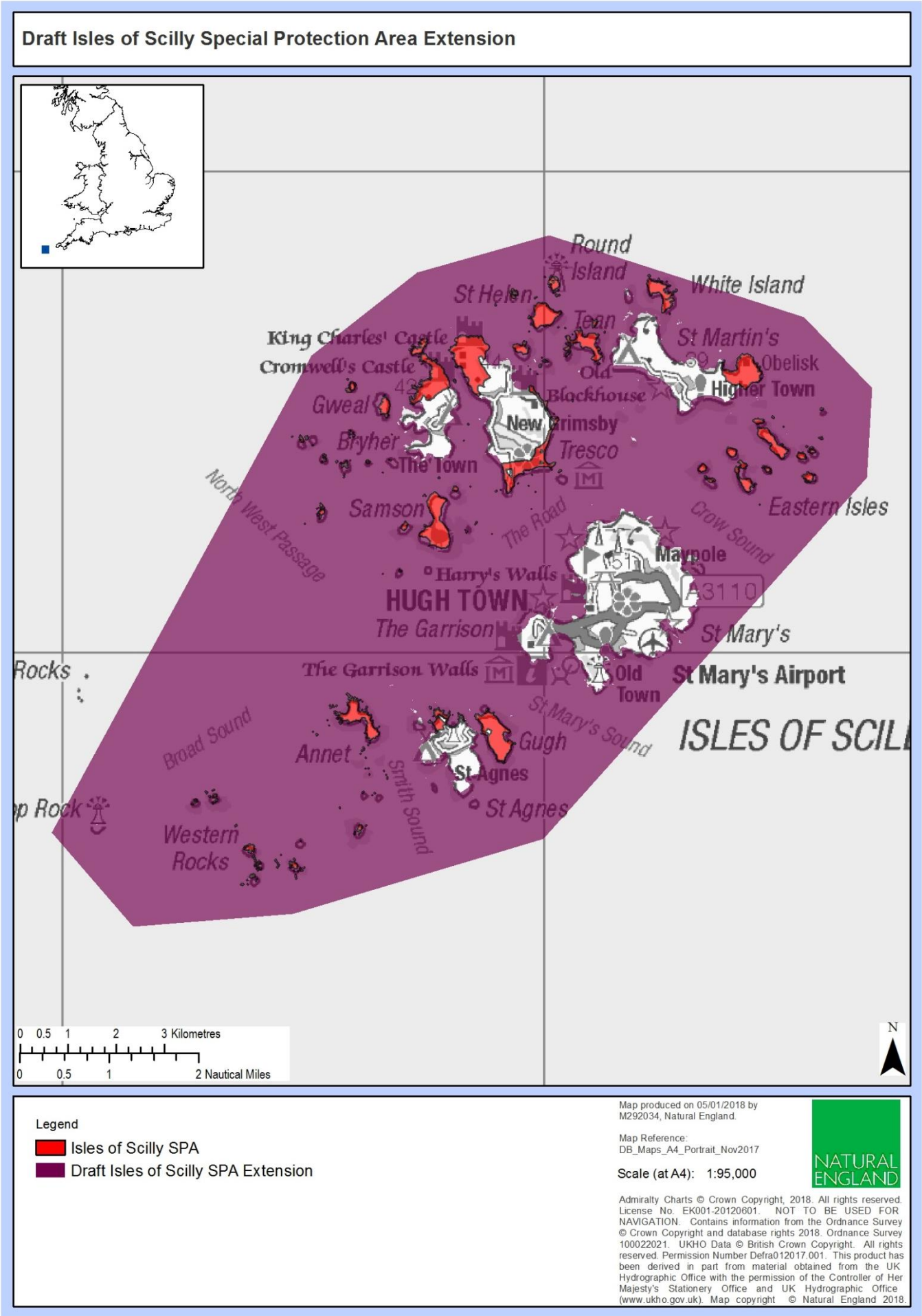
Annex 1 Boundary Map



Annex 2 Site Citation

EC Directive 79/409 on the Conservation of Wild Birds

potential Special Protection Area (pSPA)

Name: *Isles of Scilly potential Special Protection Area*

Counties/Unitary Authorities:

The pSPA covers areas within the Council of the Isles of Scilly Unitary Authority. All areas of sea are within UK territorial waters.

Boundary of the pSPA:

The pSPA encompasses most of the islands and islets within the Isles of Scilly archipelago, including the most important nesting locations for breeding seabirds. It includes areas of shallow water within which the features have been shown to occur, as well as the flight-lines to their breeding sites.

Islands supporting nesting birds that are included within the pSPA are encompassed in part or in full by the boundary; other islands, islets and rocks not contributing nesting areas to the pSPA meet the boundary at mean high water (i.e. the marine area is within the pSPA but the 'terrestrial' area is not).

It should be noted that the pSPA boundary encompasses both those areas used for nesting features as well as marine areas around the archipelago used for foraging, loafing, preening and other essential behaviours of the birds found at the site.

The new pSPA supersedes the original Isles of Scilly SPA.

Size of pSPA: The pSPA covers an area of 13,332.52 ha.

Site description:

The Isles of Scilly lie approximately 45 km (28 miles) offshore from Land's End. They are a collection of over 200 granite islands and rocks, and represent Britain's only oceanic island archipelago. Wind and wave exposure around the islands can be considerable due to their offshore location, and bathymetry drops quickly from shallow waters within the islands to depths of 60-90 m further offshore. The islands hold a unique mix of marine communities derived from variations in exposure to Atlantic storms and currents as well as the south-westerly position of the islands, which has led to the presence of some warm water species living at the northern extremes of their range. Subtidal sediments around the islands are classified as mainly sand and gravelly sand, and there are also spectacular subtidal rocky reef areas around the islands with many nationally rare and scarce marine species present. Some of the most extensive seagrass beds in the country can be found in the sheltered waters in between the islands, and the Isles of Scilly are one of only two locations in south west England protected for their breeding population of grey seals. Coastal habitats around the islands include intertidal rock habitats, such as the rocky shores and underboulder habitats found around the coastline of St. Mary's and St. Agnes, as well as intertidal sandflats such as the extensive sandflats found on the island of St. Martin's.

