

THE STATUS AND DISTRIBUTION OF EUROPEAN STORM-PETRELS *HYDROBATES PELAGICUS* AND MANX SHEARWATERS *PUFFINUS PUFFINUS* ON THE ISLES OF SCILLY

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Heaney V., Ratcliffe N., Brown A., Robinson P & Lock L. 2002. The status and distribution of European Storm-petrels *Hydrobates pelagicus* and Manx Shearwaters *Puffinus puffinus* on the Isles of Scilly. *Atlantic Seabirds* 4(1): 1-16. *This paper describes the first comprehensive survey of the distribution and abundance of breeding European Storm-petrels and Manx Shearwaters on the Isles of Scilly. Diurnal tape playback of vocalisations was used to survey those islands in the archipelago on which birds had previously been reported breeding and to search others with suitable habitat. The total breeding population of Storm-petrels was 1475 Apparently Occupied Sites and of Manx Shearwaters 201 Apparently Occupied Burrows. These numbers are of regional importance for both species and the numbers of Storm-petrels are internationally important. Storm-petrel breeding distribution was restricted to rat-free outer islands, but some Manx Shearwater colonies were found on islands with rats and also feral cats. The role of eradication and control of mammalian predators in the conservation of petrels on the Scilly Isles is discussed.*

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INTRODUCTION

The European Storm-petrel *Hydrobates pelagicus* has a world breeding population that probably lies between 135 000 and 380 000 pairs, of which 65 to 75% nest on offshore islands along the western coasts of Britain and Ireland (Lloyd *et al.* 1991; Tucker & Heath 1994). The Manx Shearwater *Puffinus puffinus* has an estimated world breeding population of 300 000 pairs, of which over 90% nest in Britain and Ireland (Lloyd *et al.* 1991). Its distribution within Britain and Ireland is restricted to three main areas: Rum, off the west coast of Scotland, the Pembrokeshire Islands in Wales and the islands off south-west Ireland (Lloyd *et al.* 1991).

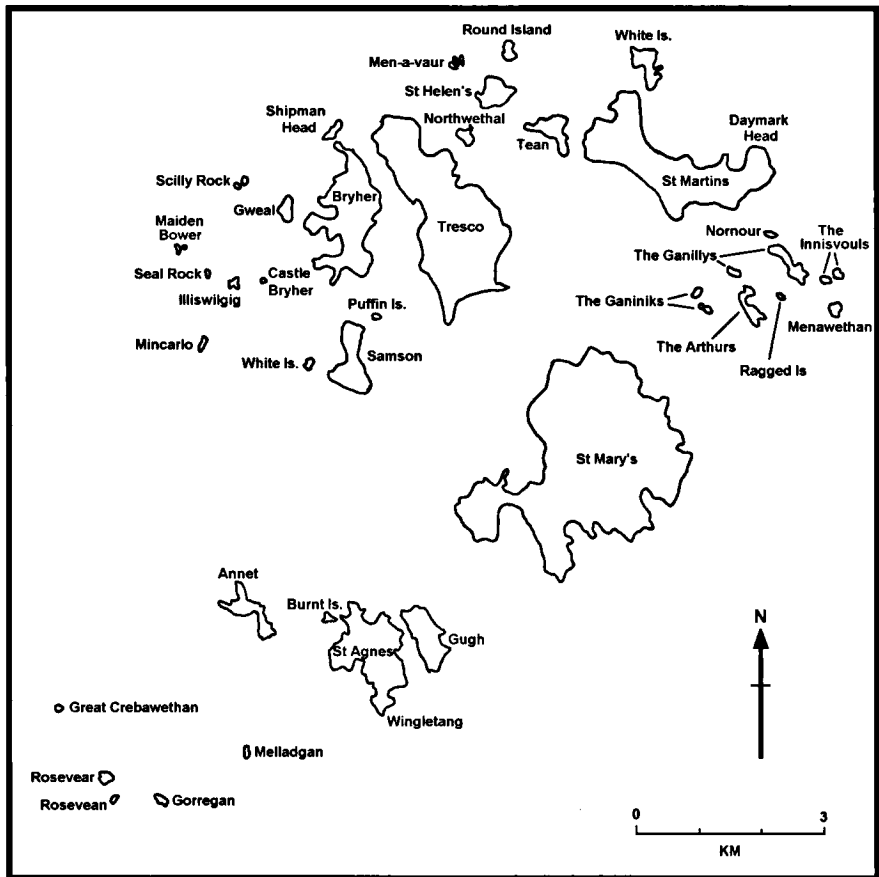


Figure 1. Map of the Scilly Isles, showing the locations of place names mentioned in the text and Tables.

