Technical Report for Isles of Scilly Seabird Recovery Project:

Breeding Landbird Survey 2013-2016

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Summary

A breeding bird survey of St Agnes and Gugh was carried out in 2013, 2014 and 2015 using staff and volunteers. The island of Bryher was used as a control to determine whether eradication was contributing to any changes in the landbird abundance. Landbird populations in the Isles of Scilly are well understood (Chown & Lock 2002, Flood et al 2007, Dawson 2012) as is the phenology of breeding (Dawson 2012) which is useful when considering land management interventions and monitoring.

Island Restoration Projects may impact on landbirds in ways that are deleterious, such as risk of non-target poisoning, or potentially beneficial, such as reduced predation and improved food availability. Monitoring indicated no significant effect of the eradication project on landbird abundance on St Agnes and Gugh, compared to the control site Bryher. There may be a number of reasons for this which are discussed further.

The following recommendations are made:

- Studies of this type should be carried out by dedicated, experienced observers. These may be volunteers, trained staff or contractors.
- Studies of abundance may need to be carried out over a longer time period to pick up any trends associated with removal.
- Work should take into account understanding of breeding landbird numbers and phenology.
- If resource allows, it may be better to focus efforts on particular species and include studies looking at productivity. On similar islands in the UK this could include rock pipit, wheatear and potentially wren.

1 Introduction

This landbird survey forms part of the wider ecological monitoring carried out as part of the Isles of Scilly Seabird Recovery Project (IOSSRP) and helps deliver the A4 and D3 actions within the project, as set out in the LIFE Nature application and detailed below in the Objectives.

The IOSSRP was specifically set up to remove known threats to burrow nesting seabirds such as Manx shearwater and storm petrel. The monitoring of seabirds is dealt with by target species surveys carried out by RSPB and the IOSSRP team (Heaney and St Pierre. 2017). There have been very few eradication projects that have carried out surveys pre- and post-eradication for other taxa so this will provide useful information for future projects.

The aim of the survey was to provide a pre-eradication baseline followed by post-eradication surveys to determine whether there were any observed changes in the abundance of selected landbirds. The report includes a number of recommendations based on the project's experiences.

2 Objectives

The survey had the following objectives:

- Carry out pre-removal surveys of wider taxa (A4) – landbirds.
- Carry out post eradication monitoring of wider taxa to assess any changes in abundance (D3) – landbirds.
- To provide recommendations for future projects that wish to include wider monitoring of non-target taxa within the objectives for an eradication project.

3 Methods

3.1 Survey area

Appendix 1, Map 1-3 shows the boundary of the survey area. Bryher was included as a control site with similar geography to St Agnes and Gugh.

3.2 Selected species

All birds (except seabirds and water birds) were recorded as part of the survey.

3.3 Breeding bird survey methods

The survey methodology used was the Breeding Bird Survey (BBS) method designed by the BTO (www.bto.org BBS, Gilbert et al. 1998) and was set up by Spalding Associates with advice from IOSSRP and RSPB staff (Spalding Associates, 2013). The recording form is reproduced in Appendix 1. The routes taken are marked on maps in Appendix 1. Staff or volunteers recorded the distance the birds were from the route in each 200m section of the route by placing their BTO species code into the relevant distance band with category. To improve the data quality an additional distance band was included (100-250m and 250m+ instead of 100m+) and in line with the new BBS methodology option, recording the detection method for each individual (i.e. whether initially seen, heard by its song or heard by its call).

3.4 Access

The islands are managed partly by the Isles of Scilly Wildlife Trust and partly by tenants of the Duchy of Cornwall. Permission was provided by the relevant landowners. The routes followed existing paths and generally avoided land not accessible to the public as much as possible to reduce problems with future access issues.

3.5 Coverage of survey area

The survey was carried out by a range of volunteers over a four-year period (three survey years) and covered the entire site to ensure adequate coverage of all habitats.

3.6 Data analysis

We explored trends for the seven most abundant species in the dataset (24 species in total): wren (n=1550), blackbird (n=840), song thrush (n=532), linnet (n=500), starling (n=465), dunnock (n=380), and rock pipit (n=285); where n= the total number of birds recorded over the three years of surveys (excluding birds in flight) on all islands. These species represented 82% of all registrations.