Qualifying species:

The site qualifies under **Article 4.1** of the Birds Directive (2009/147/EC) as it is used regularly by 1% or more of the Great Britain populations of the following species listed in Annex I in any season:

Species	Season	Count (Period)	% of population
European storm-petrel *Hydrobates pelagicus*	Breeding	2,636 individuals (2015/16)	5.07% of GB population

The site qualifies under **Article 4.2** of the Directive (79/409/EEC) as it is used regularly by 1%[10] or more of the biogeographical populations of the following regularly occurring migratory species (other than those listed in Annex I) in any season:

Species	Season	Count (Period)	% of population
Lesser black-backed gull *Larus fuscus graellsii*	Breeding	4,922 individuals (2015/16)	1.37% of biogeographic population
European shag *Phalacrocorax aristotelis aristotelis*	Breeding	2,028 individuals (2015/16)	1.46% of biogeographic population
Great black-backed gull *Larus marinus*	Breeding	1,882 individuals (2015/16)	N/A – selected under stage 1.4 guideline

Assemblage qualification:

The site qualifies under SPA selection stage 1.3 as it is used regularly by over 20,000 seabirds in any season:

In the breeding season, the site regularly supports at least 26,478 (1999) individual seabirds.

The main components of the assemblage include all of the qualifying features listed above.

Principal bird data sources:

All breeding bird data from the national Seabird Monitoring Programme database, reported in Heaney & St Pierre (2017). At sea data are from bespoke digital aerial surveys carried out by HiDef Surveying Ltd.

[10] With exception of great black-backed gull: 0.90% of biogeographic population, 5.54% GB population.

Annex 3 Sources of bird data

Source of Data	Data provider	Subject	Date produced	Method of data collection	Verification	Reference
Seabird Monitoring Programme	JNCC	Breeding seabird data for relevant colonies contributing to Isles of Scilly pSPA (counts of breeding pairs)	2015-16	Standard methodology	Published on JNCC website, and as report by RSPB (Heaney & St Pierre 2017)	http://jncc.defra.gov.uk/smp/
Digital aerial surveys	HiDef Aerial Surveying	Data on bird distribution at sea from digital aerial surveys (observations of distribution and abundance at sea)	2014-2015	Digital aerial surveys, Density Surface Models, Maximum Curvature analysis	Published in peer-reviewed journal (O'Brien *et al*. 2012); report peer-reviewed and provided for consultation	
Tracking data	RSPB; University of Exeter	Tracking data from GPS loggers fitted to 13 European shags from three islands	2010-2012	GPS loggers	Published on FAME (Future of the Atlantic Marine Environment) website and in peer-reviewed journal as Evans *et al*. (2015)	http://www.fameproject.eu/en/results/united-kingdom/tracking/shag/

Annex 4 Defining the Isles of Scilly marine pSPA boundary

1. Background and overview

The Departmental Brief sets out the rationale for basing the marine boundary of the pSPA on the distribution of European shags. Various methods were considered to collect data on shag distribution, including boat surveys (Camphuysen *et al*. 2004) and tracking (Evans *et al*. 2015). Digital aerial surveys (DAS) were chosen as the primary method so that a large area could 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 Annex summarises the survey work reported in Irwin *et al*. (2015), Webb *et al*. (2016) and the final analysis reported in McGregor *et al*. (2017).

2. Data collection

Digital aerial surveys (DAS)

Methods

Three surveys were undertaken in each of the summers of 2014 and 2015 (Table 1). Each survey involved flying an aircraft along 15 transects at an altitude of approx. 550 m above sea level (causing little or no disturbance to the birds surveyed). The survey was designed to collect more data closer to the islands, where most European shags were expected to occur. Consequently, transects were spaced 5 km apart in the 'low intensity' study area, and 2.5 km apart in the 'high intensity' study area (Figure 1), representing approx. 10% and 19% coverage of the respective study areas.

Table 1. Survey information. Differences result from minor variation in exact aircraft positioning.

Survey date	Length of transects (km)	Area (km^2)
14 May 2014	471.3	235.65
12 June 2014	478.4	239.20
2 July 2014	475.3	237.65
12 May 2015	462.0	231.00
16 June 2015	458.8	229.42
29 July 2015	462.75	231.38

The aircraft carried four High Resolution (2 cm GSD, i.e. each pixel in a resulting image is 2 cm apart 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 abundance and distribution, and is the starting point for all analyses. Behaviour (sitting / flying) was recorded.

