



JOHNS
ASSOCIATES

Appendix C (A)

Automated Bat Detector Survey

Data Analysis and Visualisation

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1 INTRODUCTION

1.1 GENERAL INFORMATION ON BAT SPECIES OBSERVED

Below is a general introduction to the species observed on the survey. Further information can be found on the Bat Conservation Trust website <https://www.bats.org.uk/about-bats/what-are-bats/uk-bats>.

Barbastelle *Barbastella barbastellus*

The barbastelle is a distinctive looking medium-sized bat. It has a pug-shaped nose and broad ears which join across the top of the head, and its fur is very dark with “frosted” tips. It prefers woodland, roosting in trees and hunting both beneath the canopy and over tree-tops but can also be found over rough meadows, ponds and streams.

Common Pipistrelle *Pipistrellus pipistrellus*

Common pipistrelles are the most common and widespread of all British bat species. They are found in lots of places, including towns and cities, as well as in the countryside. They are small, and their flight is fast and jerky as they pursue small insects which they catch and eat whilst flying. A single pipistrelle can consume up to 3,000 insects in one night!

Leisler's or Noctule

These two bats belong to the same family, and are fairly large for a British bat. The noctule is generally one of the first bats to be seen of an evening, and they like to hunt over open ground, particularly pasture. Leisler's are more likely to be found in woodland, but they can also be found in the same places as noctules-making them hard to tell apart!

Myotis Species

The Myotis are a group of bats which includes Alcaho, Bechstein's, Brandt's, Daubenton's, Natterer's and Whiskered bats. They all make very similar sounds which mean that sometimes it is very hard to tell them apart from their recordings alone.

Nathusius' Pipistrelle *Pipistrellus nathusii*

This bat is quite rare in the UK, though records have increased in recent years. It is migratory (with one bat recorded travelling between Bristol and Holland!) and is most commonly found in autumn, although there are now records of colonies remaining all year and breeding in the UK. It is similar in appearance to, but slightly larger than the common and soprano pipistrelles and the fur on its back is longer, sometimes giving a shaggy appearance. The Nathusius' is strongly associated with water and woodlands.

Serotine *Eptesicus serotinus* The serotine is one of Britain's largest bat species and usually one of the first to appear in the evening, often emerging in good light. It flies at about tree-top height (to about 10 m) often close to vegetation, and will sometimes flop, wings outstretched, on to the foliage to catch large insects. The serotine will feed around street lamps and even catch prey from the ground.

Serotines roost mainly in buildings with high gables and cavity walls. They can be found in much older buildings and churches, but are less often found in modern buildings.

Soprano Pipistrelle *Pipistrellus pygmaeus*

The soprano pipistrelle was discovered as a different species to the common pipistrelle in the 1990s - they are very similar but they use slightly different echolocation calls and there are subtle differences in how they look. They also tend to roost and hunt in slightly different places, with the soprano pipistrelle favouring river habitat and wetland areas.

Soprano Pipistrelle *Pipistrellus pygmaeus*

The soprano pipistrelle was discovered as a different species to the common pipistrelle in the 1990s - they are very similar but they use slightly different echolocation calls and there are subtle differences in how they look. They also tend to roost and hunt in slightly different places, with the soprano pipistrelle favouring river habitat and wetland areas.



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2 TABLES



2.1 TABLE OF SUNTIMES

Bats are nocturnal, active at night rather than day; therefore the surveys are reported relative to the *night* which runs from the date at sunset to dawn the following day.

Table 1 gives the survey *night*, time of sunset, time of sunrise and the length in hours of each night