Analyses of bird trends were conducted in the software package R 3.4.1 (R Development Core Team 2017) using Generalised Linear Mixed Models (GLMMs) with Poisson error distributions and transect section as a random factor to control for repeat surveys of the same section. In addition to having year and eradication (whether rat had been eradicated on the island) as single terms in the model, they were included as an interaction (year*eradication) to highlight whether trends on eradicated islands

were significantly different to the control. The interaction was removed, and the model rerun, if the interaction was not significant ($P<0.05$). Due to variation in the timing/number of visits undertaken across years, start times and effort (see supplementary table), these terms were added as fixed effects in the models.

model <- glmer(count ~ year*eradication + april_day + start_after_sunrise + effort + (1|section), family=poisson, data=scilly,

where:

- Response variable= Species counts in individual survey sections over time. Sections were only included if the species was present on at least one visit in either of the 3 years (2013, 2014 or 2016).
- Effort= average time spent per section on a visit by visit basis (e.g. total duration/number of sections surveyed).
- April day = days from the 1st April
- Start time = hours after sunrise survey started

The table of visits used in this analysis is in Appendix 2.

4 Results

The following section outlines the model outputs for each species, and a description of the results.

Wren

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.606455	0.215637	2.812	0.00492 **
Year	-0.045105	0.028289	-1.594	0.11084
Eradication	0.265513	0.145065	1.830	0.06721 .
April day	0.003183	0.001017	3.130	0.00175 **
Start time	-0.046144	0.008818	-5.233	1.67e-07 ***
Effort	15.909290	14.650192	1.086	0.27750

No significant effect of year (e.g. trend over time). Near significant positive difference between counts on St Agnes and Gugh (Eradication) when compared to Bryher (Control)

Blackbird

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.221603	0.306794	0.722	0.470098
Year	-0.073151	0.039210 `	-1.866	0.062095 .
Eradication	-0.289303	0.192305	-1.504	0.132479
April day	0.005109	0.001446	3.534	0.000409 ***
Start time	-0.016005	0.012765	-1.254	0.209913
Effort	23.700386	22.272802	1.064	0.287285

No significant difference between section counts on island where eradication has taken place (St Agnes and Gugh) and the control (Bryher), but a near significant negative relationship between count and year (e.g. decline in the number recorded across all islands).

Song thrush

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.964184	0.393187	-2.452	0.01420 *
Year	-0.006766	0.049658	-0.136	0.89162
Eradication	-0.050531	0.261736	-0.193	0.84691
April day	0.008688	0.001800	4.827	1.39e-06 ***
Start time	-0.057586	0.019141	-3.009	0.00262 **
Effort	48.025413	26.905557	1.785	0.07427.

No significant effects of year or eradication/control on section counts.

Linnet

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-2.189571	0.391096	-5.599	2.16e-08 ***
Year	0.238415	0.050608	4.711	2.46e-06 ***
Eradication	-0.189432	0.226138	-0.838	0.402
April day	0.009627	0.001847	5.213	1.86e-07 ***
Start time	0.001418	0.015025	0.094	0.925
Effort	20.536764	26.481928	0.776	0.438

Final P value for Year (extracted by comparing models using an ANOVA)= 2.733e-06

The model outputs showed that there was a significant positive relationship between Linnet counts and year (they increased over time), but the trend was not significantly different between islands where rat had been eradicated (St Agnes and Gugh) and the control (Bryher).

Starling

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-2.156e+00	4.814e-01	-4.479	7.48e-06 ***
Year	4.429e-01	6.894e-02	6.424	1.33e-10 ***
Eradication	1.158e+00	4.902e-01	2.363	0.0181 *
April Day	3.793e-04	1.932e-03	0.196	0.8444
Start Time	6.818e-02	2.289e-02	2.979	0.0029 **
Effort	-5.404e+01	3.028e+01	-1.785	0.0743.
Year*Eradication	-3.945e-01	7.826e-02	-5.041	4.64e-07 ***

The model outputs show that there was a significant interaction between year and eradication for Starling counts (e.g. a significant difference between trends on eradicated islands (St Agnes and Gugh) and the control (Bryher)). Further exploration shows a significant positive trend on Bryher (increase over time, slope= 5.301e-01, P=1.022e-09) and a non-significant trend on the eradicated islands.

Dunnock

Fixed effects:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.612199	0.400395	-4.027	5.66e-05 ***
Year	0.166251	0.056874	2.923	0.00347 **
Eradication	0.168640	0.202168	0.834	0.40419
April day	-0.002426	0.001954	-1.242	0.21427
Start time	-0.017757	0.018540	-0.958	0.33820
Effort	22.238368	29.181391	0.762	0.44602

Final P value for Year (extracted by comparing models using an ANOVA) = 0.003681

The model outputs showed that there was a significant positive relationship between Dunnock counts and year (positive trend over time), but the trend was not significantly different between islands where rat had been eradicated (St Agnes and Gugh) and the control (Bryher).