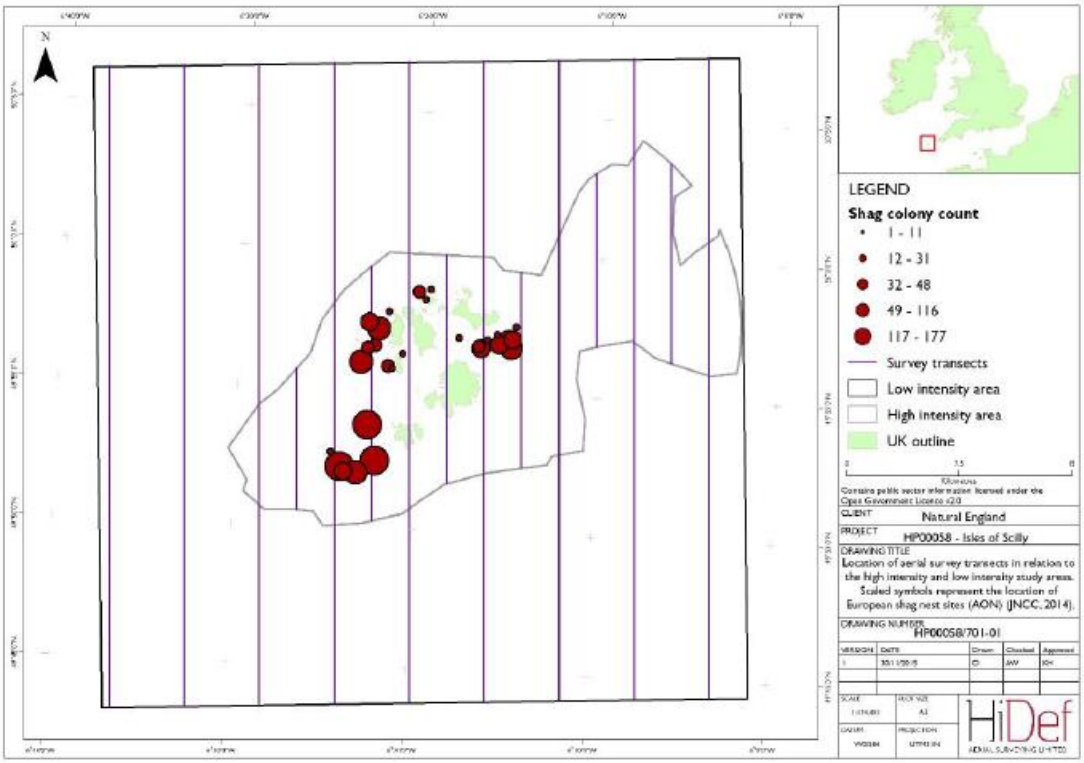


Figure 1. Aerial survey transects in relation to high and low intensity study areas. Scaled symbols show European shag nesting locations.

Results

No European shags were recorded in the low intensity area, supporting the hypothesis that birds would be found in shallow waters closer to breeding locations. Other 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 supported expectations that European shag distribution was more predictable, consistent and suitable for setting marine SPA boundaries (Figure 2).

<u>Tracking of European shags</u>

Supplementary data were also used to investigate the marine SPA boundary, kindly supplied by the University of Exeter and RSPB. These data were tracks of 13 European shags fitted with GPS loggers at three islands within the Isles of Scilly between 2010-2012 (Evans *et al*. 2015).

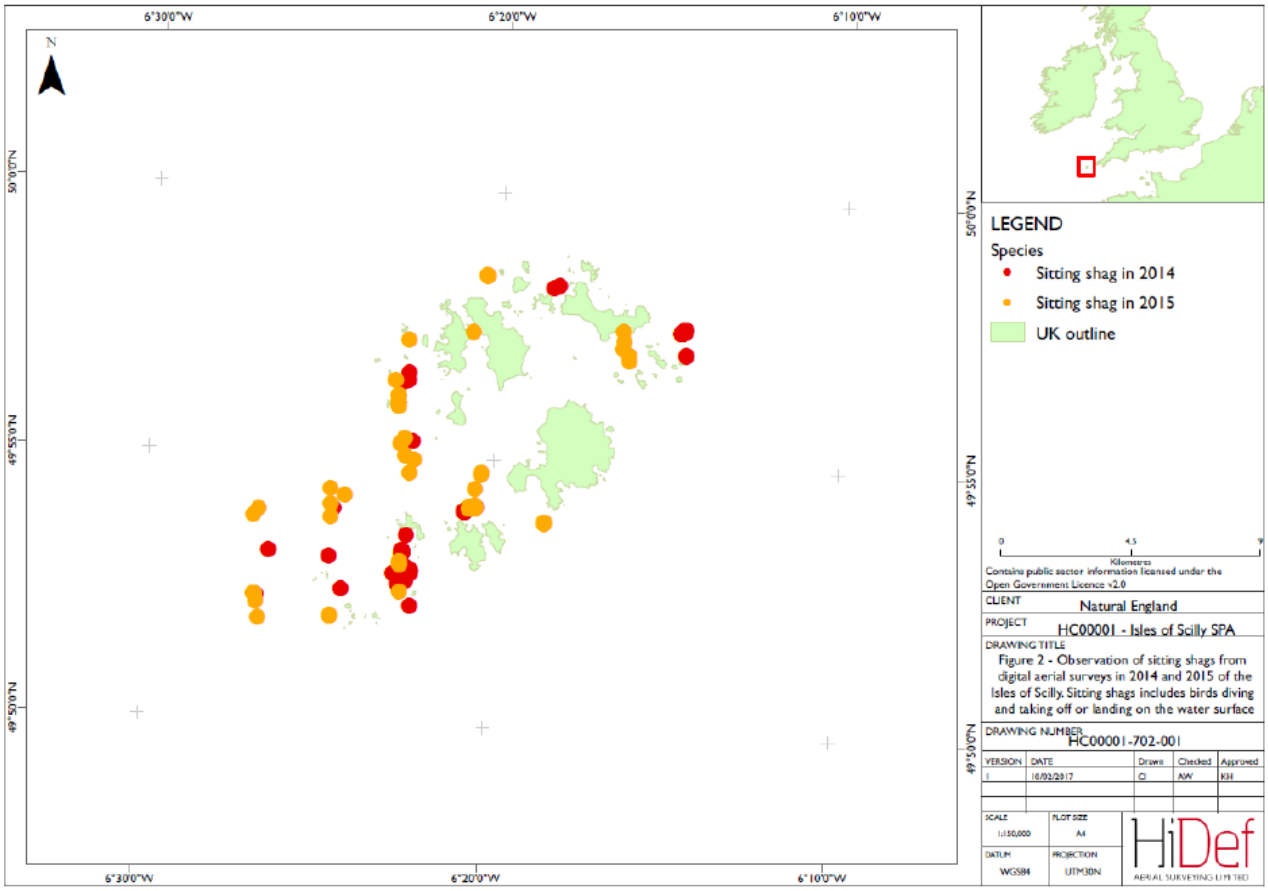


Figure 2. Location of observations of European shags (2014-2015).

3. Data analysis

<u>European shag distribution models</u>

Digital aerial survey models

The aim of this modelling was to predict European shag distribution in areas which were not surveyed. 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).