Figuur 1. De Scilly Eilanden met de ligging van de plaatsnamen die in de tekst en tabellen worden genoemd.

Although the distribution and relative abundance of nocturnal petrels in Britain and Ireland are reasonably well documented, their population status and trends are poorly known owing to difficulties in censusing them (Lloyd *et al.* 1991). These are due to the nests being underground or in cavities among boulders, the presence of birds being evident only at night, and problems in accessing the remote islands on which they breed (Lloyd *et al.* 1991). Previous

estimates of breeding population size have tended to rely on subjective impressions of bird abundance or on capturing birds in mist nets at night. The former method is non-repeatable and both methods are confounded by the presence and behaviour of large numbers of non-breeding birds, so resulting in overestimates of abundance (Scott 1970; Furness & Baillie 1981; Fowler *et al.* 1982, 1986; Brooke 1990; Fowler & Hounscome 1998). Establishing standardised methods for estimating population sizes and monitoring trends is an essential prerequisite for the conservation of the internationally important Manx Shearwater, European Storm-petrel and also Leach's Storm-petrel *Oceanodroma leucorhoa* populations in Britain.

Since the last comprehensive seabird census of Britain and Ireland in 1985-87, attention has focused on developing a simple and repeatable method for surveying nocturnal, burrow nesting petrels. James and Robertson (1985) first advocated the use of diurnal tape playback of vocalisations to elicit responses from incubating birds in their burrows. The advantages of the method are that it is simple, it can be conducted during the day (promoting safety, longer working hours, more accurate mapping and enhancing detection of nesting habitat or burrows) and it excludes non-breeders and other burrow-nesting species (James & Robertson 1985; Ratcliffe *et al.* 1998a). Accurate estimates depend upon the survey being timed to coincide with the peak of diurnal nest attendance and the likelihood of a bird responding (James & Robertson 1985). These parameters have been estimated for Manx Shearwater (Brooke 1978a,b), European Storm-petrel (Ratcliffe *et al.* 1998a) and Leach's Storm-petrel (Ellis *et al.* 1998), and used to formulate standardised survey methods (Gilbert *et al.* 1998a). Playback has been used to produce population estimates of petrel colonies in Scotland and Wales (Gibbons & Vaughan 1997; Mainwood *et al.* 1997; Wood 1997; Gilbert *et al.* 1998b; Ratcliffe *et al.* 1998b; Vaughan & Gibbons 1998; Mayhew *et al.* 2000) and is being used during Seabird 2000, the complete survey of all seabird colonies in Britain and Ireland during 1999-2001.

European Storm-petrels and Manx Shearwaters have been known to nest in the Isles of Scilly since the mid 1800s (Rodd 1880), and several attempts have been made to assess their status and distribution (Allen 1977; Harvey 1983; Robinson 1999). Estimates of population size and distribution vary widely depending on the methods used, but the regional importance of the Isles of Scilly is clear because they are the only breeding locality for European Storm-petrels and one of only two for Manx Shearwaters in England (Lloyd *et al.* 1991). It is also likely that the Storm-petrel population is internationally important (Lloyd *et al.* 1991). This paper presents the results of the first comprehensive playback survey of the distribution and status of breeding European Storm-petrels and Manx Shearwaters on the Isles of Scilly. The

results form part of a national petrel survey that will allow recognition of the importance of the Isles of Scilly in a regional, national and international context and provide baseline population estimates for further monitoring. The conservation implications of the findings are discussed.