Table 1: Ageas Bowl Suntimes for each Survey Night

Night	Sunset (hh:mm)	Sunrise (hh:mm)	Night Length (hours)
14 May 2020	20:47	05:16	8.5
15 May 2020	20:49	05:15	8.4
16 May 2020	20:50	05:13	8.4
17 May 2020	20:52	05:12	8.3
18 May 2020	20:53	05:11	8.3
10 June 2020	21:19	04:52	7.6
11 June 2020	21:20	04:52	7.5
12 June 2020	21:20	04:52	7.5
13 June 2020	21:21	04:52	7.5
14 June 2020	21:21	04:52	7.5
15 June 2020	21:22	04:51	7.5
16 June 2020	21:22	04:51	7.5
17 June 2020	21:23	04:52	7.5
18 June 2020	21:23	04:52	7.5
19 June 2020	21:23	04:52	7.5
20 June 2020	21:24	04:52	7.5
21 June 2020	21:24	04:52	7.5
13 July 2020	21:16	05:08	7.9
14 July 2020	21:15	05:10	7.9
15 July 2020	21:14	05:11	7.9
16 July 2020	21:13	05:12	8.0
17 July 2020	21:12	05:13	8.0
18 July 2020	21:11	05:14	8.1
19 July 2020	21:10	05:16	8.1
20 July 2020	21:09	05:17	8.1
21 July 2020	21:08	05:18	8.2
18 August 2020	20:22	06:00	9.6
19 August 2020	20:20	06:02	9.7
20 August 2020	20:18	06:03	9.8
21 August 2020	20:16	06:05	9.8
22 August 2020	20:14	06:06	9.9
23 August 2020	20:11	06:08	9.9
24 August 2020	20:09	06:09	10.0
25 August 2020	20:07	06:11	10.1
26 August 2020	20:05	06:12	10.1
08 September 2020	19:37	06:33	10.9
09 September 2020	19:34	06:34	11.0
10 September 2020	19:32	06:36	11.1
11 September 2020	19:30	06:37	11.1
12 September 2020	19:28	06:39	11.2
13 September 2020	19:25	06:40	11.2
14 September 2020	19:23	06:42	11.3
15 September 2020	19:21	06:43	11.4
07 October 2020	18:31	07:18	12.8
08 October 2020	18:29	07:20	12.8
09 October 2020	18:27	07:21	12.9
10 October 2020	18:24	07:23	13.0
11 October 2020	18:22	07:25	13.0
13 October 2020	18:18	07:28	13.2
23 June 2021	21:24	04:53	7.5
24 June 2021	21:24	04:53	7.5
25 June 2021	21:24	04:53	7.5
26 June 2021	21:24	04:54	7.5
27 June 2021	21:24	04:54	7.5
28 June 2021	21:24	04:55	7.5
29 June 2021	21:24	04:56	7.5
30 June 2021	21:24	04:56	7.5



Table 1: Ageas Bowl Suntimes for each Survey Night (*continued*)

Night	Sunset (hh:mm)	Sunrise (hh:mm)	Night Length (hours)
02 July 2021	21:23	04:58	7.6
22 July 2021	21:07	05:19	8.2
23 July 2021	21:06	05:21	8.3
24 July 2021	21:04	05:22	8.3
25 July 2021	21:03	05:23	8.3
26 July 2021	21:02	05:25	8.4
27 July 2021	21:00	05:26	8.4
28 July 2021	20:59	05:28	8.5
29 July 2021	20:57	05:29	8.5
30 July 2021	20:56	05:31	8.6
31 July 2021	20:54	05:32	8.6
09 August 2021	20:39	05:46	9.1
10 August 2021	20:37	05:47	9.2
11 August 2021	20:36	05:49	9.2
12 August 2021	20:34	05:50	9.3
13 August 2021	20:32	05:52	9.3
14 August 2021	20:30	05:53	9.4
15 August 2021	20:28	05:55	9.4
16 August 2021	20:26	05:57	9.5
21 September 2021	19:08	06:52	11.7
22 September 2021	19:05	06:54	11.8
23 September 2021	19:03	06:55	11.9
24 September 2021	19:01	06:57	11.9
25 September 2021	18:59	06:59	12.0
26 September 2021	18:56	07:00	12.1
27 September 2021	18:54	07:02	12.1
13 October 2021	18:19	07:27	13.1
14 October 2021	18:16	07:29	13.2
15 October 2021	18:14	07:31	13.3
16 October 2021	18:12	07:32	13.3
17 October 2021	18:10	07:34	13.4
18 October 2021	18:08	07:36	13.5
19 October 2021	18:06	07:37	13.5



2.2 BAT PASSES PER SPECIES

Table 2 shows total number of passes recorded for each species across all of the detectors. A total of 102,451 passes were recorded.

Table 2: Ageas Bowl Species and Number of Bat Passes

<i>Scientific Name</i>	<i>Common Name</i>	<i>Count (No)</i>	<i>Percentage of total (%)</i>
<i>Pipistrellus pipistrellus</i>	Common pipistrelle	70626	68.94
<i>Nyctalus noctula</i>	Noctule	25751	25.13
<i>Pipistrellus pygmaeus</i>	Soprano pipistrelle	5413	5.28
<i>Eptesicus serotinus</i>	Serotine	449	0.44
<i>Myotis spp.</i>	Myotis	124	0.12
<i>Plecotus spp.</i>	Long-eared	38	0.04
<i>Nyctalus leisleri</i>	Leisler's	23	0.02
<i>Pipistrellus nathusii</i>	Nathusius pipistrelle	18	0.02
<i>Barbastella barbastellus</i>	Barbastelle	7	0.01
<i>Nyctalus spp.</i>	Noctule or Leisler's	2	0.00



