CHAPTER 2: SCILLY SHREW MONITORING USING FOOTPRINT TUNNELS ON ST AGNES, GUGH AND BRYHER 2013 -2016

2.1. SUMMARY OF SURVEY RESULTS

Overall over the course of this survey work on both St Agnes and Gugh there has been a significant increase in the number of tunnels in which Scilly Shrew activity has been recorded and a significant increase in the intensity of the activity seen. For Gugh an increase in the number of tunnels in which Scilly Shrew activity has been recorded and intensity of the activity seen has increased each year. For St Agnes an increase in the number of tunnels in which Scilly Shrew activity and intensity of the activity was recorded up to 2015 with a decrease in 2016, but nowhere near down to the 2013 levels. In addition from 2014 onwards Scilly Shrews were recorded in tunnels placed within every habitat on St Agnes and Gugh whereas in 2013 activity was only recorded in the scrub on St Agnes and on the foreshore and heathland on Gugh. However the number of tunnels in which Scilly Shrew activity was recorded on Bryher has overall decreased dramatically, dropping between 2013 and 2014 and only partially recovering in 2016.

- On Gugh the total number of tunnels with shrew prints in them increased from 12/120 tunnels in 2013 to 111/120 tunnels in 2016
- On St Agnes the total number of tunnels with shrew prints in them increased from 3/120 tunnels in 2013 to 25/120 tunnels in 2016 (with a peak of 31/120 tunnels in 2015).
- On Bryher the total number of tunnels with shrew prints in them reduced from 34/120 tunnels in 2013 to 12/120 tunnels in 2015 and 2016 (with a drop to 3/120 tunnels in 2014).

(Note that 2014 results have been adjusted to 3 surveys to allow comparison with 2013 results).

There does not appear to be any relationship between the levels of shrew activity recorded and the Lawn Hopper numbers in the same habitats on any of the islands.

Fig 2.1. Number of tunnels with shrew prints recorded on each island each year

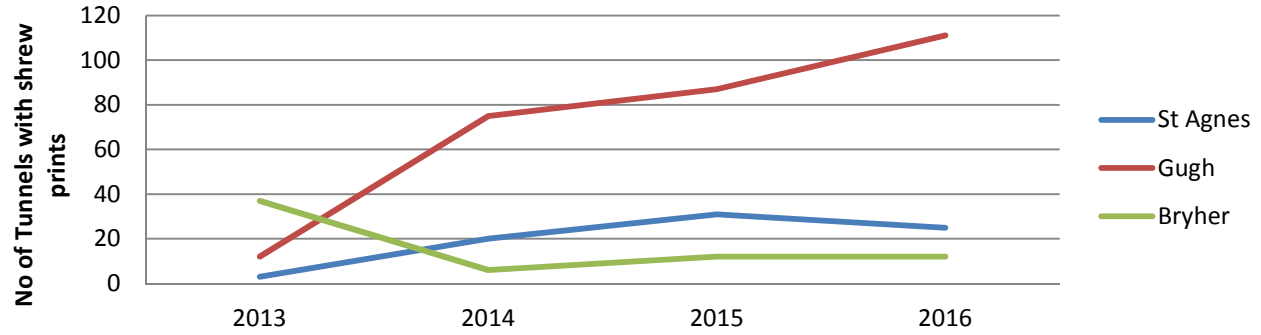


Table 2.1. Overall trends in number of tunnels with shrew prints for each habitat on each island between 2013 and 2016

Island	Habitat			
	Heathland	Scrub	Coastal Grassland	Foreshore
St Agnes	⇧	⇧	⇧	⇧
Gugh	⇧	⇧	⇧	⇧
Bryher	⇧	⇩	⇩	⇩

2.2. AIM OF SURVEYS

To carry out surveys to assess the impact of the removal of the rats from St Agnes and Gugh on Scilly Shrew activity on St Agnes, Gugh and Bryher.

This report details the findings of three years of monitoring of Scilly/Lesser White-toothed Shrew following the successful eradication of the rats in the winter of 2013/14 and assessment of these initial results against the baseline information.

2.2.1. Lesser White-toothed Shrew ecology

Lesser White-toothed Shrew *Crocidura suaveolens*, also known as the Scilly Shrew, has a very wide distribution, ranging from southern Europe into Asia and into northern parts of Africa. In the British Isles Lesser White-toothed Shrew are only found on the Isles of Scilly and two of the Channel Islands, Jersey and Sark (Harris & Yalden, 2008). They are believed to have been present on Scilly since at least the Bronze Age, possible having been introduced by early traders. The Lesser White-toothed Shrews of the Isles of Scilly were once thought to be a sub-species but this separation is now not considered to be valid. Lesser White-toothed Shrew is the only species of shrew which occurs on the Isles of Scilly (The Isles of Scilly Wildlife Trust website).

Traditionally on the Isles of Scilly Lesser White-toothed Shrews are associated with coastal habitats, specifically boulder beaches, but are likely to be much more widely distributed. In other parts of their range they are found in most habitats which offer adequate cover including scrub, hedges and woodland and they are regularly found in gardens in continental Europe (Harris & Yalden, 2008).

The home range of Lesser White-toothed Shrew on the Isles of Scilly is believed to be about 50 metres for a male shrew and 27 metres for females. They are firmly established here, occurring at a density of 1 per $30m^3$. They are active during both the day and night but are most active (around 80%) at night. They can live in burrows, which they are able to excavate, but also will shelter under boulders, under piles of logs/vegetation or in walls. They eat invertebrates, including beetles and earthworms, but on the Isles of Scilly are believed to predominately feed on sandhoppers (Harris & Yalden, 2008) but also Land Hoppers.

They breed from March to September and can produce 2 to 4 litters a year of 1 to 5 individuals and live for 12 to 18 months in the wild (Harris & Yalden, 2008). Their main predators on the Isles of Scilly are thought to be kestrels and domestic cats. However evidence that they are also eaten by rats was found during the feasibility study; during the dissection of the stomach contents of 50 rats 18% were found to contain the remains of Scilly Shrew (Bell, 2011).

2.3. METHODOLOGY

The survey technique used involved setting out 10 footprint/tracking tunnels in each of the 4 habitat types (scrub, coastal grassland, heathland and foreshore) on each island in May, June, July and September 2014, 2015 and 2016 to compare to the survey data collected in 2013 using the same methodology. Three months survey data (May, June and September for St Agnes; May, July and September for Gugh) were used to compare the activity levels across the years. These tunnels were installed at regular intervals within each habitat in a zigzag pattern, approximately 5 metres apart in approximately the same areas as the invertebrate surveys.

Each tunnel was secured in place using large metal staples and a baited insert card installed. These tunnels were then left in place for three days before either being collected or relocated at which time the insert cards were checked for footprints.

When footprints were found the location of the tunnel was noted, the species which created the footprints recorded and a score allocated to define the level of activity (from 1 to 4). In this scoring system a score of 1 denoted a single set of prints, a score of 2 two to three sets of prints, a score of 3 three to five sets of prints and a score of 4 more than five sets of prints.

2.3.1. Tunnels

In 2013 half of the tunnels used (40) were purchased from the Mammal Society and the other half were 'Gotcha Traps' from New Zealand.

The 'Gotcha Traps' are square, measuring about 40 cm long and 15 cm high and come with a pre inked card which you open, place the bait in the centre and slide into the tunnel.