METHODS

Scope of survey The Isles of Scilly are situated 45 km off the south-west tip of Cornwall, at approximately 49° 59' N 06° 21' W. There are five inhabited islands and approximately 200 other islands, islets and rocks; not all of these could be surveyed with the resources available. Effort was therefore directed at surveying those sites where either Storm-petrels or Manx Shearwaters had previously been recorded (Rodd 1880; Bestwetherick 1968; Penhalluric 1969; Allen 1977; Harvey 1983; Robinson 1999).

Most inhabited islands (and those adjoining them at low tide), islets or rocks lacking suitable habitat, and those islands heavily infested with rats *Rattus norvegicus* would be very unlikely to support a breeding colony of Storm-petrels and so were not surveyed. Their omission was further justified given that many such sites were surveyed for the presence of Storm-petrels in 1999, but no breeding birds were found (Robinson 1999).

The presence or absence of petrels on 17 uninhabited islands at which they had not been recorded breeding previously was also assessed (Table 2). These were selected on the basis of being uninhabited islets not joined to inhabited islands at low tide, and also being adjacent to recorded colonies or having suitable areas of breeding habitat for Storm-petrels or Manx Shearwaters.

The locations of sites mentioned in the text and tables are shown in Figure 1. It is unlikely that any large colonies were omitted from the survey, but it is possible that some small ones were overlooked.

Survey coverage on islands Complete surveys of all suitable habitat were undertaken on each of the islands selected for survey except for Annet. Suitable habitat comprised boulder beach above the high tide mark, burrows, cracks in rocks, scree and dry-stone walls for Storm-petrels and burrows for Manx Shearwaters. Most of the islands were small enough to allow a complete survey of all these habitats. For Manx Shearwaters on the larger inhabited islands such as Bryher and St. Martins, the entire areas from which birds had been recorded previously were surveyed.

The extent of suitable habitat for both Storm-petrels and Manx Shearwaters on Annet precluded a full survey. In the case of Storm-petrels, all areas of boulder beach and rocky outcrops were surveyed fully, including any

burrows along their landward edges. Burrows along the coast away from boulder beaches were sampled using a total of 27 10x10 m quadrats placed every 100 m along the coast. A total of 13 10x10 m quadrats was surveyed in the interior of the island.

The distribution of Manx Shearwaters on Annet was established by a low intensity survey of the whole island, which involved searching the island for burrows and directing playback into them. The main concentration was found to be along the east coast within 10 m of the coast, extending to within 30 m of the coast along the thrift *Armeria maritima* covered slopes at the north-east end of the island. Outside this area only a single response was obtained. The eastern coast was surveyed completely using a series of 76 contiguous 10x10 m quadrats, extending to 30x10 m (N = 22) transects in the thrift. Within the thrift area, burrows under the overhang along the cliff to the north of the island could not be surveyed safely, but breeding birds were found in the few areas that could be accessed. The rest of the coast was surveyed using 27 10x10 m quadrats spaced every 100 m and seven were placed randomly in the interior of the island.

Survey methods Playback surveys of Storm-petrels were conducted between 24 June and 13 July 2000. The survey period was coincident with the peak of incubation for Storm-petrels according to data on laying phenology from colonies in Brittany collected during June 2000 (B. Cadiou, *unpubl. data*). For Manx Shearwater, the survey was conducted between 31 May and 15 June 2000, which coincides with the average peak of incubation for this species (Brooke 1978a). Nest attendance is highest during the peak of incubation in both species (Brooke 1978a; Scott 1970) so the likelihood of detecting breeding birds with playback was maximised by the timing of the survey.

The playback survey for both species followed the methods outlined in Gilbert *et al.* (1998a), using Sony TCM 50DV dictaphones played at full volume. For Storm-petrels, a male purr call recorded on Mousa, Shetland was used. In all habitats, the tape was played for 10 seconds and any responses elicited were noted. In boulder beach habitat, ropes were set 10 m apart along the width of the beach and the tape played at 2 m intervals along these ropes. The playback was therefore always within 1 m of any bird, and at this distance the response probability is similar to that if the playback were directly over the bird (Ratcliffe *et al.* 1998a). In all other habitats where potential nest entrances could be discerned (e.g. burrows or cracks in rocks) the tape was played at each of them. The unit of survey for Storm-petrel was the Apparently Occupied Site (AOS), defined as any cavity or burrow from which a bird responded to playback.