Rock pipit

Fixed effects:

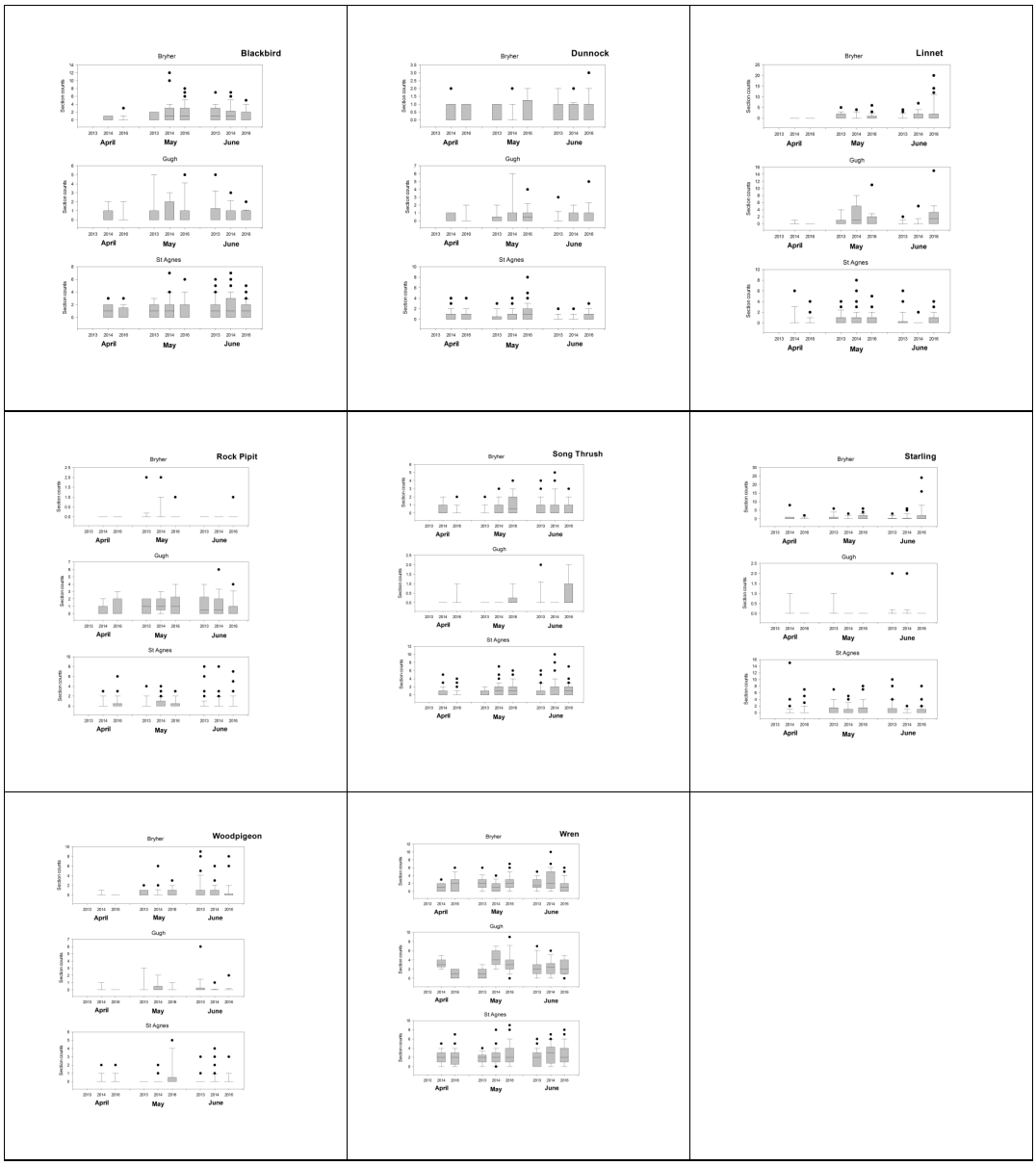
	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-2.920391	0.646952	-4.514	6.36e-06 ***
Year	0.105447	0.070066	1.505	0.13233
Eradication	1.621140	0.542669	2.987	0.00281 **
April Day	0.001463	0.001443	1.014	0.31075
Start time	0.031032	0.015115	2.053	0.04007 *
Effort	12.695804	29.422259	0.432	0.66610

The model outputs showed no significant relationship between count and year (no significant trend over time), but counts on eradicated islands (St Agnes and Gugh) were significantly higher when compared to the control (Bryher).