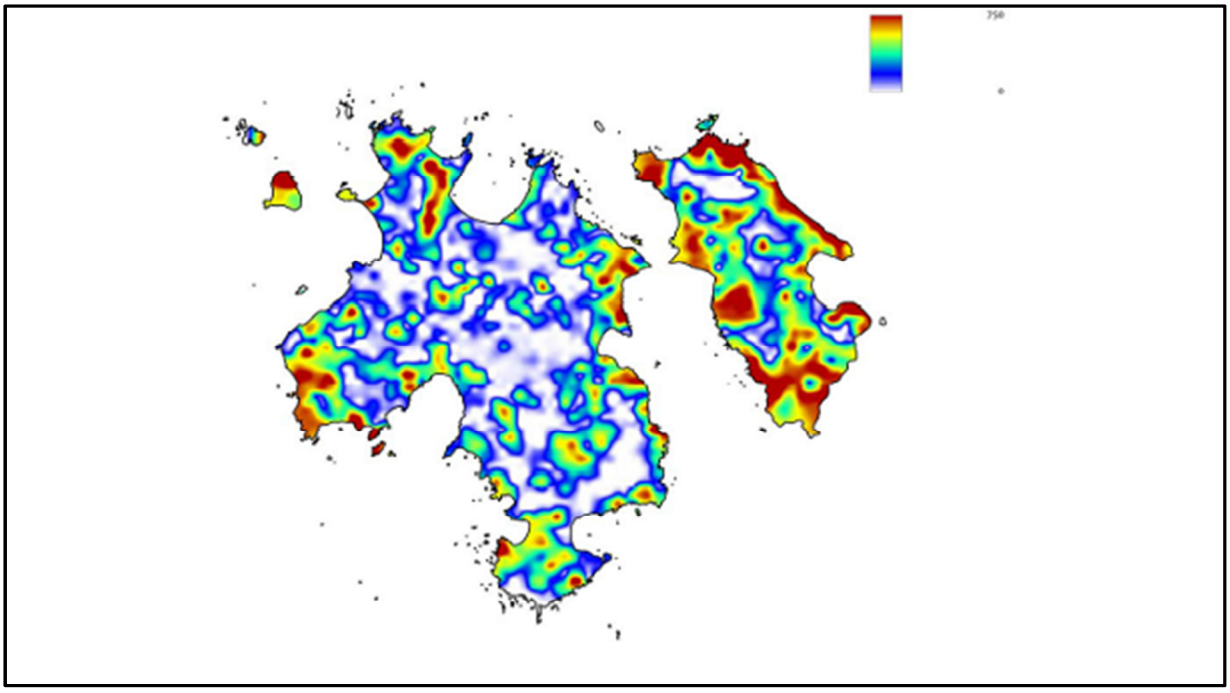
The Mammal Society traps were much larger than the 'Gotcha Traps' and less easy to transport, especially in windy weather, so in 2014, 2015 and 2016 it was decided to only use the 'Gotcha Traps'. However although it was suspected that the size of the trap would have no impact on the level of use by Scilly Shrew a test of this was carried out in 2014 by setting out the tunnels side by side and assessing the results.

2.3.2. Cat Predation questionnaires

To supplement the footprint tunnels Cat Predation questionnaires were circulated to the inhabitants of St Agnes in the winter of 2013/14.

2.3.3. Results of bait uptake by rats during the eradication

Map 1 shows the levels of bait take-up by rats across on St Agnes and Gugh. The take-up appears to be greater on Gugh than on St Agnes with areas directly alongside the coast having the greatest take-up. It does show, perhaps surprisingly, that it is not the areas close to dwellings which had the highest bait take-up which is where you might have expect the highest rat populations to be.



Map 1. Distribution of bait take up by Brown Rats on St Agnes and Gugh, 8 November 2013 to 8 March 2014. Red denotes highest amount of bait take

There may be some relationship between the higher bait take-up on Gugh and this island seeing the most dramatic increase in shrew numbers, suggesting that the shrew were a significant food resource for the rats here. However this would not explain the difference in the populations in the years following the removal of the rats and the more limited recovery in the number of shrew on St Agnes.

2.3.4. Limitations to survey work

In 2016 a number of tunnels were reported as missing in the survey tables and the score method has been changed to compensate for this by converting the number of tunnels with prints in them into a percentage of the total number of tunnels deployed where appropriate.

2.4. RESULTS

2.4.1. Comparison of Mammal Society tunnels verses "Gotcha Traps"

To assess the comparability of the results of the different footprint tunnel types 10 of each tunnel were set out side by side in each habitat on St Agnes on 14th May 2014 and were checked after 3 days and then again after 5 days before being collected in on 19th May 2014. Both sets of tunnels were baited with the same amount of the same bait. The results are set out in Table 2.2.

Table 2.2. Comparison of the level of shrew activity recorded by Mammal Society tunnels versus "Gotcha Traps"

Habitat	Number of tunnels with shew prints			
	After 3 days		After 5 days	
	Mammal Society tunnels	New Zealand 'Gotcha Traps'	Mammal Society tunnels	New Zealand 'Gotcha Traps'
Foreshore	1 (2)	1 (3)	1 (2)	1 (3)
Coastal Grassland	0	1 (2)	2 (3,3)	3 (2,2,3)
Scrub	1 (2)	0	0	0
Heathland	0	0	2 (2,3)	2 (2,3)
Total no of tunnel with prints	**2**	**2**	**5**	**6**

The number in brackets is the score of activity between 1 and 4.

The results show that both types of tunnel appear to record very similar levels of shrew activity over both a three and five day period. There are too few results for the data to be statistically analysed but there appear to be no significant differences between the data sets. This supports the conclusion that there will be no impact on the results by switching from one tunnel type to another. This is as expected as the discovery of the tunnel within the habitat is a chance encounter. Although the mammal tunnels have a slightly larger entrance catch area, this is likely to be balanced by shrew preference for smaller darker areas.

The only difference noted was that in the New Zealand "Gotcha Traps" birds were recorded in 9 out of the 10 tunnels placed within the heathland and none within the Mammal Society ones. However the reverse was seen in 2013 so this is not indicative of a pattern.

2.4.2. Results of tunnel surveys in 2013 - Prior to the rat eradication

Ten tunnels were deployed into each of four habitats on each island, three times for three days during each deployment. The results of the surveys are set out in Table 2.3.

Table 2.3. Results of the tunnel surveys showing the number of tunnels in which shrew prints were found (and other species prints) along with a score for the level of activity