Manx Shearwaters were surveyed using a tape of both male and female calls (both contained within each 10 second loop) recorded on Skokholm. This was played for 10 seconds at all burrow entrances within the survey area and any responses were noted. The use of both male and female calls maximises the response likelihood as birds reply only to calls of the same sex (Brooke 1978b). The unit of survey for Manx Shearwaters was the Apparently Occupied Burrow (AOB), defined as any burrow from which a bird responded to playback.

Presence or absence of breeding Storm-petrels at sites where they had not been recorded previously was established using diurnal playback during incubation on the smaller islands. Larger islands with extensive tracts of habitat were visited overnight to listen for purr calls between 8 and 13 June when males are most vocal and few non-breeders are present (Scott 1970; Ratcliffe *et al.* 1998a). This is the most effective way to locate colonies on large islands quickly so they can be surveyed by playback later in the year (Ratcliffe *et al.* 1998b).

Data analysis Not all active nest sites are detected during a single playback survey because both parents may be absent or a bird may be present that fails to respond. Correction factors must therefore be applied to the total number of responses elicited to produce an accurate population estimate. The response rate on Annet in 1996 was 0.35 (Ratcliffe *et al.* 1998a) and the number of Storm-petrel responses were divided by this value in order to estimate population size. The lower and upper 95% confidence limits of the response rate were 0.252 and 0.448 respectively (derived from Ratcliffe *et al.* 1998a), and so the total number of responses were divided by these values in order to produce confidence intervals around the archipelago-wide population estimate. For Manx Shearwater the number of responses was multiplied by 1.08, which was derived from attendance data and response rates for both sexes presented in Brooke (1978a,b).

The surveys of both species on Annet were based on a combination of complete surveys of some areas or habitats and sampling of others. The number of AOSs or AOBs in areas or habitats that were surveyed completely were estimated by multiplying the total number of responses by the appropriate correction factor. Population estimates of the sampled areas necessitated estimating the mean and confidence limits of the densities within quadrats and extrapolating this to the total area of the habitat. The frequency distributions of AOS and AOB density were skewed, and this invalidated the arithmetic calculation of confidence intervals. Instead, a bootstrapping procedure (Westfall & Young 1993) was used to estimate the average density and the 95% confidence limits. The recorded density data were resampled with replacement (i.e. each value could be sampled more than once or not at all), until the sample

size equalled that of the original data set, and the mean of these values then calculated. This procedure was repeated 999 times to produce a frequency distribution of resampled mean values. The average of these was taken as the measure of central tendency and the 2.5 and 97.5 percentiles as the lower and upper 95% confidence intervals respectively.

For the Storm-petrels in burrow habitats on Annet, only the strata along the coast contained AOSs. The length of the island perimeter in metres was calculated using a Geographical Information System, and the length of the boulder beaches subtracted because burrows behind those were surveyed completely. This length was multiplied by 10, as sampling was conducted within 10x10 m quadrats to determine the area of the strata sampled. This area was multiplied by the mean and confidence limits of the density estimate. These were corrected for response rate and added to the survey total for boulder beaches to arrive at the final population estimate for the island.

Densities of Manx Shearwater burrows on Annet were analysed and extrapolated in four strata: the east coast, which was surveyed completely; the cliff overhang along the east coast cliffs that was not safe to survey; the remainder of the coast; and the interior of the island. No AOBs were located in the island's interior, so this was excluded from further calculations. A single AOB was found in the 27 quadrats along the coastal strip away from the east coast and these data were bootstrapped to produce 999 resampled means. The number of AOBs along the cliff top was estimated by calculating 999 resampled mean densities from the 76 10x10 m quadrats surveyed along the east coast. Of the AOBs found here, 70% were in overhang habitats similar to those along the cliff top, and the remainder were in the flat ground within the 10x10 m quadrat. As the flat thrift-covered ground along the cliff top had already been surveyed, the resampled mean was multiplied by 0.70 to exclude birds that had already been counted.