Final P value for Eradicated islands (extracted by comparing models using an ANOVA)=0.004002

Box plots showing section counts for the eight most abundant species across the three years, are shown below in Figure 1.

Figure 1. Box plots showing section counts (excluding those just recorded in flight) for blackbird, dunnock, linnet, rock pipit, song thrush, starling, wood pigeon and wren across the three years, split down in the individual months and islands. **The boundary of the box closest to zero indicates the 25th percentile, a line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Whiskers (error bars) above and below the box indicate the 90th and 10th percentiles. The dots are outliers.**



4.1 Confidential data

All confidential data has been archived at the RSPB South West England Office in Exeter. A copy of this report has been placed on the IOSSRP website alongside other reports on ecological monitoring.

4.2 Archive

All raw data and field recording forms are archived at RSPB Exeter.

5 Discussion and conclusions

This report provides the findings of three years of landbird surveys on St Agnes, Gugh and Bryher between 2013 and 2016. The purpose of the survey was to assess whether there were any measurable changes to the landbird populations that could be attributed to the removal of rats, by carrying out surveys pre and post removal. However, no relationship was found. There are a number of potential factors for this which are discussed below.

5.1 Survey limitations

It was felt that local landbird ecology and survey design and delivery had an impact on the ability to detect changes in abundance during this survey on the Isles of Scilly. These factors include:

- The small size of the islands, even with high local densities of several landbird species.
- Non standardised start times, dates, efforts and recorder, and a relatively late start date in the baseline year reduced the sample sizes for statistical analysis.
- Statistically significant changes in landbird abundance as a result of removal of brown rats may not be detected over the four year period of the surveys. For the Isles of Scilly this is exacerbated by landbird densities often much higher than elsewhere, that are subject to high year-to-year variation.

5.2 Other environmental factors

Potential confounding effects on landbird populations during the survey period include the impact of an increase in rabbit numbers, affecting vegetation and invertebrate populations, and nest predation rates by carrion crows, as well as:

- Substantial changes in land management during the period. Socio-economic factors resulting in changes on even a small number of farms may have a substantial impact, especially as these are habitats of high landbird density.
- Programmes of scrub removal in semi-natural habitats (linked with environmental stewardship schemes) that reduced the available habitat for scrub-nesting species (though may have helped boost invertebrate numbers and diversity).

Potential impacts of eradications on landbirds

A range of potential impacts of eradications have been identified including poisoning of non-target species (-), changes in adult survival and breeding success (+), and changes in competition resulting in changes in food availability (+/-). These are discussed below.

Poisoning

During eradication using poison bait there is a potential threat of poisoning to a variety of species of birds, particularly via secondary poisoning. This includes crows, owls, and birds of prey which may feed on dead or dying rats. Of these, only carrion crow regularly breeds on St Agnes and Gugh (c.5 pairs) and there are no non-breeding flocks of this species as recorded on several other islands during the period. However, access to the bait is physically restricted by the use of tunnels in which bait is placed. During eradications very few dead or dying rats are found on the surface as most animals retreat to burrows where they expire out of reach of the birds at risk. On St Agnes and Gugh daily

monitoring of bait stations included checking for dead or dying rats, and bird carcasses. Only 18 such rats were found and removed immediately. Of bird carcasses found, none were the result of poisoning. Thus the mitigation measures were considered effective.

Slugs and snails frequently enter bait stations and eat bait. As their blood system is different they are not affected by the poison, but it is possible that birds (such as thrushes) that ingested a slug or snail that has fed on bait could suffer secondary poisoning as a result. The daily checks of bait stations included the removal of molluscs which had consumed the bait and their disposal along with any spoilt bait. None were recorded outside the boxes and no bird carcasses were found that indicated secondary poisoning by this route. The mitigation measures were considered effective.

The analysis from the bird surveys seem to support this with no negative relationship found between the eradication and population changes for song thrush and blackbirds for the islands baited when compared to Bryher. The data for carrion crow were too few to use in this analysis.