McGregor *et al*. (2017) applied two different methods of predicting European shag distribution: Kernel Density Estimation (KDE), an older technique applied in earlier marine SPA selection (e.g. O'Brien *et al*. 2012); and Density Surface Modelling (DSM), a newer technique. DSM is a type of 'habitat association model' (linking bird distribution with environmental predictors; Wilson *et al*. 2014), and these have been applied to SPA selection before (e.g. Northumberland Marine SPA; Morecambe Bay & Duddon Estuary SPA); DSMs are now 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). KDE is relatively simple, using the bird observations to 'interpolate' density between sightings. DSM is more sophisticated, using relationships between bird observations and environmental predictor variables to estimate bird densities within discrete grid cells (typically 500 m^2 or 1 km^2). Only birds using the water (i.e. those engaged in a behaviour requiring the sea and not in flight to or from the breeding location) were included in analysis.

DSM was preferred as KDE outputs produced larger, fairly simplistic, boundary options extending beyond the range of empirical observations. Several candidate DSMs were tested, with the best-fitting model including environmental predictor variables describing spatial location, seabed depth, sea surface temperature and a temporal factor (McGregor *et al*. 2017). The outputs result in a prediction of density of European shags within each grid cell, analogous to the output from a KDE model (O'Brien *et al*. 2012).

Tracking data models

Unlike DAS analysis, birds in flight were included, as it was considered important to include the areas used to commute between breeding sites and marine locations. These are measured by this method, but not by DAS (because it records birds in one space and time only, not continuously).

Because tracking devices record the movements of individual birds, output DSMs do not reflect densities but presence or absence, expressed as a probability of presence within each grid cell. The best fitting models included the temporal factor, breeding location, spatial location, and whether the bird was successfully breeding. Habitat also provided useful information, but produced different recommended boundaries. McGregor *et al*. (2017) advised caution in using these DSMs given the relatively small number of birds tracked (<1% of all breeding individuals, and less than the recommended sample calculated by Soanes *et al*. 2013) and small number of breeding islands represented (three of 31 occupied: Heaney & St Pierre 2017).

4. Boundary delineation

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, though has been used for other relationships (abundance and depth).

In applying the DAS DSM, the relationship is between predicted bird abundance and increasing habitat, expressed as km^2 (Figure 3). A double exponential model was found to offer the best fit, based on sum of squares of residuals.

Maximum curvature was also applied to DAS KDE and tracking DSM model data for comparison, but these were not taken forward for boundary recommendation (although the tracking DSM boundary provides useful support for the DAS DSM boundary).

The grid cells falling below the maximum curvature threshold established in Figure 3 are those that define the pSPA boundary (i.e. those that are selected before the law of diminishing returns applies: Figure 4).

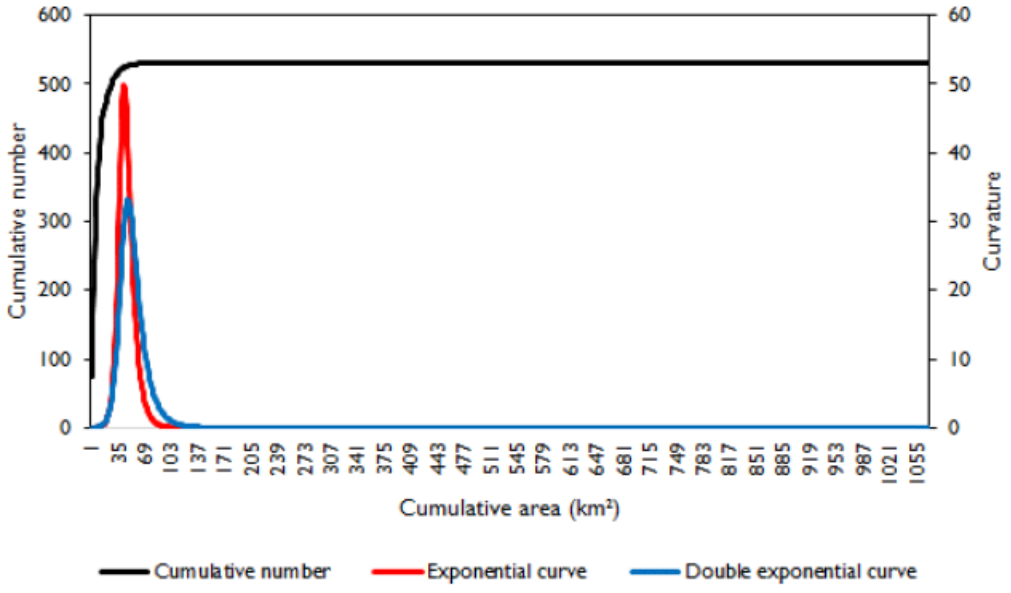


Figure 3. Cumulative number of shags against cumulative area of habitat, with maximum curvature from two models, based on DSM of sitting shags from DAS.