Island	Surveyors	Habitat	Species	Number of tunnels with shrew footprints	Activity Score	Overall Activity Score
May 2013						
St Agnes 1	SJB	Foreshore	Bird	8/10		**0/40**
	SJB	Coastal Grassland	Rat	9/10		**0/40**
	SJB	Scrub	**Scilly Shrew**	**2/10**	**1,1**	**2/40**
	SJB	Heathland	-	-	-	**0/40**
Gugh 1	KB	Foreshore	**Scilly Shrew**	**3/10**	**1,1,1**	**3/40**
	KB	Coastal Grassland	Rat	2/10		**0/40**
	KB	Scrub	-	-	-	**0/40**
	KB	Heathland	-	-	-	**0/40**
June 2013						
St Agnes 2	JP	Foreshore	Rat	1/10		**0/40**
	JP	Coastal Grassland	Rat	2/10		**0/40**
	SJB	Scrub	**Scilly Shrew**	**1/10**	**1**	**1/40**
	SJB	Heathland	-	-	-	**0/40**
Gugh 2	SJB	Foreshore (Shrew on left hand side of beach rat on the right)	**Scilly Shrew**	**4/10**	**1,3,4,4**	**12/40**
			Rat	5/10		
	JP	Coastal Grassland	-	-	-	**0/40**
	JP	Scrub	-	-	-	**0/40**
	SJB	Heathland	**Scilly Shrew**	**2/10**	**1,3**	**4/40**
Bryher 1	SJB	Foreshore	**Scilly Shrew**	**2/10**	**1,3**	**4/40**
			Rat	5/10		
	SJB	Coastal Grassland	**Scilly Shrew**	**3/10**	**1,2,2**	**5/40**
	SJB	Scrub	**Scilly Shrew**	**1/10**	**1**	**1/40**
	SJB	Heathland	-	-	-	**0/40**
July 2013						
Bryher 2	CH	Foreshore	**Shrew/Rat**	**2/10**	**1, 2**	**340**
			Rat	8/10		
	CH	Coastal Grassland	**Scilly Shrew**	**4/10**	**3, 4, 2, 3**	**12/40**
	KB	Scrub	**Scilly Shrew**	**6/10**	**3, 4, 3, 2, 3, 1**	**16/40**
	KB	Heathland	-	-	-	**0/40**
September 2013						
St Agnes 3	SJB	Foreshore	Rat	7/10	-	**0/40**
			Bird	1/10	-	
	SJB	Coastal Grassland	Rat	9/10	-	**0/40**
			Bird	2/10	-	
	SJB	Scrub	-	-	-	**0/40**
	SJB	Heathland	Bird	1/10	-	**0/40**
Gugh 3	JP	Foreshore	**Scilly Shrew**	**2/10**	**1, 2**	**3/40**
	JP	Coastal Grassland	-	-	-	**0/40**
	JP	Scrub	-	-	-	**0/40**
	JP	Heathland	**Scilly Shrew**	**1/10**	**1**	**1/40**
Bryher 3	SJB	Foreshore	**Scilly Shrew**	**5/10**	**1, 1, 1, 2, 1**	**6/40**
	SJB	Coastal Grassland	**Scilly Shrew**	**7/10**	**1, 1, 4, 4, 1, 3, 3**	**17/40**
			Rat	1/10 (Moved)	-	
	SJB	Scrub	**Scilly Shrew**	**7/10**	**1,1,3, 2, 3, 4,4**	**20/40**

			Rat	2/10	-	
	SJB	Heathland	Rat	9/10 (I lost)	-	**0/40**

2.4.3. Results of tunnel survey 2014 – Year 1 following the rat eradication

10 tunnels were deployed in each of four habitats on each island, on four occasions for three days during each deployment. The results of the surveys are set out in Table 2.4.

Table 2.4. Results of tunnel deployments for each deployment per habitat

Island	Surveyors	Habitat	Species	Number of tunnels with shrew footprints	Activity Score	Overall Activity Score
May 2014						
St Agnes 1	JP and TS	Foreshore	**Scilly Shrew**	**1/10**	**3**	**3/40**
		Coastal Grassland	**Scilly Shrew**	**1/10**	**2**	**2/40**
		Scrub	**-**	**-**	**-**	**0/40**
		Heathland	**-**	-	-	**0/40**
Gugh 1	LT and NH	Foreshore	**Scilly Shrew**	**7/10**	**1,1,2,2,2,3, 3**	**14/40**
		Coastal Grassland	**Scilly Shrew**	**2/10**	**1,2**	**3/40**
		Scrub	**Scilly Shrew**	**6/10**	**1,4,4,4,4,4**	**21/40**
		Heathland	**Scilly Shrew**	**1/10**	**4**	**4/40**
Bryher 1	MT & OW	Foreshore	-	-	-	**0/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	-	-	-	**0/40**
		Heathland	-	-	-	**0/40**
June 2014						
St Agnes 2	JP, TB and AP	Foreshore	-	-	-	**0/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	**Scilly Shrew**	**2/10**	**1,2**	**3/40**
		Heathland	**Scilly Shrew**	**1/10**	**2**	**2/40**
Gugh 2	LT & A H-N	Foreshore	**Scilly Shrew**	**1/10**	**1**	**1/40**
		Coastal Grassland	**Scilly Shrew**	**7/10**	**1,2,3,3,4,4, 4**	**21/40**
		Scrub	**Scilly Shrew**	**9/10**	**2,2,3,4,4,4, 4,4,4**	**31/40**
		Heathland	**Scilly Shrew**	**5/10**	**1,2,2,4,4**	**13/40**
Bryher 2	JP	Foreshore	-	-	-	**0/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	Rat	1/10	**n/a**	**0/40**
		Heathland	-	-	-	**0/40**
July 2014						
St Agnes 3	SH & ND	Foreshore	**Scilly Shrew**	**5/10**	**1,2,3,3,4**	**13/40**
		Coastal Grassland	**Scilly Shrew**	**3/10**	**1,3,3,**	**7/40**
		Scrub	**Scilly Shrew**	**3/10**	**1,4,4**	**9/40**
		Heathland	**Scilly Shrew**	**3/10**	**1,1,2**	**4/40**
Gugh 3	SH & ND	Foreshore	**Scilly Shrew**	**7/10**	**2,2,3,3,3,3, 3**	**19/40**
		Coastal Grassland	**Scilly Shrew**	**8/10**	**1,1,2,3,4,4, 4,4**	**23/40**
		Scrub	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Heathland	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**

Bryher 3	OW, LT, E, JP	Foreshore	-	-	-	**0/40**
		Coastal Grassland	**Scilly Shrew**	**4/10**	**2,2,3,3**	**10/40**
		Scrub	Rat	1/10	**n/a**	**0/40**
		Heathland	-	-	-	**0/40**
September 2014						
St Agnes 4	VT and CD	Foreshore	**Scilly Shrew**	**2/10**	**2,2**	**4/40**
		Coastal Grassland	**Scilly Shrew**	**1/10**	**2**	**2/40**
		Scrub	**Scilly Shrew**	**8/10**	**2,2,2,3,4,4, 4,4**	**25/40**
		Heathland	**Scilly Shrew**	**4/10**	**2,2,2,3**	**9/40**
Gugh 4	VT and CD	Foreshore	**Scilly Shrew**	**9/10**	**1,2,2,2,3,3, 3,3,3**	**22/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**3,4,4,4,4,4, 4,4,4,4**	**39/40**
		Scrub	**Scilly Shrew**	**8/10**	**2,3,4,4,4,4, 4**	**25/40**
		Heathland	**Scilly Shrew**	**10/10**	**3,4,4,4,4,4, 4,4,4,4**	**3940**
Bryher 4	AW, WB & NS	Foreshore	**-**	**-**	**-**	**0/40**
		Coastal Grassland	**Scilly Shrew**	**1/10**	**2**	**2/40**
		Scrub	Rat	1/10		**0/40**
		Heathland	-	-	-	**0/40**

2.4.4. Results of tunnel survey 2015 – Year 2 following the rat eradication

10 tunnels were deployed in each of four habitats on each island, on four occasions for three days during each deployment. The results of the surveys are set out in Table 2.5.