Predation

The impact of rat predation on a range of endemic and non-endemic seabird species on isolated islands across the world is well documented including the eating of eggs, chicks and adults (Jones et al, 2008). In the UK the impact has been demonstrated for a number of burrow-nesting seabirds e.g. storm petrel and Manx shearwater from sites such as the Calf of Man, Canna, Lundy and Ramsey Island (Mitchell et al. 2004). However there is only limited evidence of how rat eradications may affect landbirds in the UK (Morgan, 2012) which currently co-exist with rats across their range, as studies have not been routinely carried out previously elsewhere. It should be stated that there are no endemic landbirds in the Isles of Scilly, but a number of species on the 'Red List' of birds of conservation concern are strongly represented (Dawson 2012).

Landbirds frequently have breeding strategies that include large clutch sizes or multiple broods reared per year. This helps offset high mortality rates that occur in the first year, and thereby over time sustains their populations (depending on other factors). It is conceivable that if rats were a significant cause of juvenile mortality, or if rats reduced food levels to such an extent that adult survival was reduced, or adult condition resulted in smaller clutches or fewer broods, a response within the project period may have been detected. No relationship was found during the analysis to indicate that either direct rat predation or significant indirect effects were suppressing landbird populations. Some of the commonest landbird species on the Isles of Scilly rear one or two broods in a season compared with three or four that they would be expected to rear on the mainland. However, this appears to be in response to seasonal limitations of food availability and not predation; as a consequence there may be greater investment in adult longevity. It is recognised that because of the existence of a number of confounding factors, more subtle impacts of brown rat removal on landbird numbers may require a longer period of monitoring to detect any significant changes. It is also of interest to see whether any colonisations occur. A potential colonist is the wheatear, a ground-nesting bird that breeds nearby along the Cornish coastline, yet breeds only erratically in Scilly.

Changes in competition for food

Globally various invasive non-native species have been identified as threatening native birds through competition for food. An example of this is the common and German wasps in New Zealand which are thought to be out competing the Kaka, Tui and Bellbird for honeydew from native trees (Elliott et al. 2010) over at least some of their range.

Rats are omnivorous, feeding on a wide range of food sources and successfully competing against a range of species for that food. An estimated population of 3,100 animals prior to removal (Bell 2012) was thought to represent potential competition for food for landbirds. Because of the complexities of food webs this could have a range of outcomes. This could simply result in more food becoming available for particular birds that are competing directly for the same food as rats. Alternatively there may be indirect impacts, for example through vegetation changes influencing seed availability or prey

invertebrate numbers, and/or increased competition owing to population increases of other species suppressed by rats, such as the Scilly shrew.

No significant relationship was found between landbird trends and rat removal. As the landbirds in the study co-exist with rats on the mainland it is likely that other drivers, such as habitat change (land management), food availability, presence of competitors and weather/climate impacts, will be similar to those experienced on the Isles of Scilly, although these drivers may be more pronounced on islands.

6 Monitoring recommendations for other projects

- Take account of all local information for the site to inform an appropriate, robust survey method (with a suitable control site if possible) with the survey performed in a timely manner.

- Unless annual monitoring is required for rare, endemic species, for widespread, common landbird species repeat the survey once every five years for a period of up to 25 years.

- Experienced volunteers (or paid staff/contractors) with a high level of expertise are essential. This is because of the skills required and discipline to minimise variance between observers. There is, however, a valuable outreach role to engage with a local community to demonstrate what is being done, how and why, and potentially deliver training. If there are relatively few species and there is sufficient time to properly train local volunteers who already have some familiarity with habitats and species, this option could be included.

- Consider focusing future eradication landbird studies on selected species and their productivity, especially on small sites. In some cases for rare, endemic species this may already be done, but it remains an option for more widespread species and may include indirect methods, such as mark-recapture.

7 Funding

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www.HLF.org

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Appendix 1

St Agnes and Gugh Breeding Bird Survey:

Recording form for surveyors

Goldfinch e.g.