To combine the overall mean and confidence limits, each of the 999 resampled means for the coastal strip was multiplied by the area of this stratum and those for the cliff top were multiplied by the length. Both were then divided by the response rate. The bootstrapped population means were then added together pairwise in random order. The mean and percentiles were calculated to produce a population estimate with confidence intervals and this was added to the total counted in the complete survey of the east coast.

RESULTS

Eleven Storm-petrel colonies were located in the Isles of Scilly; the estimated breeding population of each is shown in Table 1. A further 17 sites were surveyed but no evidence of breeding was found (Table 2). The main Storm-

Table 1. The number of European Storm-petrel diurnal playback responses and AOSs on each of the Isles of Scilly that held breeding birds.

Tabel 1. Het aantal antwoorden van Stormvogeltjes op overdag afgespeelde roep en het aantal blijkbaar bezette nestplaatsen (AOS) op de afzonderlijke Scilly Eilanden, waar Stormvogeltjes broeden.

Island site	Number of responses	AOS
Illiswilgig	1	3
Scilly Rock	5	14
Castle Bryher	6	17
Mincarlo	6	17
Men-a-vaur	7	20
Rosevean	13	37
Gorregan	17	49
Rosevear	20	57
Melledgan	49	140
Round Island	64	183
Annet	281 (see text)	938

petrel nesting habitat at most of these colonies was cavities in boulder beaches, with a few birds nesting in deep cracks in rock behind boulder piles (most notably on Men-a-Vaur). On Round Island, boulder beach was absent; 10 of the responses came from old stone walls, two from holes in the walls of the lighthouse and the remainder were in scree.

The boulder beaches on Annet produced a total of 276 responses, equating to 789 AOSs. The few cairns and rocky outcrops produced a further six responses. No responses were obtained from any of the 13 sample quadrats searched in the interior as this was generally unsuitable as nesting habitat, being covered with either thick bracken that was occupied by breeding gulls or thrift containing very few burrows.

For the sample quadrats searched along the coast of Annet, the mean bootstrapped count of burrow-nesting Storm-petrels per 10x10 m square was 0.1889 (lower 95% confidence limit (LCI) = 0.0095, upper 95% confidence limit (UCI) = 0.3683). The island perimeter was estimated at 3 986 m, with 2 752 m of this free of boulder beach. Extrapolating the bootstrapped AOSs density to this 27 520 m² strip returns an estimated total of 149 AOS (LCI = 8, UCI = 290). Combining this with the corrected population count for boulder beaches gives an estimated breeding population on Annet of 938 AOSs (LCI = 797, UCI = 1 079). Adding this figure to the sum totals found at other islands returns an estimated population of 1 475 (LCI = 1 055, UCI = 2 268) Storm-petrel AOSs in the Isles of Scilly in 2000.

Table 2. Isles of Scilly surveyed in 2000 at which no European Storm-petrel AOSs were found (no birds heard calling at night or no response to diurnal playback of call). Tabel 2. Scilly Eilanden die in 2000 zijn geïnventariseerd, waar geen blijkbaar bezette nestplaatsen (AOS) van Stormvogeltje werden gevonden (geen vogels gehoord die 's nachts riepen of antwoordden op overdag afgespeelde roep).

Island site	Past presence?	Day/Night?
Daymark, St. Martin's	Yes ⁴	Day
Great Crebawethan	Yes ³	Day
Great Ganilly	Not checked	Day
Gugh	Yes ¹ 1943, ² 50 pairs 1974	Night
Gweal	Not checked	Day
Innisvouls	Not checked	Day
Maiden Bower	Not checked	Day
Menawethan	No ⁴	Day
Nornour	Not checked	Day
Norwethel	Not checked	Night
Puffin Island	Not checked	Day
Samson	Not checked	Night
Seal Rock	Not checked	Day
St. Agnes	Yes ² 50 pairs 1974	Night
St. Helen's	Not checked	Night
Tean	Not checked	Night
White Island, St. Martin's	Not checked	Day

¹Penhalluric (1969), ²Allen (1977), ³Lloyd *et al.* (1991), ⁴Robinson (1999).