Table 2.5. Results of tunnel deployments for each deployment per habitat

Island	Surveyors	Habitat	Species	Number of tunnels with shrew footprints	Activity Score	Overall Activity Score
May 2015						
St Agnes 1	JP & MT	Foreshore	**Scilly Shrew**	**2/10**	**3, 4**	**7/40**
		Coastal Grassland	**-**	**-**	**-**	**0/40**
		Scrub	**Scilly Shrew**	**2/10**	**1, 2**	**3/40**
		Heathland	**-**	-	-	**0/40**
Gugh 1	JP & MT	Foreshore	**Scilly Shrew**	**8/10**	**2,2,2,2, 2,2,3,3**	**18/40**
		Coastal Grassland	**Scilly Shrew**	**3/10**	**1,1,2**	**4/40**
		Scrub	**Scilly Shrew**	**4/10**	**1,1,1,3**	**6/40**
		Heathland	**-**	**-**	**-**	**0/40**
Bryrer 1	JP & MT	Foreshore	**-**	-	-	**0/40**
		Coastal Grassland	Rat	1/10	-	**0/40**
		Scrub	-	-	-	**0/40**
		Heathland	-	-	-	**0/40**
June 2015						
St Agnes 2	JP, TB and AP	Foreshore	**Scilly Shrew**	**2/10**	**2,4**	**0/40**
		Coastal Grassland	**Scilly Shrew**	**1/10**	**1**	**0/40**
		Scrub	**Scilly Shrew**	**2/10**	**2,3**	**0/40**
		Heathland	**Scilly Shrew**	**1/10**	**3**	**0/40**
Gugh 2	MA, LL, ML & LW	Foreshore	**Scilly Shrew**	**8/10**	**3,3,3,4,4,4, 4,4**	**29/40**
		Coastal Grassland	**Scilly Shrew**	**6/10**	**4,4,4,4,4,4**	**24/40**

		Scrub	**Scilly Shrew**	**6/10**	**3,3,4,4,4,4**	**22/40**
		Heathland	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
Bryher 2	LL, ZL & P St.P	Foreshore	**Scilly Shrew**	**1/10**	**2**	**2/40**
		Coastal Grassland	**Scilly Shrew**	**3/10**	**2,3,4**	**9/40**
		Scrub	**Scilly Shrew**	**1/10**	**1**	**1/40**
		Heathland	-	-	-	**0/40**
July 2015						
St Agnes 3	MA & LL	Foreshore	**Scilly Shrew**	**10/10**	**2,3,3,3,3,4, 4,4,4,4**	**0/40**
		Coastal Grassland	**Scilly Shrew**	**2/10**	**1,1**	**0/40**
		Scrub	**Scilly Shrew**	**7/10**	**1,1,1,2,2,2, 3**	**0/40**
		Heathland	**Scilly Shrew**	**1/10**	**1**	**0/40**
Gugh 3	MA, ML & LW	Foreshore	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**1,1,2,4,4,4, 4,4,4,4**	**32/40**
		Scrub	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Heathland	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
Bryher 3	MA, ML & LW	Foreshore	-	-	-	**0/40**
		Coastal Grassland	Rat	1/10	**n/a**	**0/40**
		Scrub	**Scilly Shrew**	**8/10**	**2,3,4,4,4,4, 4,4**	**29/40**
		Heathland	-	-	-	**0/40**
September 2015						
St Agnes 4	LT, MM, & PM	Foreshore	**Scilly Shrew**	**10/10**	**2,3,3,3,3,4, 4,4,4,4**	**34/40**
		Coastal Grassland	**Scilly Shrew**	**2/10**	**1,1**	**2/40**
		Scrub	**Scilly Shrew**	**7/10**	**1,1,1,2,2,2, 3**	**12/40**
		Heathland	**Scilly Shrew**	**2/10**	**1,2**	**3/40**
Gugh 4	JP, MM, PM	Foreshore	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**1,1,2,4,4,4, 4,4,4,4**	**32/40**
		Scrub	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Heathland	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
Byrher 4	JP, MM, PM & NT	Foreshore	**Rat**	**4/10**	**n/a**	**0/40**
		Coastal Grassland	**Rat**	**4/10**	**n/a**	**0/40**
		Scrub	**Scilly Shrew**	**10/10**	**1,2,2,2,2,3, 3,3,4,4,**	**26/40**
		Heathland	-	-	-	**0/40**

2.4.5. Results of tunnel survey 2016 – Year 3 following the rat eradication

10 tunnels were deployed in each of four habitats on each island, on four occasions for three days during each deployment. The results of the surveys are set out in Table 2.6.

Table 2.6. Results of tunnel deployments for each deployment per habitat

Island	Surveyors	Habitat	Species	Number of tunnels with shrew footprints	Activity Score	Overall Activity Score
May 2016						
St Agnes 1	LT & MP	Foreshore	**-**	**0/9**	**-**	**0/36**
		Coastal Grassland	**-**	**-**	**-**	**0/40**
		Scrub	**-**	**-**	**-**	**0/40**
		Heathland	**-**	-	-	**0/40**
Gugh 1	JG & MP	Foreshore	**Scilly Shrew**	**7/8**	**1,2,2,2, 2,3,4,**	**16/32**
		Coastal Grassland	**Scilly Shrew**	**5/10**	**1,1,2,3 4**	**11/40**
		Scrub	**Scilly Shrew**	**9/10**	**3,3,4,4,4,4, 4,4,4,4**	**30/40**
		Heathland	**Scilly Shrew**	**10/10**	**1,2,3,4,4,4, 4,4,4**	**38/40**
Bryher 1	LT & HP-B	Foreshore	-	-	-	**0/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	-	-	-	**0/40**
		Heathland	-	-	-	**0/40**
June 2016						
St Agnes 2	HP-B	Foreshore	-	0/9	-	0/36
		Coastal Grassland	-	0/9	-	0/36
		Scrub	**-**	**-**	**-**	**0/40**
		Heathland	**-**	**-**	**-**	**0/40**
Gugh 2	HP-B, AB, LT	Foreshore	**Scilly Shrew**	**10/10**	**3,3,3,3,3,4, 4,4,4,4**	**35/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**2,2,2,2,2,3, 3,3,3,3**	**25/40**
		Scrub	**Scilly Shrew**	**10/10**	**2,3,3,3,3, 4,4,4,4,4**	**34/40**
		Heathland	**Scilly Shrew**	**10/10**	**2,3,3,3,3, 3,3,4,4,4**	**32/40**
Bryher 2	HP-B, AM, HR & AF	Foreshore	-	-	-	**0/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	-	-	**-**	**0/40**
		Heathland	-	-	-	**0/40**
July 2016						
St Agnes 3	HR, AF, LL and LB	Foreshore	**Scilly Shrew**	**1/10**	**1**	**1/40**
		Coastal Grassland	**Scilly Shrew**	**1/10**	**1**	**1/40**
		Scrub	**Scilly Shrew**	**5/10**	**1,1,1,2,2**	**7/40**
		Heathland	**Scilly Shrew**	**10/10**	**2,2,2,3,3,3, 3,3,3,3**	**30/40**
Gugh 3	HP-B & AB	Foreshore	**Scilly Shrew**	**10/10**	**3,3,4,4,4,4, 4,4,4,4**	**38/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**1,2,3,3,3,3, 3,4,4,4**	**30/40**
		Scrub	**Scilly Shrew**	**10/10**	**2,3,3,4,4,4, 4,4,4,4**	**36/40**
		Heathland	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
Bryher 3	HR, AF, LL and LB	Foreshore	**Scilly Shrew**	**1/10**	**2**	**2/40**
		Coastal Grassland	-	-	-	**0/40**
		Scrub	-	-	**-**	**0/40**

		Heathland	-	-	-	**0/40**
September 2014						
St Agnes 4	LT	Foreshore	**Scilly Shrew**	**9/9**	**2,4,4,4,4,4, 4,4,4,**	**34/36**
		Coastal Grassland	**Scilly Shrew**	**2/8**	**2,2**	**4/32**
		Scrub	**Scilly Shrew**	**7/10**	**1,1,2,2,2,3, 4,**	**15/40**
		Heathland	**Scilly Shrew**	**7/10**	**1,1,2,2,3,3, 3**	**15/40**
Gugh 4	AC	Foreshore	**Scilly Shrew**	**10/10**	**4,4,4,4,4,4, 4,4,4,4**	**40/40**
		Coastal Grassland	**Scilly Shrew**	**10/10**	**2,3.3.3.3.3. 3.3,4,4**	**31/40**
		Scrub	**Scilly Shrew**	**10/10**	**3,3,3,3,3,3, 4,4,4,4**	**34/40**
		Heathland	**Scilly Shrew**	**10/10**	**3,3,3,4,4,4, 4,4,4,4**	**37/40**
Bryher 4	HR, AF, LL and LB	Foreshore	-	**-**	**-**	**0/40**
		Coastal Grassland	**Scilly Shrew**	**4/10**	**1,1,1,3**	**6/40**
		Scrub	**Scilly Shrew**	**2/10**	**1,2**	**3/40**
		Heathland	**Scilly Shrew**	**5/10**	**1,1,1,1,2**	**6/40**

In 2013 low levels of shrew activity were found on St Agnes with the level of tunnel use being 2.5%, only 3 out of the 120 tunnels showing signs of shrew activity. Low levels of shrew activity were found on Gugh with the level of tunnel use being 10%, 12 out of the 120 tunnels showing signs of shrew activity. There were medium activity levels on Bryher, with the level of tunnel use being 30%, 37 out of the 120 tunnels showing signs of shrew activity.