2.3 LOCATION AND NUMBER OF BAT PASSES

Table 3 shows the location and number of bat passes

Table 3: Number of Bat Passes and Location - part 1 of 2

Species	ST1	ST2
<i>Barbastella barbastellus</i>	7	
<i>Eptesicus serotinus</i>	287	19
<i>Myotis spp.</i>	72	2
<i>Nyctalus leisleri</i>	9	14
<i>Nyctalus noctula</i>	12,150	10,417
<i>Nyctalus spp.</i>	1	
<i>Pipistrellus nathusii</i>	15	1
<i>Pipistrellus pipistrellus</i>	16,375	19,956
<i>Pipistrellus pygmaeus</i>	707	96
<i>Plecotus spp.</i>	23	7

Table 4: Number of Bat Passes and Location - part 2 of 2

Species	ST3	ST4
<i>Barbastella barbastellus</i>		
<i>Eptesicus serotinus</i>	143	
<i>Myotis spp.</i>	10	40
<i>Nyctalus leisleri</i>		
<i>Nyctalus noctula</i>	3,169	15
<i>Nyctalus spp.</i>	1	
<i>Pipistrellus nathusii</i>		2
<i>Pipistrellus pipistrellus</i>	28,317	5,978
<i>Pipistrellus pygmaeus</i>	4,440	170
<i>Plecotus spp.</i>		8



2.4 MONTH AND NUMBER OF BAT PASSES

Table 5 shows the month and number of bat passes

Table 5: Number of Bat Passes and Month

Species	May	Jun	Jul	Aug	Sep	Oct
<i>Barbastella barbastellus</i>			6		1	
<i>Eptesicus serotinus</i>	9	66	190	152	32	
<i>Myotis spp.</i>	4	25	17	36	14	28
<i>Nyctalus leisleri</i>			8	1	12	2
<i>Nyctalus noctula</i>	25	1,283	6,680	10,465	6,801	497
<i>Nyctalus spp.</i>		1				1
<i>Pipistrellus nathusii</i>		12	6			
<i>Pipistrellus pipistrellus</i>	749	13,789	22,411	16,797	10,800	6,080
<i>Pipistrellus pygmaeus</i>	29	117	253	286	2,032	2,696
<i>Plecotus spp.</i>	3	6	10	6	12	1



2.5 MONTH/LOCATION AND NUMBER OF BAT PASSES

Table 6 shows the location, month and number of bat passes

Table 6: Number of Bat Passes, Month and Location

Month	Location	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Myotis</i> spp.	<i>Nyctalus leisleri</i>	<i>Nyctalus noctula</i>	<i>Nyctalus</i> spp.	<i>Pipistrellus nathusii</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Plecotus</i> spp.
May	ST1		8	4		7			402	27	3
	ST2		1			18			347	2	
June	ST1		28	7		1,137	1	10	2,892	92	1
	ST2					126			4,657	7	1
	ST3		38	1		19			2,894	4	
	ST4			17		1		2	3,346	14	4
July	ST1	6	83	7	7	5,087		5	4,192	68	10
	ST2		8	2	1	1,037		1	8,402	8	
	ST3		99			555			7,608	107	
	ST4			8		1			2,209	70	
August	ST1		144	33		4,084			5,435	60	6
	ST2		3		1	4,282			1,860	8	
	ST3		5	3		2,099			9,205	192	
	ST4								297	26	
September	ST1	1	24	11		1,751			2,340	205	3
	ST2		7		12	4,936			4,015	66	6
	ST3		1			113			4,330	1,717	
	ST4			3		1			115	44	3
October	ST1			10	2	84			1,114	255	
	ST2					18			675	5	
	ST3			6		383	1		4,280	2,420	
	ST4			12		12			11	16	1



2.6 MEDIAN BAT PASSES PER HOUR BY LOCATION

Table 7 shows the median *nightly pass rate* (bat passes per hour, per night) of each species.

Bat pass rates are often highly variable between nights, with some nights having few or no passes and other nights having high activity. In these circumstances, the median is likely to be a more useful summary of the 'average' activity than is the mean.

Table 7: Number of Bat Passes and Location - part 1 of 2

Species	ST1	ST2
<i>Barbastella barbastellus</i>	0.12	
<i>Eptesicus serotinus</i>	0.36	0.15
<i>Myotis spp.</i>	0.13	0.13
<i>Nyctalus leisleri</i>	0.12	0.13
<i>Nyctalus noctula</i>	9.13	18.28
<i>Nyctalus spp.</i>	0.13	
<i>Pipistrellus nathusii</i>	0.13	0.13
<i>Pipistrellus pipistrellus</i>	13.90	25.08
<i>Pipistrellus pygmaeus</i>	0.53	0.20
<i>Plecotus spp.</i>	0.12	0.13

Table 8: Number of Bat Passes and Location - part 2 of 2

Species	ST3	ST4
<i>Barbastella barbastellus</i>		
<i>Eptesicus serotinus</i>	0.78	
<i>Myotis spp.</i>	0.18	0.14
<i>Nyctalus leisleri</i>		
<i>Nyctalus noctula</i>	4.80	0.15
<i>Nyctalus spp.</i>	0.08	
<i>Pipistrellus nathusii</i>		0.13
<i>Pipistrellus pipistrellus</i>	107.61	5.57
<i>Pipistrellus pygmaeus</i>	3.39	0.33
<i>Plecotus spp.</i>		0.11



2.7 MEDIAN BAT PASSES PER HOUR BY MONTH

Table 9 shows the median Nightly Pass Rate (bat passes per hour, per night) of each species.