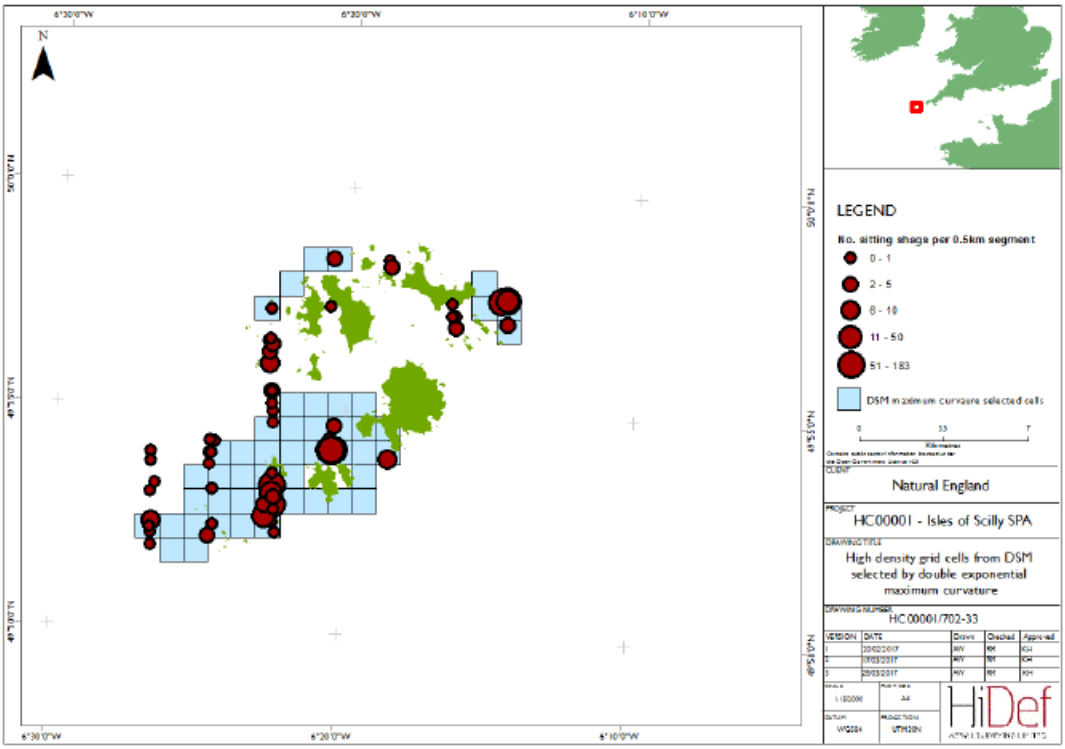


Figure 4. Grid cells identified as falling below (double exponential) maximum curvature threshold from DAS DSM, with original observations of European shags shown.

Recommended boundary

Finally, the cells identified by maximum curvature from the DAS DSM were encompassed within a suggested boundary 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). The polygon included the cells identified by maximum curvature, their centroids buffered by 707 m (the furthest distance between the centroid of a 1 km^2 grid cell and the corner of that cell), and 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. Finally, the boundary was snapped to the nearest lines of longitude and latitude, as recommended by Johnston *et al*. (2002) (Figure 5).

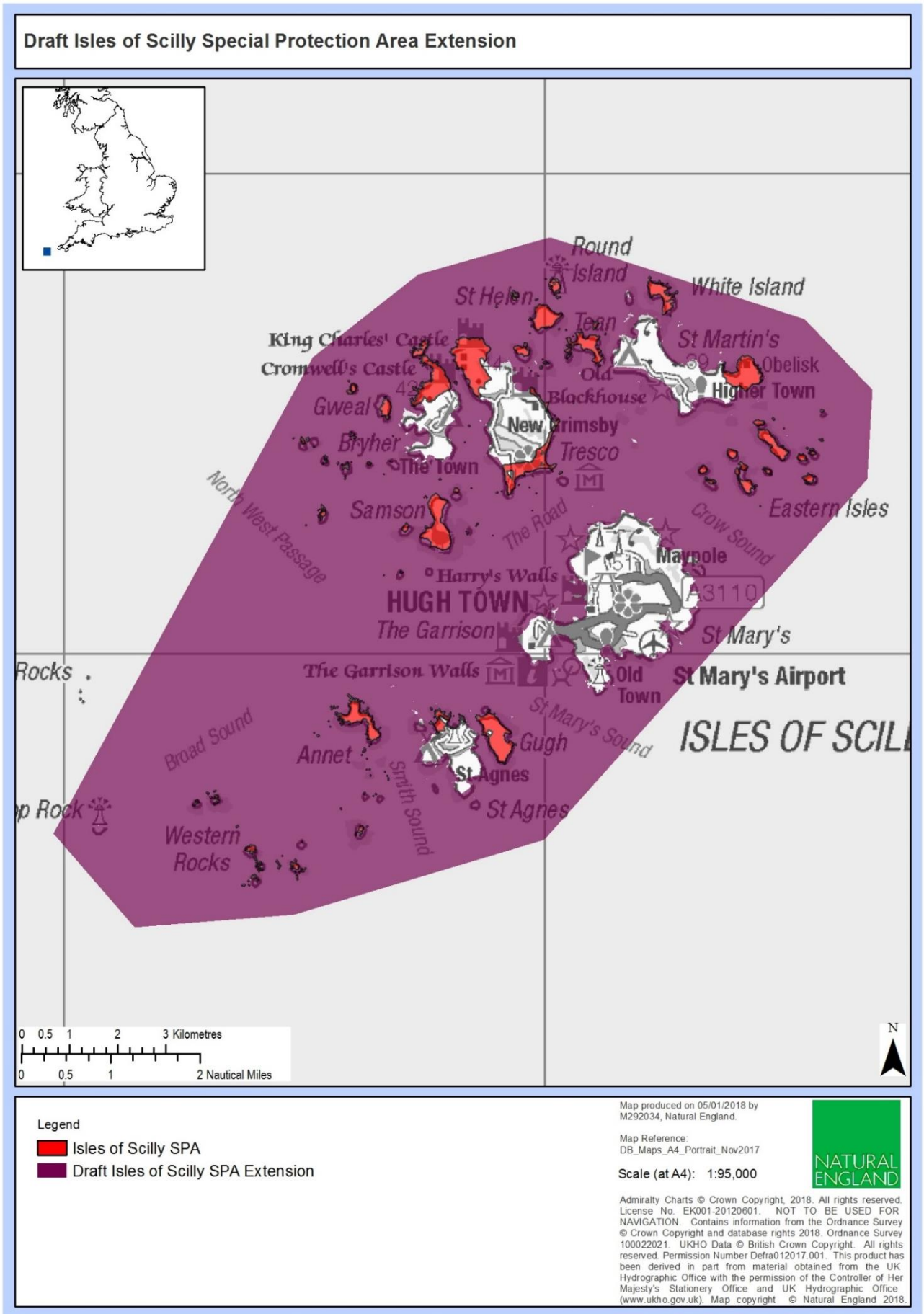


Figure 5. Recommended pSPA boundary, based on DAS DSM and maximum curvature and snapped to lines of latitude and longitude.

5. Conclusion

In line with Natural England QA 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 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.