In 2014, 2015 and 2016 the results show that on St Agnes and Gugh, across all the surveys carried out, Scilly Shrews were recorded in every habitat. On Bryher in 2014 shrews were only found on coastal grassland and scrub, in 2015 they were recorded in the coastal grassland, foreshore and scrub and in 2016 were found in all habitats.

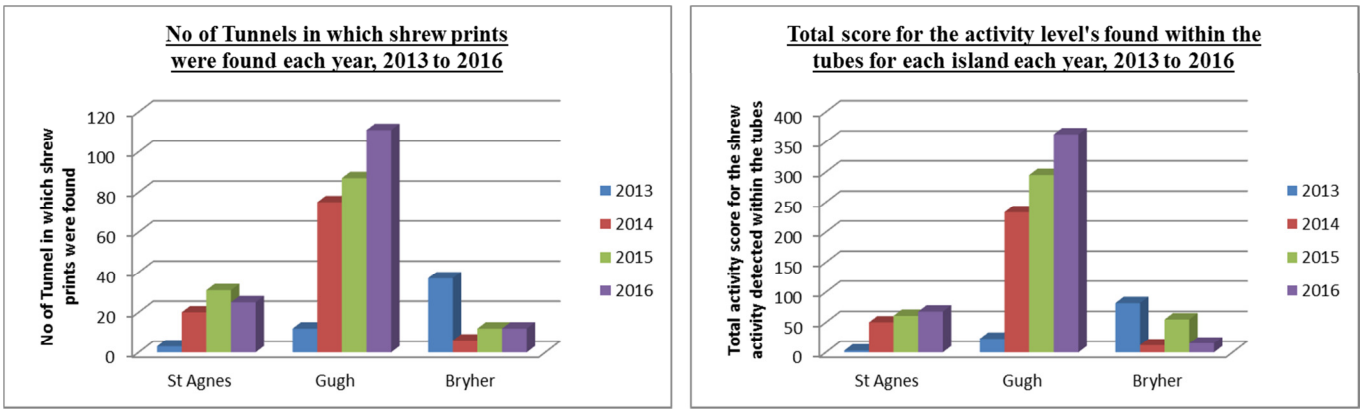
Following on from the rat eradication overall medium levels of shrew activity were recorded on St Agnes, concentrated in the scrub and heathland in 2014 with the level of tunnel use being 23%, with 36 out of the 160 tunnels showing signs of shrew activity. In 2015 this increased to 32%, with 51 of the 160 tunnels showing signs of shrew activity, and in 2016 dropped to 26%, with 42 of the 156 tunnels showing signs of shrew activity.

Following on from the rat eradication overall high to very high levels of shrew activity were recorded on Gugh across all the habitats. In 2014 the level of tunnel use by shrew was 69%, with 110 of the 160 tunnels showed signs of shrew activity. In 2015 this increased to 78%, with 125 of the 160 tunnels showing signs of shrew activity, and in 2016 this increased again 94%, with 151 of the 159 tunnels showing signs of shrew activity.

Following the rat eradication on St Agnes and Gugh on Bryher only low levels of activity by shrew were detected and the shrews were restricted to coastal grassland. Overall presence in tunnels averaged out at 4%, with 6 of the 160 tunnels showed signs of shrew activity. The footprints of 3 rats were recorded on Bryher, all in scrub.

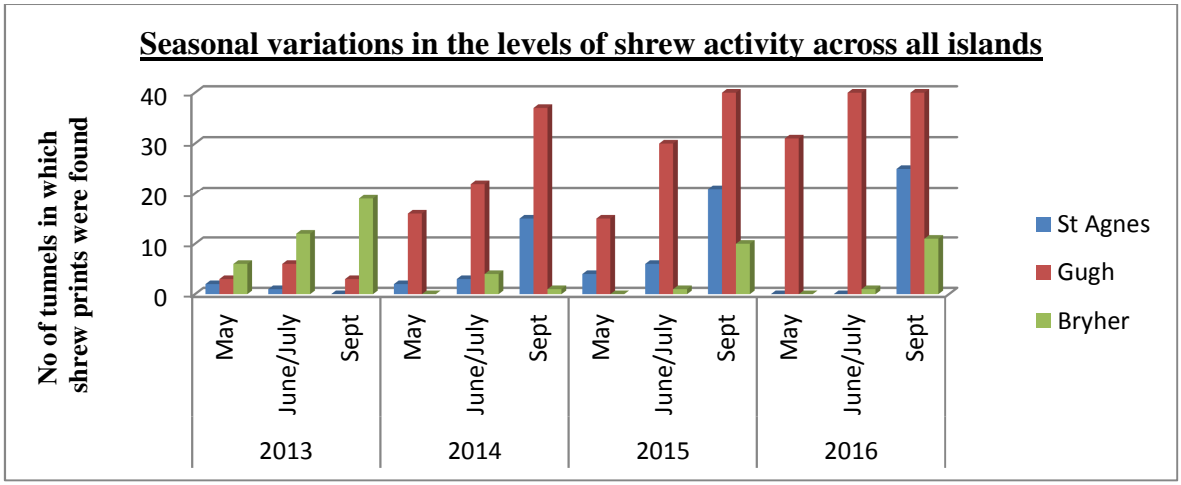
The pattern shown by the number of tunnels in which the shrew prints were found is echoed by the activity ratings (Fig. 2.2). There are some small variations, such as an increase in the levels of activity between 2015 and 2016 as opposed to a slight decrease in the number of tunnels with shrew prints in them for the same period, but overall they are very similar.

Figure 2.2. Comparison between the number of tunnels in which the shrew prints were found and the activity ratings



There is also a distinct seasonal variation in the numbers of shrews detected particularly on St Agnes, and also on Bryher. Indicators of the presence of shrews in May and June are very low and increase over the year. This pattern is also seen on Gugh but much higher numbers of shrew prints are seen early in the year (Fig. 2.3). The increase in numbers as the year progresses is not unexpected as the population will increase as the shrews breed. However the fact that on Gugh higher levels of presence are detected in the early part of the year would suggest that a larger density of individuals survive the winter. This may be a result of the predation of shrews by cats on St Agnes and cats and rats on Bryher.