Manx Shearwaters were found to be nesting on six of the islands in the Scilly archipelago; the numbers found at each is presented in Table 3. Eight others were checked for presence of AOBs but none were found (Table 4). On St. Helens, St. Agnes, Gugh and Bryher, birds were discovered breeding in burrows among rocky outcrops and at the edges of grassy slopes along the coast. On Round Island AOBs were recorded only in three gullies that held sufficiently deep turf to allow burrow excavation.

A total of 72 responses was elicited along the east coast of Annet. These were all from burrows and the majority (70%) were in the eroded, bare soil under overhanging vegetation at the very edge of the island. The others were mostly under tussocks of thrift within 2 m of the coastline, although some burrows were located slightly further inland in both bracken and long grass. No responses were elicited from the plots in the interior of the island. The combined bootstrapped estimate within the 10 m wide coastal strip away from the east coast and under the cliff overhang was 41 AOBs (LCI = 26, UCI = 56).

Combining the data for all six colonies results in a total estimated breeding population of 201 Manx Shearwater AOBs (LCI = 185, UCI = 217).

DISCUSSION

The total breeding population of Storm-petrels was estimated to be 1 475 AOSs. Previous estimates of the breeding population on Scilly range from as low as 500 pairs in 1987 (Lloyd *et al.* 1991) to over 1 900 pairs in 1974 (Allen 1977) and as many as 9 811 – 17 390 pairs in 1999 (Robinson 1999). However, these counts are not comparable to this survey, as they were based on guesses and rates of trapping in mist nets, and cannot be used to interpret trends. The numbers of birds recorded in this survey represent 1-7% of the British breeding population based on the totals in Lloyd *et al.* (1991). However, the British totals are based largely on guesswork and so the true importance of the Storm-petrel in the Scilly Isles can be confidently established only once playback surveys from other colonies in Britain are analysed. However, the Isles of Scilly is certainly the only known breeding locality of the Storm-petrel in England and probably hold over 1% of the UK population of this Annex 1 listed species; if so, the islands would thus qualify for Special Protection Area status.

The total breeding population of the Manx Shearwater on Scilly was estimated to be 201 pairs. This is considerably lower than previous population estimates, which range from 900 pairs in 1974 (Allen 1977) to 375-530+ pairs in 1977 (Harvey 1983) and 500-700 pairs in 1999 (Robinson 1999). Harvey (1983) reported that the population on Annet declined from 800-900 to 350-500 pairs and suspected that predation by the expanding gull population was to blame. This survey recorded an even lower total of 123 AOBs. Harvey (1983) also recorded 224 occupied burrows on Round Island, which is far higher than the total of 32 AOBs recorded there in this study. Although these could represent population declines, the differences in methodology among surveys prevent this conclusion being drawn unequivocally. Previous surveys did not deploy playback to confirm burrow occupation by Manx Shearwaters and so empty burrows or those occupied by non-breeders, rabbits *Oryctolagus cuniculus* and Atlantic Puffins *Fratercula arctica* (both the latter occur on Annet, but neither on Round Island) could have been included in the totals. These would not have been included in this survey so this could explain the apparent decline in population size.

The estimated breeding population of Manx Shearwaters in Britain during 1985 was 220 000-250 000 pairs (Lloyd *et al.* 1991), so the numbers on Scilly are not of importance in a UK context. However, the Isles of Scilly are important for Manx Shearwaters in an English context since the only other

Table 3. Number of Manx Shearwater diurnal playback responses and AOBs at each of the Isles of Scilly that held breeding birds.

Tabel 3. Het aantal antwoorden van Noordse Pijlstormvogels op overdag afgespeelde roep en het aantal blijkbaar bezette holen (AOB) op de afzonderlijke Scilly Eilanden, waar Noordse Pijlstormvogels broeden.

Island site	Number of responses	AOBs
St. Helen's	5	5
Wingletang, St. Agnes	5	5
Shipman Head, Bryher	11	12
Gugh	20	22
Round Island	32	34
Annet	73 (see text)	123

Table 4. Isles of Scilly checked with no evidence of Manx Shearwater breeding presence (no birds heard calling at night or no response to diurnal playback of call).