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Annex 5 Implementation of Natural England Evidence Standards

Decision-making processes within Natural England are evidence driven and the Natural England strategic evidence standard, and supporting guidance were followed. In particular, the four principles for the analysis of evidence set out in the Natural England Standard *Analysis of Evidence* have been adhered to. These two standards documents can be downloaded from the following web-links:

Strategic Evidence Standard:

http://publications.naturalengland.org.uk/publication/7699291?category=3769710

Analysis of Evidence Standard:

http://publications.naturalengland.org.uk/publication/7850003?category=3769710

An explanation follows as to how the principles within the *Analysis of Evidence* standard have been applied in defining the set of qualifying features and boundary of the Isles of Scilly pSPA.

1.) The evidence used is of a quality and relevance appropriate to the research question or issue requiring advice or decision

1. Quantification of qualifying feature population sizes

In order to assess the suite of species present within the pSPA which meet the SPA selection guidelines (JNCC 1999), most relevant bird count data were used, in this case all-island surveys in 1999, 2000, 2006 and 2015/16. Data on breeding bird numbers are held in JNCC's Seabird Monitoring Programme (SMP) database (http://jncc.defra.gov.uk/smp/) and reported in Robinson (1999), Heaney *et al*. (2002), Heaney *et al*. (2008) and Heaney & St Pierre (2017). All surveys since 2000 follow recognised standard methods (Walsh *et al*. 1995; Gilbert *et al*. 1998).

These data represent best available information, and are of the highest quality and relevance regarding SPA classification decisions.

Within this Departmental Brief, current population figures (2015/16) for most qualifying features have been used to demonstrate how the site meets selection guidelines with the exception of the seabird assemblage; the 'at original SPA classification' population has been used to retain the ambition of the original SPA, following interim declines and methodological changes. Although such methodological changes mean that European storm petrel abundance is now estimated in a different way, the 1999 data represented best available evidence at the time of the original classification, and have been through public consultation. The seabird assemblage feature has been retained accordingly, to reflect the long history of multi-species occupancy of the islands, and current aims to recover numbers following recent conservation interventions.

The size of the breeding populations in Great Britain are taken from Musgrove *et al*. (2013) but are based on data from 2000, as Mitchell *et al*. (2004) represents the most recent national census of breeding seabirds. National populations may have changed since then, but these are the most recent data available for all colonies in Great Britain. There is some evidence that national European shag populations have declined (JNCC 2016), meaning that the relative importance of the Isles of Scilly may be underestimated.

2. Establishment of extent of marine pSPA using digital aerial survey data

Webb & Reid (2004) provide a series of guidelines for the selection of marine SPAs for aggregations of inshore non-breeding waterbirds. This guidance does not directly consider the evidence requirements for the selection of marine SPAs focussed on the principal marine areas used by breeding seabirds. However, a number of the issues and principles covered in Webb & Reid (2004) have some relevance; accordingly, the following section describes a comparison of the evidence base with the guidelines produced therein.

Webb & Reid (2004) note that the UK SPA selection guidelines, as described in Stroud *et al*. (2001), are adequate and competent for application to site selection for inshore non-breeding waterbird aggregations. However, given that the type and quality of data which underpins the Isles of Scilly pSPA differs from those used in identifying sites for terrestrial birds and aggregations of non-breeding waterbirds, it is necessary to consider their adequacy and relevance.

Webb & Reid (2004) set out seven criteria to assess the adequacy of count data. Although not all of direct relevance, these are set out in Table 1 with accompanying comments regarding the digital aerial survey data for European shags, and modelling work.

Table 1. Criteria for inshore SPA data adequacy.

Criterion	Adequacy of digital aerial surveys
Experience of observers	All data collection and image processing was contracted to HiDef Aerial Surveying, one of two very experienced providers of this service in the UK. HiDef have been active in the field of digital imagery for bird data collection since its inception (e.g. Mellor *et al*. 2007), and employ a team of highly expert image processing staff. Quality Assurance processes ensure validity of data.
Systematic surveys	All six surveys followed the same transect design and method, meaning surveys followed a repeatable and systematic approach.
Completeness	The aim of the surveys was not to cover all sea areas, but to ensure that effort was sufficient to capture European shag usage across a representative proportion of that area. Subsequently, reliable habitat association models were constructed to predict shag usage patterns across the wider area – including those areas in which no direct observations were made. The 'high' and 'low' intensity study area design meant that more data were collected in the areas in which shags were expected; the lack of shags in the 'low' intensity area supported this decision and infers that the sampling strategy was robust.
Counting method	Although it was possible to estimate total abundance from the aerial surveys (Irwin *et al*. 2015; Webb *et al*. 2016), this was not factored into boundary setting (aside from density predictions used for maximum curvature analysis). In common with SPAs for foraging terns (e.g. Northumberland Marine SPA), all birds counted by conventional methods at the nest are assumed to use the marine area, and it is these abundance values that inform the citation for the pSPA, not those estimated from the aerial surveys.
Quality of sampling	Surveys were carefully designed to provide adequate coverage to deliver sufficient observations of European shags for robust modelling. Survey areas were defined according to knowledge of shag ecology, and transects were favoured over plots to maximise detections of birds. Transects were oriented in such a way to ensure variation within transects, and were not aligned to any obvious habitat features.
Robustness of population estimate	Not applicable as the surveys were not used to generate a population estimate.
External factors affecting the survey	Survey data were gathered only under favourable weather conditions. Video cameras were angled to avoid sun glare issues.

Webb & Reid (2004) also discuss collating sufficient evidence to establish 'regularity of use', which is a key element of the SPA selection guidelines. The guidelines describe demonstration of occurrence in two thirds of the seasons for which adequate data are available, suggesting three seasons as a minimum. Because of the high level of consistency between data collected in 2014 and 2015, here regularity of use of marine areas is shown using two seasons of data; i.e. as regularity is established from two seasons, collecting more data in a third season is redundant as the criterion is already met. Furthermore, the supplementary information from tracking studies (2010-2012) suggests very similar patterns of usage, further supporting the case for regularity of use.