Figure 2.3. Seasonal variation in the numbers of shrew detected on each island



* June data was used for St Agnes and Gugh and July for Bryher as these were the months these islands were surveyed in 2013

2.4.6. Comparison between the baseline survey results from 2013 and the 2014, 2015 and 2016 survey results

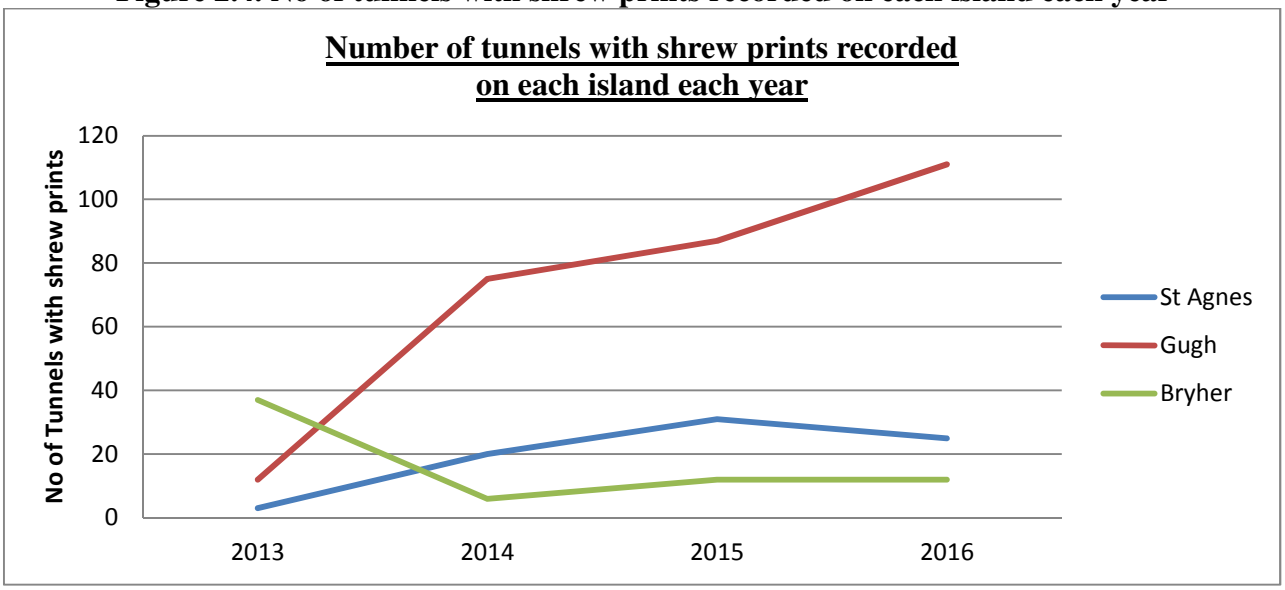
In 2013 the tunnels were only deployed on three occasions rather than four so to allow direct comparison to be made one set of data (July for St Agnes and Gugh and June for Bryher) has been omitted for the following analysis in 2014, 2015 and 2016 (Table 2.7).

Table 2.7. Summary of the annual results of tunnel use for tunnel deployments for each habitat each year

		Number of tunnels with shrew prints per habitat and year			
Island	**Habitat**	**2013***	**2014***	**2015***	**2016***
St Agnes	Foreshore	0	3	14	9/29
	Coastal Grassland	0	2	3	2/27
	Scrub	**3**	10	**11**	**7**
	Heathland	0	5	3	7
	Total no of tunnels in which shrew presence was detected per year	**3**	**20**	**31**	**25**
	% of tunnels in which shrew presence was detected	**2.5%**	**16.67%**	**25.84%**	**21.55%**
Gugh	Foreshore	9	**17**	28	27/28
	Coastal Grassland	0	**19**	19	25
	Scrub	0	**23**	20	29
	Heathland	3	**16**	20	30
	Total no of tunnels in which shrew presence was detected per year	**12**	**75**	**87**	**111**
	% of tunnels in which shrew presence was detected	**10%**	**62.5%**	**72.5%**	**94.1%**
Bryher	Foreshore	9	0	1	1
	Coastal Grassland	14	5	1	4
	Scrub	14	1	10	2
	Heathland	0	0	0	5
	Total no of tunnels in which shrew presence was detected per year	**37**	**6**	**12**	**12**
	% of tunnels in which shrew presence was detected	**30.1%**	**5%**	**10%**	**10%**

* June data was used for St Agnes and Gugh and July for Bryher as these were the months these islands were surveyed in 2013

Figure 2.4. No of tunnels with shrew prints recorded on each island each year



The results for St Agnes show an increase in the number of tunnels in which Scilly Shrew were recorded between the 2013 and 2014 surveys and a very large increase for Gugh for the 2014 and 2015 surveys. Between 2015 and 2016 the results for Gugh show another large increase in the number of tunnels in which Scilly Shrew were recorded but there was a decrease on St Agnes (Table 2.7; Fig. 2.4).

The largest increase overall has been on Gugh from a total of 12 of 120 tunnels having prints in them in 2013 to 111 of 120 tunnels having shrew prints in them in 2016 (Table 2.7; Fig. 2.4).

On St Agnes there is again a large overall increase from 3 of 120 tunnels with shrew prints in them in 2013 to 25 of 120 tunnels in 2014 (peaking at 31 of 120 in 2015) (Table 2.7; Fig. 2.4).

Along with this increase in the number of tunnels in which prints were recorded, the levels of activity recorded also increased dramatically (Figure 2.2). During the June survey in 2015 and the June and September 2016 surveys on Gugh, all the tunnels had footprints in and all 10 tunnels scored 4 out of 4 on the activity rating.

On the control sites on Bryher higher levels of shrew activity were recorded in 2013 than where recorded on St Agnes and Gugh. The level of shrew activity recorded then fell from 37 out of 120 tunnels with shrew prints in them to 6 of 120 in 2014. This then only partially recovered to 12 of the 120 tunnel having shrew prints in them in 2015 and 2016 (Table 2.7; Fig. 2.4).

A cat predation questionnaire was given out to residents on St Agnes in the winter of 2013/14. However only one was returned. This was from Rosie Felton at Covean Cottage who recorded that her cats had brought in 20 Scilly Shrews in the previous 12 months to April 2014. This potentially indicates that cats are a major predator of Scilly Shrew, at least in the vicinity of residential dwellings. Additional survey would provide further information on this matter. Due to the low take up of the survey it was not repeated.

2.5. Exploring the possible relationship between Lawn Hoppers and Scilly Shrew

There has been a hypothesised relationship between Lawn Hoppers and Scilly Shrew, with the Lawn Hoppers believed to form a major component of the diet of Scilly Shrews in inland habitats and therefore their abundance should influence their distribution. In 2013 we investigated this by comparing the level of Scilly Shrew activity seen to the abundance of Lawn Hoppers caught in the pitfall traps in the same habitats. There was no obvious correlation. Similarly we compared the 2013

and 2014 results to see if there are any discernible patterns in the Lawn Hopper numbers which could be attributed to changes in shrew numbers (Table 2.8; Fig. 2.5).