Species Code: GO

1st detected by:

Sight = GO× Song = (GO) Call = GO

If in flight mark = broken arrow over sp. code

(GO)

(Male goldfinch 1st detected by song in flight)

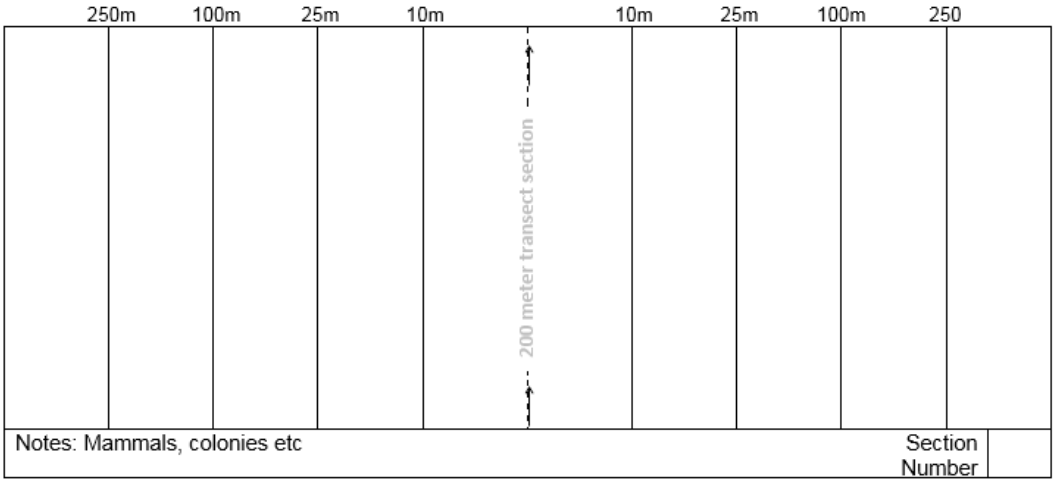
THE ISLES OF SCILLY SEABIRD RECOVERY PROJECT

rspb giving nature a home

BREEDING BIRD SURVEY - FIELD RECORDING SHEET

PLEASE USE BLOCK CAPITALS

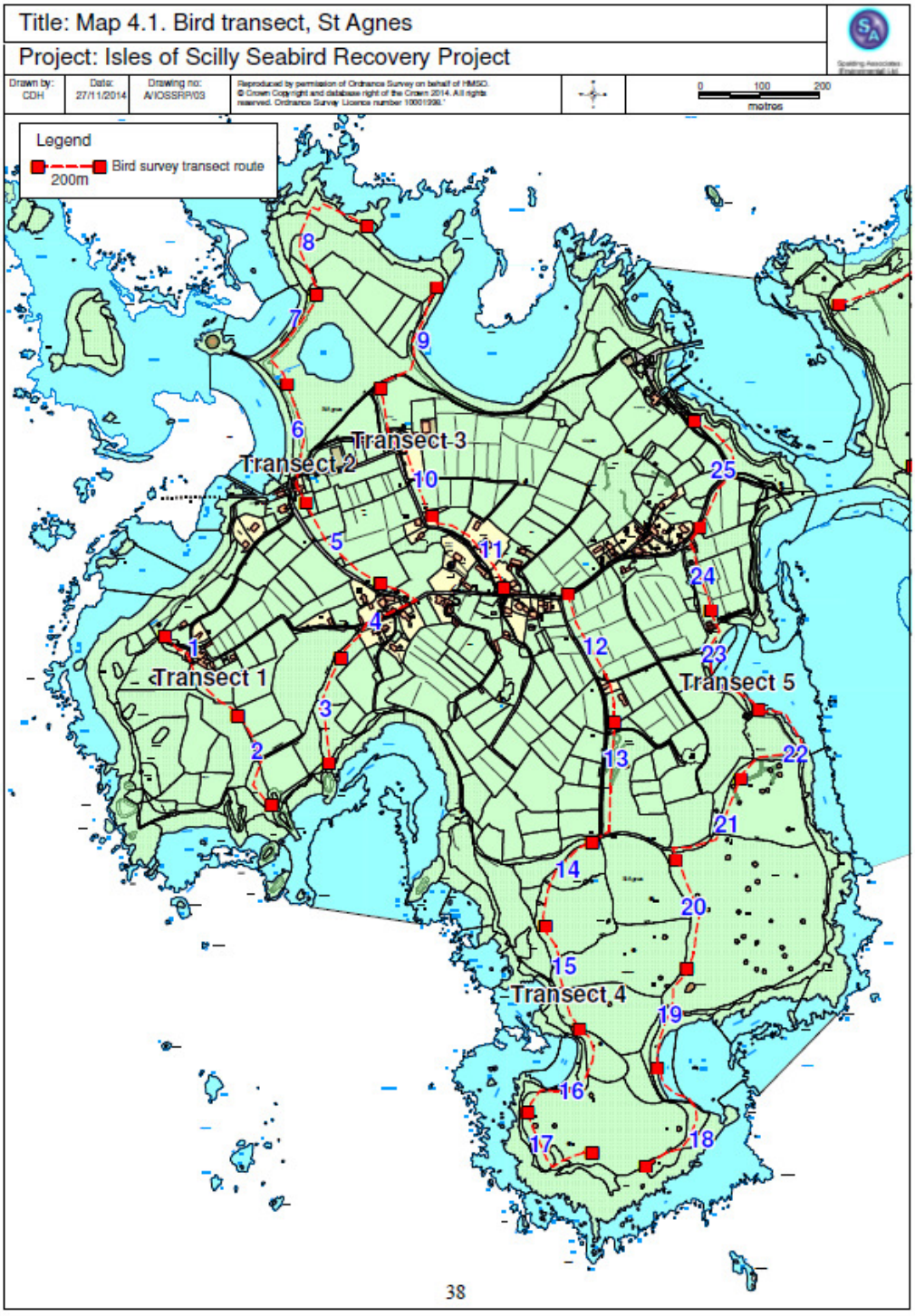
Observer Name					Visit E=before 16 May or L=on/after 16 May	E / L
Site					Start time	
Visit Date					Finish time	
Weather	Cloud	Rain	Wind	Visibility	Sheet number	-·- / -·-
0 low to 3 high						