Webb & Reid (2004) discuss boundary placement. They note that the principles for defining boundaries for terrestrial SPAs in the UK are described in Stroud *et al.* (2001) thus (emphasis added):

> *"The first stage of boundary determination involves **defining the extent of area required by the qualifying species concerned**. These scientific judgements are made in the light of the*

ecological requirements of the relevant species that may be delivered by that particular site, and the extent to which the site can fulfil these requirements. This follows a ***rigorous assessment of the best-available local information regarding distribution, abundance and movements of the qualifying species****. It may also involve the* ***commissioning of special surveys*** *where the information base is weak. Following this stage, every attempt is made to define a boundary that is identifiable on the ground and can be recognised by those responsible for the management of the site. This* ***boundary will include the most suitable areas for the qualifying species*** *identified in the first stage……"*

The digital aerial data originated from specially commissioned surveys, conducted to define the extent of the area required by European shags. These generated the best available local information regarding distribution and abundance of this qualifying species, whilst 'movements' were investigated through the tracking data. Maximum curvature then selected the 'most suitable areas' of sea for the pSPA.

Webb & Reid (2004) discuss the principles of setting both landward and seaward boundaries of marine SPAs.

In regard of setting landward boundaries they note that "*Where the distribution of birds at a site is likely to meet land, a boundary should usually be set at the mean high water mark (MHW)……. unless there is evidence that the qualifying species make no use of the intertidal region at high water*."

The landward boundary of the pSPA has been drawn at MHW. This means it abuts the original Isles of Scilly SPA, where habitats were included within that boundary, and provides intertidal habitat provision where they were not. There is evidence that the features of the pSPA will use the intertidal area, supporting this approach (e.g. D'Elbée & Hémery 1998; Garthe *et al*. 1999; Ellis *et al*. 2005; BirdLife International 2016).

Webb & Reid (2004) set out a recommended method for defining the seaward boundary of SPAs for inshore non-breeding waterbirds on the basis of analysing bird data from aerial or boat-based sample surveys using spatial interpolation combined with spatial analysis. They note exceptions to this method which include the case in which "*habitat data are also used in combination with bird distribution data to determine boundaries*". This approach was followed here.

Webb & Reid (2004) describe spatial interpolation methods by which survey sample data can be used to generate maps of species probability of occurrence or abundance. This involves use of a "….*suite of modelling techniques in which the probability of bird occurrence or the total number of birds present is estimated at unsampled locations (usually in grid cells) using information on the presence or absence, or the number of birds recorded at sampled locations*". This is the principle underlying the Density Surface Models used to describe European shag distribution, and is thus in line with the recommendation of Webb & Reid (2004).

Webb & Reid (2004) conclude by discussing the method by which a boundary should be drawn around the parts of a site identified as being most important. They refer to Webb *et al.* (2003) which sets out a method for classifying grid cells so that the most important ones for a species on any given survey are highlighted. In that method, the grid cells are ranked from lowest predicted bird abundance to highest, and the cumulative population calculated from lowest ranked grid cell to highest. The highest ranking grid cells were selected such that they comprised 95% of the total population. The analytical approach which has been applied to the grid-based, modelled predictions of European shag usage to define the most important areas to include within the pSPA boundary (McGregor *et al*. 2017) follows the basic ranking principle outlined by Webb *et al.* (2003). However, the application of the maximum curvature technique to such cumulative usage curves reflects the advances in the details of this analytical method by JNCC since then (O'Brien *et al.* 2012).

Thus, in summary, although Webb & Reid (2004) does not directly address the issue of data requirements in regard of establishing marine SPAs for breeding seabirds, many aspects of the collection and analysis of data used to define the location and extent of the Isles of Scilly pSPA accord with the guidelines set out in that document.

3. Establishment of the extent of pSPA

The extent of the pSPA boundary is determined by European shag distribution, derived from models based on at-sea records of the locations of birds from digital aerial surveys.

The adequacy and relevance of these various models is discussed in the 'analysis' section.

4. Adequacy of sample size data

A total of 1,094 European shags were detected across the six surveys, of which 57% (624) were used for analysis (sitting birds only). The rule of thumb for spatial modelling is a minimum of 60 observations, meaning the sample size used was an order of magnitude greater than the notional minimum.

2.) The Analysis carried out is appropriate to the evidence available and the question or issue under consideration

Breeding bird distribution was analysed using methods established in marine SPA boundary setting – Kernel Density Estimation, Maximum Curvature (O'Brien *et al*. 2012) and habitat association modelling (Wilson *et al*. 2014), in the form of DSM. These methods are entirely appropriate, have been subjected to the highest level of scrutiny, and have been used in classifying other marine SPAs for breeding seabirds (e.g. Northumberland Marine SPA; Morecambe Bay & Duddon Estuary SPA).

The way in which the resultant maps of predicted bird distribution were analysed to determine threshold levels of predicted bird usage (i.e. maximum curvature analysis) represents application of an established method used at other marine SPAs (O'Brien *et al.* 2012) and is thus entirely appropriate to the evidence available.

Following completion of the work (McGregor *et al*. 2017), an external peer review was carried out in line with Natural England's Quality Management Standard (http://publications.naturalengland.org.uk/publication/7783711?category=3769710). This peer review did not highlight any significant issues with the appropriateness of the analyses, and minor challenges were resolved by subsequent discussion between the reviewers and HiDef. Further details of the external peer review are provided in section 5 of this Annex.

3.) Conclusions are drawn which clearly relate to the evidence and analysis

The conclusions regarding the list of features and their reference population sizes within the pSPA are based on application of the SPA selection guidelines (JNCC 1999) to the best and most recent count data (with the exception of the seabird assemblage, which is retained from the original SPA citation for reasons described in the evidence section of this annex). As such, the conclusions clearly relate to the best available evidence.

The conclusions regarding the seaward boundary of the pSPA are based upon the evidence from DAS, modelled within DSMs, and selected by maximum curvature. The resulting convex hull polygon defining the pSPA boundary uses the output of this analysis. Thus, the conclusions clearly relate to the best available analysis of the best available evidence.

4.) Uncertainty arising due to the nature of the evidence and analysis is clearly identified, explained and recorded.