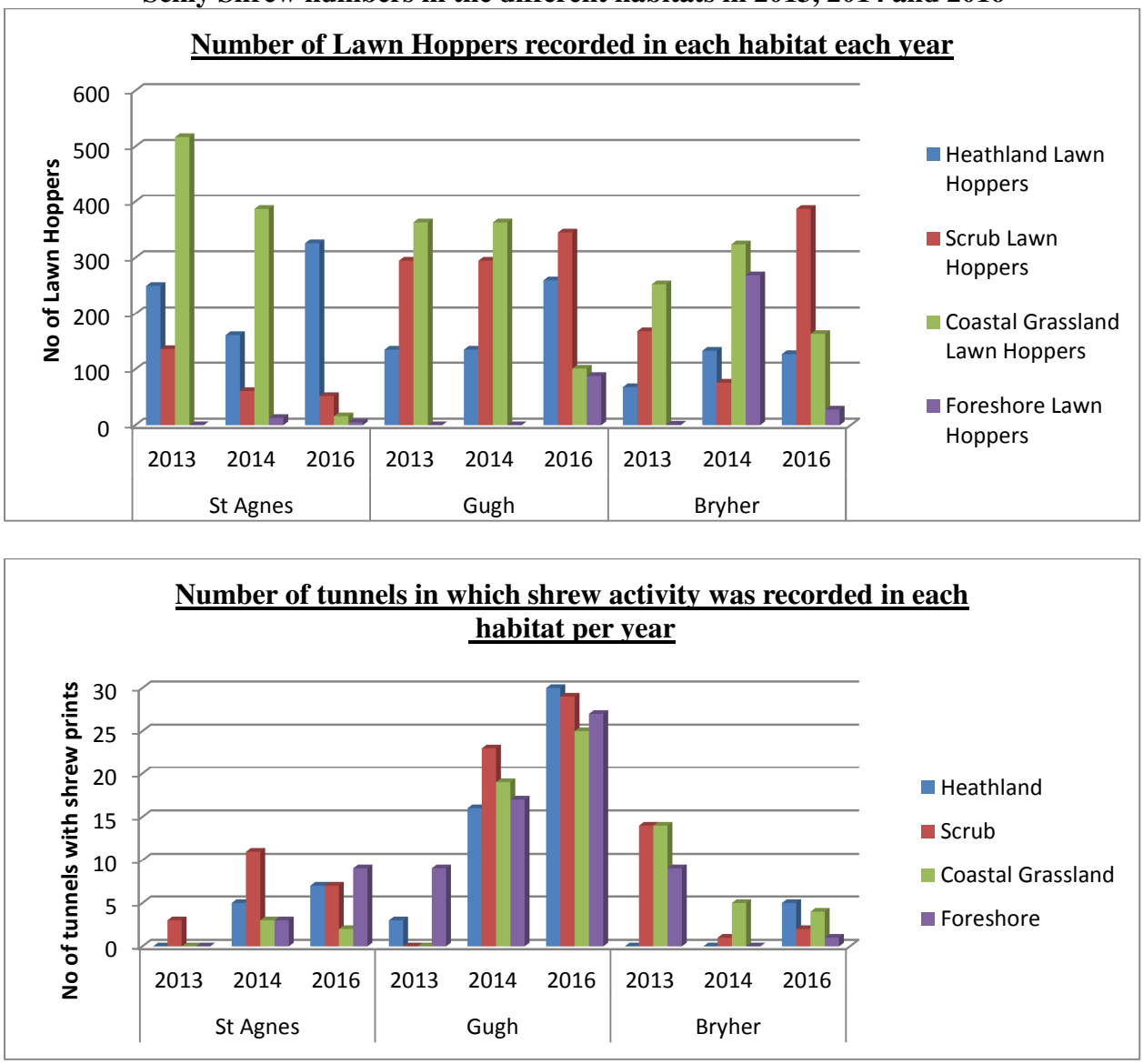
Table 2.8. Total number of Lawn Hoppers and footprint tunnels with Shrew activity within each habitat type on each island for 2013, 2014 and 2016

Year	Island	Heathland		Scrub		Coastal Grassland		Foreshore		Total for Lawn Hoppers	Total for Shrew
		Lawn Hoppers	Shrew	Lawn Hoppers	Shrew	Lawn Hoppers	Shrew	Lawn Hoppers	Shrew	Lawn Hoppers	Shrew
2013	St Agnes	250	0	136	3	517	0	0	0	**903**	**3**
	Gugh	67	3	171	0	465	0	39	9	**742**	**12**
	Bryher	68	0	168	14	253	14	1	9	**490**	**37**
2014	St Agnes	161	5	61	11	387	3	13	3	**622**	**22**
	Gugh	135	16	295	23	363	19	0	17	**793**	**75**
	Bryher	133	0	76	1	324	5	269	0	**802**	**6**
2016	St Agnes	326	7	52	7	16	2	5	9	**399**	**25**
	Gugh	260	30	345	29	101	25	88	27	**794**	**111**
	Bryher	127	5	387	2	163	4	28	1	**705**	**12**

Between 2013 and 2014 there was a large increase in the amount of shrew activity recorded on St Agnes and Gugh across all 4 habitats and a decrease in shrew activity on Bryher. If there is a relationship between shrew and Lawn Hopper numbers we would expect to see a decrease in the number of Lawn Hoppers on St Agnes and Gugh and an increase on Bryher. As the shrew numbers increase we would expect numbers of Lawn Hoppers to decrease due to predation. There was no obvious correlation (Table 2.8; Fig. 2.5).

In 2016 we compared the 2013, 2014 and 2016 results to see if there are any discernible patterns in the Lawn Hopper numbers which could be attributed to changes in shrew numbers (Table 2.8; Fig. 2.5).

Figure 2.5. Comparison of Lawn Hoppers numbers and Scilly Shrew numbers in the different habitats in 2013, 2014 and 2016



On St Agnes, between 2013 and 2014, and 2014 and 2016 there was an overall decrease in the number of Lawn Hoppers recorded each year. Within the different habitats over the survey period the number of Lawn Hoppers recorded fell each year in the coastal grassland and scrub. Within the heathland between 2013 and 2014 the number of Lawn Hoppers fell but then increased between 2014 and 2016. This does not appear to have any relationship with the changes in shrew numbers in the same habitats (Table 2.8; Fig. 2.5, 2.6).

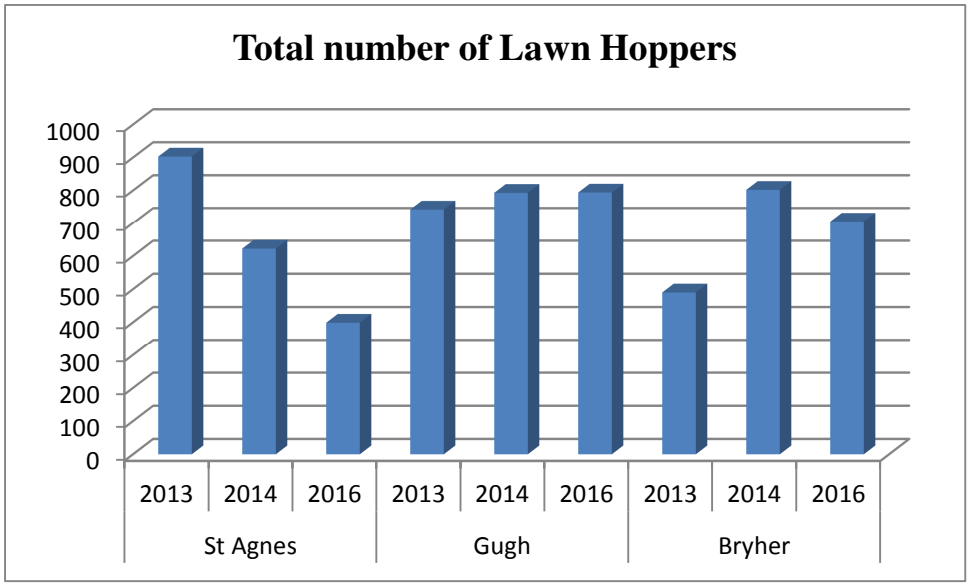
On Gugh the population of Lawn Hoppers appears to be stable with a small increase in the numbers of individuals recorded between 2013 and 2014. Then in 2014 and 2016 very similar numbers of Lawn Hoppers were recorded in spite of the year on year increases in the levels of shrew activity. Within the different habitats over the survey period the number of Lawn Hoppers decreased in the coastal grassland but increased in the other habitats. There does not appear to be any relationship between the levels of shrew activity recorded and the Lawn Hopper numbers in the same habitats (Table 2.8; Fig. 2.5, 2.6).