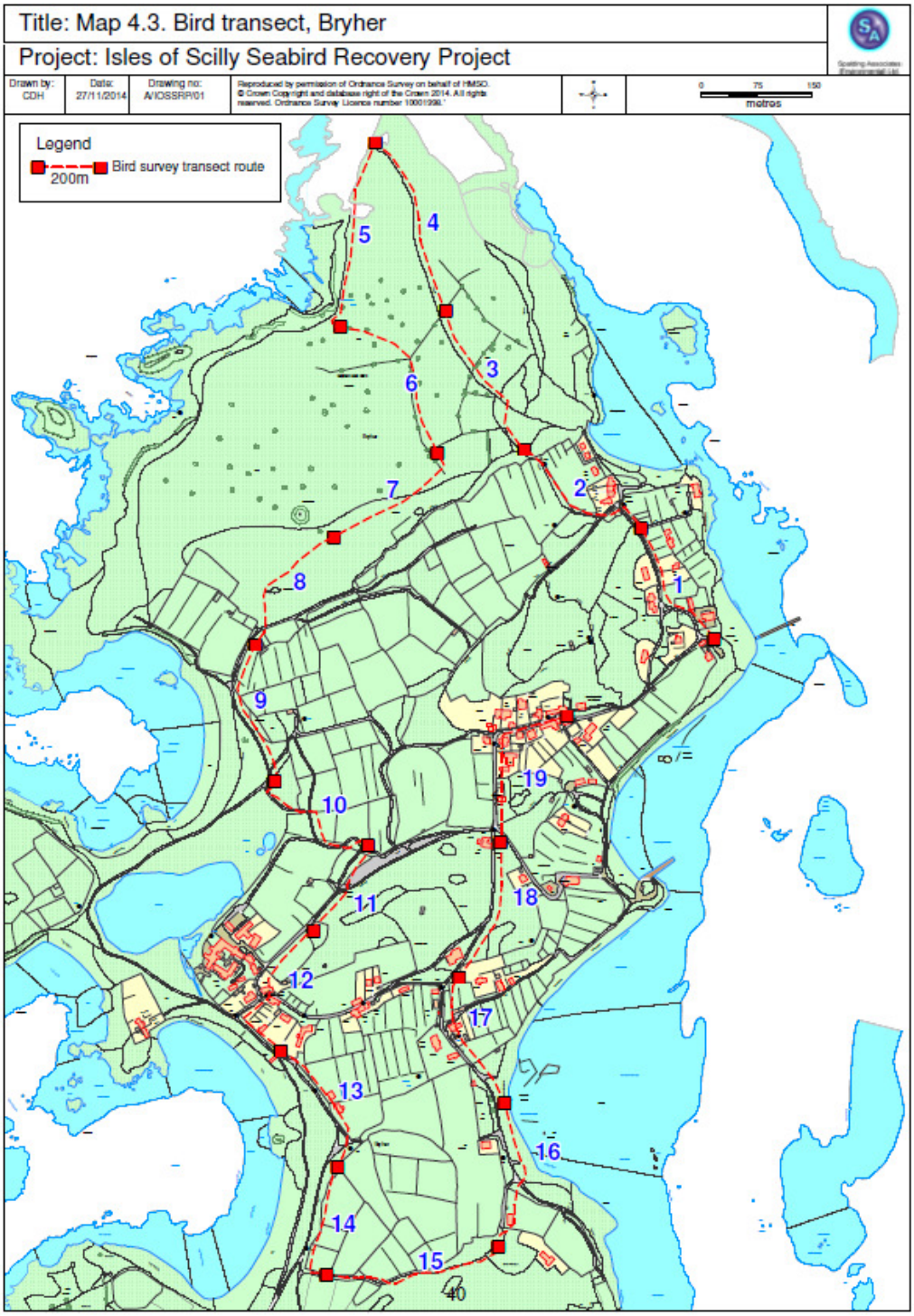


Notes: Mammals, colonies etc

Section Number

Map of survey routes (from Spaldings 2014 Report)




Title: Map 4.3. Bird transect, Bryher
Project: Isles of Scilly Seabird Recovery Project
Drawn by: CDH
Date: 27/11/2014
Drawing no: A/IOSSRP/01
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0 75 150
metres
Legend
200m
Bird survey transect route
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Appendix 2

Table of visits

Island	Year	Month	E/L	Date	April day	Start	Finish
Bryher	20135	L	31/05/2013	61	06:00:00	09:30:00	
Bryher	20136	E	09/06/2013	70	07:25:00	09:50:00	
Bryher	20136	L	21/06/2013	82	06:45:00	09:15:00	
Bryher	20144	E	04/04/2014	4	07:10:00	08:40:00	
Bryher	20145	E	02/05/2014	32	06:30:00	09:00:00	
Bryher	20145	L	16/05/2014	46	07:15:00	09:55:00	
Bryher	20146	E	09/06/2014	70	05:30:00	06:50:00	
Bryher	20146	L	17/06/2014	78	05:35:00	07:43:00	
Bryher	20164	E	09/04/2016	9	06:50:00	09:30:00	
Bryher	20165	E	13/05/2016	43	05:45:00	08:05:00	
Bryher	20165	L	28/05/2016	58	05:25:00	08:05:00	
Bryher	20166	E	06/06/2016	67	05:45:00	07:15:00	
Bryher	20166	L	26/06/2016	87	05:24:00	06:30:00	
Gugh	20135	L	24/05/2013	54	10:20:00	11:30:00	
Gugh	20136	E	09/06/2013	70	09:30:00	10:35:00	