Count data

The UK SMP is an internationally recognised monitoring scheme coordinated by JNCC in partnership with others (e.g. statutory nature conservation bodies, the RSPB and other colony managers as data providers, etc.). It collects data according to standardised field methods (Walsh *et al.* 1995). Most SMP data rely on direct field observations of nesting birds, and are verified by the JNCC seabird team. Therefore, there is high confidence in SMP data. The data used in determining the size of the populations of each of the species considered for inclusion as features of the pSPA is based on counts which are in the SMP database and so justify high confidence.

There are some uncertainties with data estimating European storm petrel abundance. This species nests in burrows, crevices and other hidden places, which makes direct observational methods difficult or impossible. The 1999 surveys used in original SPA classification (Robinson 1999) relied upon extrapolating densities from ringing recoveries and represented best available evidence at that time. New methods of estimating abundance rely on responses to playback of singing birds at apparently suitable nesting sites. Although this method is less likely to incorrectly include non-breeders in abundance estimates, it is necessary to correct response rates to allow for non-responses and birds absent from the nest. These correction factors tend to be derived from other studies, and some uncertainty thus exists in terms of representativeness (e.g. Heaney

et al. 2002). Correction factors were, however, consistent with those used in 2000 and 2006 (Heaney & St Pierre 2017).

Uncertainties with empirical digital aerial survey data should be minimal, as the method is objective, subject to Quality Assurance and accurately geo-referenced.

Landward boundary
The landward boundary is at MHW to meet the original SPA boundary or to comply with guidance from Webb & Reid (2004), meaning uncertainty is not an issue.

Seaward boundary
The seaward boundary process has been quality assured to the highest level, but as the boundary is based on a model, some uncertainties will inevitably exist. McGregor *et al*. (2017) comprehensively explain the various tests and checks used to ensure the model is as robust as possible. This included model diagnostic tests to investigate independence and cross-correlation of variables. Similarly, the maximum curvature analysis included two potential models, with the best fit chosen statistically. Thus the models are considered to be the best fitting, despite any uncertainties associated with their use.

5. Independent expert review and internal quality assurance processes

Independent expert review
Natural England's standard in quality management has been followed to determine the level of review required to assess the analysis of the evidence for this site and the resulting boundary recommendation. Independent expert review is generally adopted where there is a high novelty or technical difficulty to the analysis.

McGregor *et al*. (2017) was thus indepedently reviewed by Dr Julie Black (Senior Seabird Ecologist, JNCC) and Dr Steve Votier (Senior Lecturer in Natural Environment, University of Exeter).

Dr Black's summary comments were:

"*The report provides a comprehensive summary and analysis of various data that are available and shows clearly the data, analysis and boundary options that might be considered further. The approach of comparing different data sources and analyses is useful as it allows readers to see the extent to which there is a consistent picture emerging, and also what the scale and nature of any differences might be if using different data and analysis. There are a few details which are missing from the report which would be helpful for the reader to make sense of the results (and the different boundary options), these are indicated in the detailed comments below. In particular, a key omission is an indication of the survey area for the DAS.*

The authors appear to have understood what the evidence will be used for and the context for this work, and have assessed data and undertaken analysis within this context.

The assessment of the data is generally fair and reasonable (though see specific comments below).

The analysis undertaken is appropriate for the data and for the question that is being addressed, and by having a simple and a more complex analysis for comparison of outputs, the additional 'value' in terms of refinement of outputs and additional information, can be assessed by the reader. Methods are described in enough detail for the reader to follow what has been done at a superficial level (but with some areas where the wording is confusing and clarity is needed on what was done, again see specific comments below). An annex with more detailed analysis description (and eg. R code) would be useful to ensure repeatability.

Conclusions are drawn which relate to the data and analysis, with an element of professional judgement. Although I don't disagree with the judgements made, clearer justification is required in some cases, particularly in discarding one of the boundary options from further discussion / consideration. Specific comments are made below relating to this, but in particular; it is difficult to know whether the authors assessment of the KDE boundary as being larger than is perhaps required (because it goes beyond all observations by a considerable distance) is fair without having a clearer picture of how the observations relate to the survey extent, and to the smoothing window used.

Limitations of the data and of the analysis, and assumptions made at each stage, are stated and an indication of the levels of uncertainty and robustness is provided. This further helps the reader, NE and any other users of this work to make fair assessments.

Overall I would have no concerns if NE were to further consider the outputs from this work."

Dr Votier offered a critical appraisal of the work, including some clarifications and challenges, concluding:

"Overall this is a sound piece of work and I am confident that the conclusions drawn (and more precisely the proposed SPA boundary) are robust. There are four key elements: (1) spatially explicit data on shag distribution, (2) creation of density surfaces based upon these data, (3) projecting these distributions using habitat modelling and (4) drawing of a proposed SPA boundary. I consider each of these elements to be reliable. The bird distribution data (mostly) of a high standard and despite this variety it importantly points in the same direction. The modelling of density surfaces and projection of this based upon environmental covariates constitutes state-of-the-art habitat modelling - there are other approaches to this (which see below) but I am confident that this has been done well. Finally the maximum curvature is the most appropriate method for drawing a boundary and this has been applied in the correct way."

O'Brien *et al*. (2012) describe the process of maximum curvature. As a peer-reviewed publication in a scientific journal, this work was also subject to the highest level of independent review.

Internal peer review and quality assurance

The first version of this Departmental Brief was drawn up by Dr Alex Banks (Senior Marine Ornithologist) and Kate Sugar (Marine Lead Adviser).

Departmental Briefs are drafted by an ornithologist with support from the site lead who provides the local site specific detail. This document is then quality assured by the Marine N2K National Project Management team as well as selected members of the Project Board. The brief is then circulated for external comments from Defra Marine Policy Officer, JNCC senior seabird ecologists, Marine Protected Area Technical Group (MPATG) and UK Marine Biodiversity Policy Steering Group (UKMBPSG). The amended briefs are then reviewed and approved by the Marine N2K Project Board, Director and relevant Area Managers and subsequently by the Natural England Chief Scientist in accordance with our Quality Management Standard. The brief is then signed off as required by Natural England's Non-Financial Scheme of Delegation by a representative of the Senior Leadership Team with delegated authority before being submitted to Defra.

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