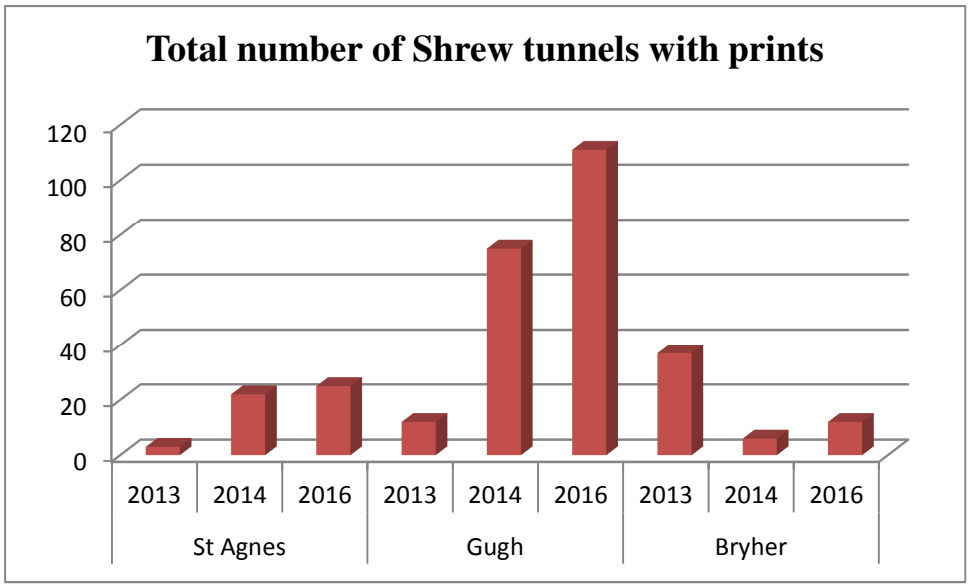
On Bryher the population of Lawn Hoppers increased a little between 2013 and 2014 and then fell slightly between 2014 and 2016 which follows the overall shrew activity pattern. Over the survey period the number of Lawn Hoppers increased in the coastal grassland and heathland between 2013 and 2014 but then decreased between 2014 and 2016; this was the opposite to the scrub. There does not

appear to be any relationship between the levels of shrew activity recorded and the Lawn Hopper numbers in the same habitats (Table 2.8; Fig. 2.5, 2.6).

There does not appear to be any relationship between the levels of shrew activity recorded and the number Lawn Hoppers within each of the habitats across the islands.

Figure 2.6. Comparisons between Lawn Hoppers numbers and levels of Scilly Shrew activity per island in 2013, 2014 and 2016





At a glance, looking at the levels of shrew activity per island vs the number of Lawn hoppers, there is an inverse relationship on St Agnes and Bryher between the two (Fig. 2.5, 2.6). However this is not seen Gugh where the largest increase in the levels of shrew activity were recorded and is not seen when the results are broken down to habits.

The number of Lawn Hoppers found within each habitat, each year on each island appears to be very variable with no apparent pattern relating to shrew numbers. The only exception is the number of Lawn Hoppers found in the scrub on Gugh as this is fairly consistent. In each year, except 2016, the highest number of Lawn Hoppers on each island was found in the coastal grassland.

2.6. CONCLUSION

Overall over the course of this survey work on both St Agnes and Gugh there has been a significant increase in the number of tunnels in which Scilly Shrew activity has been recorded and a significant increase in the intensity of the activity seen. For Gugh an increase in the number of tunnels in which Scilly Shrew activity has been recorded and the intensity of the activity seen has increased each year. On St Agnes an increase in the number of tunnels in which Scilly Shrew activity was found and the intensity of that activity was recorded up to 2015. Then between 2015 and 2016 a drop in the number of tunnels in which Scilly Shrew activity was found and the intensity of that activity was recorded but not down to the levels in 2013.

In addition from 2014 onwards Scilly Shrew were recorded in tunnels placed within every habitat on St Agnes and Gugh whereas in 2013 activity was only recorded in the scrub on St Agnes and on the foreshore and heathland on Gugh. The apparent restriction of activity to scrub on St Agnes in 2013 might have been due to the greater cover that scrub gives from potential predators, especially cats and rats. However the 2014, 2015 and 2016 surveys now record shrew as being plentiful in all habitats.

In 2013 Scilly Shrew was significantly more abundant on Bryher than on either of the other two islands. However the level of shrew activity recorded on Bryher in 2014 reduced to a level more similar to that seen on St Agnes and Gugh in 2013 and then recovered slightly in 2015 but to nowhere near the 2013 level.

It is not understood why the number of shrews on Bryher suddenly reduced between 2013 and 2014. Rats are unlikely to be entirely responsible for this fall in shrew numbers as numbers recovered slightly in 2015 despite rats still being present. Loss in numbers over this period could perhaps be partly down to winter storms in 2013-2014 and consequent loss of foreshore habitat, but storms affected Gugh as well and there was no collapse in shrew numbers here.

It is therefore reasonable to assume that the presence of rats was severely depressing shrew numbers on St Agnes and Gugh. The reason for the initially higher numbers on Gugh compared with St Agnes may be due to lower predation pressures on Gugh as there are no cats resident on this island. There are approximately 10 cats on St Agnes and no resident cats on Gugh, although one cat from St Agnes is known to cross the sandbar to hunt rabbits and shrews (personal conversation with Jaclyn Pearson from trail camera footage). This may also be the reason differences in shrew activity recorded in 2016.

The levels of Shrew activity recorded also increased over each year, as the shrews bred without the pressure on their population from the rats, recovering to a peak population level. The lower starting point seen each year in the levels of activity on St Agnes may be due to the predation of shrews in the winter by resident cats, compared to reduced predation by cats on Gugh which are not resident here, just one individual is known to hunt here. We expect shrew activity on Gugh to remain high and possibly increase further until a natural balance is reached without pressure from the rats affecting the population. However this is dependent on the foraging and hunting behaviour of St Agnes cats crossing the sand bar.

We have been told that the residents have said they will not bring anymore cats to the islands now that the rats have been removed (most cats were brought in to control the rats on farms). Therefore the pressure from cat predation should reduce over time, resulting in further a reduction of the pressures on shrew and a corresponding increase in their numbers, in particular on St Agnes.

2.7. ASSESSMENT OF THE METHODOLOGY USED

The methodology used, "**Gotcha Traps",** appears to have been very successful at recording the changes in the levels of shrew activity across the islands as a result of the removal of the rats but is limited in that it does not give a direct indication of the change in the numbers of shrews present.

Ideally a technique such as Capture-Mark-Recapture using live trapping would have been undertaken as this would give a population estimate but this requires intensive training, significant experience and is very labour intensive and would have been very difficult to have carried out with volunteers. A small trial using Longworth Traps was carried out during the first visit to the islands but failed to catch any shrews. However the methodology used gave good data and conclusively showed that the levels of shrew activity increased after the rats had been removed and yielded information on habitat and island differences in that recovery.

Ideally more information would have been gathered from the cat predation questionnaire as this would have given a good indication of any increase in number of shrew being predated, which would be expected with an increase in population.

Future monitoring would allow changes in the levels of shrew activity on the islands to be noted, including variations in seasonal activity levels and future population changes. It could also be used to establish if populations have reached a stable state or if the populations are still recovering. This would be interesting as currently we suspect populations on St Agnes to be lower than on Gugh and it would be interesting to see if they become comparable. It would be desirable to continue this monitoring three times a year for the foreseeable future and this would be fairly easy to get volunteers to do.

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