Tabel 4. Scilly Eilanden zonder bewijs van de aanwezigheid van broedende Noordse Pijlstormvogels (geen vogels gehoord die 's nachts riepen of antwoadden op overdag afgespeelde roep).

Island site	Past presence?	Day/Night?
Burnt Island, St. Agnes	Not checked	Day
Daymark, St. Martin's	Not checked	Day
White Island, St. Martin's	Not checked	Day
Teian	Not checked	Both
Samson	Not checked	Both
Tresco, North End	Yes ¹ 1945	Day
Norwethel	Not checked	Both
Gweal	Not checked	Day

¹Penhalluric (1969).

breeding locality in the country is Lundy, where an estimated 1 200 pairs breed (Taylor 1985).

The distributions of the breeding colonies of both Storm-petrels and Manx Shearwaters generally accorded with previous information for the archipelago. No previously undocumented Storm-petrel colonies were found, but several sites that were believed to hold breeding birds in the past did not during this survey (Allen 1977; Robinson 1999). Some of these sites were headlands of inhabited islands and the presence of breeding birds at most sites was inferred from captures of birds in mist nets using tape lures (Robinson 1999). It is well-known that this method captures birds at sites where none breed (Maguire *et al.* 1980; Furness and Baillie 1981; Fowler *et al.* 1982, 1986; Fowler & Okill 1988; Harris *et al.* 1998), and given that the headlands and islands were frequented by rats or feral cats it seems unlikely that Storm-petrel

Table 5. The status of mammalian predators on selected Isles of Scilly during the 1990s and action taken to remove them (D. Moore pers. comm.).

Tabel 5. De status van zoogdierpredatoren op geselecteerde Scilly Eilanden in de jaren negentig en actie die is ondernomen om deze zoogdieren te verwijderen (D. Moore pers. med).

Island Site	Predators	Action
Great & Little Arthur	Rats	None
Great & Little Ganinick	Rats	None
Grt. & Little Innisvoulis	Rats	Failed eradication attempt
Grt. Ganilly & Normour	Rats	None
Guthier's Island	Rats	Apparently successful eradication
Gweal	Rats	Apparently successful eradication
Little Ganilly	Rats	None
Menawethan	Rats	None
Norwethel	Rats	Apparently successful eradication
Puffin Island	Rats	Apparently successful eradication
Ragged Island	Rats	Apparently successful eradication
Samson	Rats and cats	Successful eradication
White Island, Samson	Rats and cats	Successful eradication
St. Helen's	Rats	Apparently successful eradication
Teian	Rats	None

colonies would persist there. Great Crebawethan was the only predator-free site previously reported as a breeding site (Lloyd *et al.* 1991) and that was not occupied in this survey. The island is so low-lying that it can be inundated by large swells, so nesting attempts could be flooded and abandoned in some years. The only Manx Shearwater breeding locality previously reported that was not confirmed in this survey was the north end of Tresco, and it is possible that mammalian predation has extirpated this small colony. A previously undocumented colony was found on the island of St. Helen's.

No island in the archipelago supported both rats and Storm-petrels during this survey. Small petrels are known to be very vulnerable to rat predation (Moors & Atkinson 1984) and the introduction of rats to islands generally produces rapid extirpation of breeding Storm-petrels. The conservation of Storm-petrels on the Isles of Scilly is dependent on preventing rats colonising those islands where they currently breed. This is particularly true of Annet and Round Island, where most of the Scilly population nest, and which have sufficient alternative sources of food to support a viable rat population over winter. Monitoring the continued absence of rats at these colonies and developing plans for their eradication should they colonise are essential to prevent potentially large declines. The other main colonies on the Western and

Northern Rocks have little or no vegetation and are washed over by winter storms, and are unlikely to sustain a rat population even if they were colonised.