Gugh	20136	L	19/06/2013	80	10:15:00	11:30:00	
Gugh	20144	E	05/04/2014	5	06:45:00	08:35:00	
Gugh	20145	E	03/05/2014	33	06:30:00	08:30:00	
Gugh	20145	L	14/05/2014	44	09:30:00	12:10:00	
Gugh	20146	E	05/06/2014	66	06:30:00	08:30:00	
Gugh	20146	L	19/06/2014	80	07:00:00	09:00:00	
Gugh	20164	E	07/04/2016	7	07:46:00	09:30:00	
Gugh	20165	E	11/05/2016	41	06:10:00	07:45:00	
Gugh	20165	L	27/05/2016	57	05:10:00	06:25:00	
Gugh	20166	E	13/06/2016	74	05:15:00	07:15:00	
Gugh	20166	L	29/06/2016	90	06:20:00	07:20:00	
St Agnes	20135	L	24/05/2013	54	07:00:00	11:00:00	
St Agnes	20136	E	09/06/2013	70	07:18:00	10:04:00	
St Agnes	20136	L	19/06/2013	80	07:00:00	10:00:00	
St Agnes	20144	E	01/04/2014	1	07:30:00	09:30:00	
St Agnes	20144	L	19/04/2014	19	06:30:00	08:30:00	
St Agnes	20145	E	14/05/2014	44	07:15:00	09:00:00	
St Agnes	20145	L	21/05/2014	51	07:00:00	12:00:00	
St Agnes	20146	E	12/06/2014	73	05:30:00	09:00:00	
St Agnes	20146	L	23/06/2014	84	06:00:00	08:00:00	
St Agnes	20164	E	08/04/2016	8	06:50:00	09:00:00	
St Agnes	20164	L	19/04/2016	19	06:30:00	08:15:00	
St Agnes	20165	E	12/05/2016	42	05:45:00	08:10:00	
St Agnes	20165	L	17/05/2016	47	05:55:00	07:20:00	
St Agnes	20166	E	12/06/2016	73	05:16:00	09:00:00	
St Agnes	20166	L	30/06/2016	91	06:09:00	08:09:00	