Rats may limit the population size of Storm-petrels on the Isles of Scilly by rendering large areas of nesting habitat unsuitable for breeding. Many of the islands that host rats have large areas of boulder beach that are apparently suitable for breeding Storm-petrels. The Isles of Scilly Environmental Trust and the Isles of Scilly Seabird Group have conducted eradication work on several islands in the archipelago (Table 5). The colonisation of restored islands could arise through redistribution rather than population increase, and so the success of these projects needs to be assessed at the scale of the whole archipelago rather than at individual islands.

Small colonies of Manx Shearwaters breed on islands where both rats and cats are present (St. Agnes, Gugh and Bryher). Predation on eggs and chicks could be causing a chronic, long-term decline at these colonies. Rat predation caused the extirpation of the large colony on the Calf of Man (Brooke 1990) and has been associated with reduced productivity and population declines on Rum and Canna (Thompson *et al.* 1997, 1998; Upton *et al.* 2000). Maintaining or increasing the populations of Manx Shearwaters at these sites will depend on targeted control programmes around the colony during the breeding season as eradication on large and inhabited islands is generally impractical.

Gull predation is a potential threat to both Storm-petrels and Manx Shearwaters breeding on the Isles of Scilly. Harvey (1983) suggested that declines in Manx Shearwater populations on Annet could be due to gull predation. The remains of Manx Shearwaters that had been killed by gulls and gull pellets containing Storm-petrel feathers and bones were found on Annet, but the population level effects of this predation are unknown. Bioenergetic studies of the number of petrels that are consumed by gulls annually (Phillips *et al.* 1999) and modelling of the likely effects of this on the population are advisable.

Another predator recently introduced to the Isles of Scilly is the hedgehog *Erinaceus europaeus*. The adverse impacts of introduced hedgehogs on ground nesting birds has been documented (Jackson & Green 2000), and it is possible that they could also prey on burrow nesting birds where these are accessible. At present, hedgehogs have been recorded only on St. Mary's and although it may be too daunting a task to eradicate them from such a large island, it is vital that they are prevented from establishing elsewhere in the archipelago.

STATUS EN VERSPREIDING VAN STORMVOGELTJE *HYDROBATES PELAGICUS* EN
NOORDSE PIJLSTORMVOGEL *PUFFINUS PUFFINUS* OP DE SCILLY EILANDEN

Dit artikel beschrijft de resultaten van de eerste uitgebreide inventarisatie naar de verspreiding en aantallen van broedende Stormvogeltjes en Noordse Pijlstormvogels op de Scilly Eilanden. Eilanden, waar uit het verleden meldingen van broedende vogels bekend zijn, werden geïnventariseerd door het overdag afspelen van respectievelijk de mannelijke putt-roep van Stormvogeltje en de roep van mannelijke en vrouwelijke Noordse Pijlstormvogels. Deze methode werd tevens gebruikt om andere eilanden met geschikt habitat te inventariseren. De totale broedpopulatie van Stormvogeltje bedroeg 1475 blijkbaar bezette nestplaatsen (AOS, gedefinieerd als iedere holte waaruit gereageerd werd op het afspelen van de roep) in 11 kolonies (tabel 1). Op 17 onderzochte eilanden werden geen Stormvogeltjes aangetroffen (tabel 2). De totale broedpopulatie van Noordse Pijlstormvogel bedroeg 201 blijkbaar bezette nestholten (AOB) verdeeld over zes eilanden (tabel 3). Voor beide soorten zijn deze aantallen van regionaal belang. De aantallen Stormvogeltjes zijn bovendien van internationaal belang. De verspreiding van broedende Stormvogeltjes was beperkt tot de ratvrije eilanden. De bescherming van Stormvogeltje op de Scilly Eilanden is gericht op het voorkomen dat ratten deze ratvrije eilanden koloniseren. Sommige kolonies van Noordse Pijlstormvogel werden gevonden op eilanden met ratten en verwilderde katten. Bescherming van de Noordse Pijlstormvogel is gericht op het gedurende het broedseizoen binnen de perken houden van predatoren rond de kolonies. De invloed van predatie door meeuwen op de populaties van beide stormvogels zou in kaart gebracht moeten worden. De egel tenslotte is een recent geïntroduceerde predator, waarvan uitbreiding voorkomen dient te worden.

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