Bat pass rates are often highly variable between nights, with some nights having few or no passes and other nights having high activity. In these circumstances, the median is likely to be a more useful summary of the 'average' activity than is the mean.

Table 9: Median Bat Passes per Hour by Month

<i>Species</i>	May	Jun	Jul	Aug	Sep	Oct
<i>Barbastella barbastellus</i>			0.36		0.09	
<i>Eptesicus serotinus</i>	0.24	0.27	0.51	0.64	0.18	
<i>Myotis spp.</i>	0.12	0.40	0.12	0.32	0.18	0.30
<i>Nyctalus leisleri</i>			0.13	0.10	1.09	0.08
<i>Nyctalus noctula</i>	0.36	7.08	40.00	59.93	25.58	4.53
<i>Nyctalus spp.</i>		0.13				0.08
<i>Pipistrellus nathusii</i>		0.13	0.12			
<i>Pipistrellus pipistrellus</i>	18.01	60.54	85.72	102.46	57.48	13.32
<i>Pipistrellus pygmaeus</i>	0.48	0.73	0.71	0.42	2.73	4.47
<i>Plecotus spp.</i>	0.12	0.13	0.25	0.31	0.09	0.07



2.8 SUMMARY STATISTICS: BAT PASSES PER HOUR GROUPED BY SPECIES/LOCATION

Table 10 shows the summary statistics of the *bat passes per hour* grouped by *species* and *location*

Table 10: Summary Statistics: Bat Pass Rate (per hour)

Species	Location	Minimum	Q1	Mean	Median	Q3	Maximum	SD
<i>Barbastella barbastellus</i>	ST1	0.09	0.10	0.27	0.12	0.36	0.61	0.29
		0.08	0.13	0.61	0.36	0.58	4.15	0.82
<i>Eptesicus serotinus</i>	ST2	0.09	0.12	0.21	0.15	0.27	0.50	0.13
	ST3	0.09	0.21	1.77	0.78	3.19	5.36	1.94
<i>Myotis spp.</i>	ST1	0.07	0.12	0.23	0.13	0.21	2.17	0.36
	ST2	0.13	0.13	0.13	0.13	0.13	0.13	0.00
	ST3	0.11	0.13	0.23	0.18	0.28	0.45	0.16
	ST4	0.08	0.12	0.22	0.14	0.27	0.67	0.15
<i>Nyctalus leisleri</i>	ST1	0.07	0.09	0.16	0.12	0.21	0.36	0.11
	ST2	0.10	0.12	0.44	0.13	0.61	1.09	0.56
<i>Nyctalus noctula</i>	ST1	0.12	3.50	17.47	9.13	26.11	98.92	20.35
	ST2	0.12	1.19	31.37	18.28	41.02	231.22	45.57
	ST3	0.07	0.98	12.38	4.80	17.85	59.04	16.93
	ST4	0.09	0.13	0.18	0.15	0.19	0.38	0.10
<i>Nyctalus spp.</i>	ST1	0.13	0.13	0.13	0.13	0.13	0.13	NA
	ST3	0.08	0.08	0.08	0.08	0.08	0.08	NA
<i>Pipistrellus nathusii</i>	ST1	0.12	0.12	0.32	0.13	0.22	1.19	0.43
	ST2	0.13	0.13	0.13	0.13	0.13	0.13	NA
	ST4	0.13	0.13	0.13	0.13	0.13	0.13	0.00
<i>Pipistrellus pipistrellus</i>	ST1	0.08	5.57	21.29	13.90	25.80	115.06	22.76
	ST2	0.08	5.54	61.04	25.08	111.34	212.32	72.19
	ST3	5.17	45.55	106.72	107.61	149.78	254.99	71.12
	ST4	0.08	1.29	20.58	5.57	26.65	120.04	29.96
<i>Pipistrellus pygmaeus</i>	ST1	0.08	0.24	0.90	0.53	1.03	6.81	1.11
	ST2	0.08	0.12	0.36	0.20	0.43	1.55	0.37
	ST3	0.32	1.05	15.01	3.39	13.04	75.65	22.39
	ST4	0.07	0.19	0.51	0.33	0.53	5.39	0.89
<i>Plecotus spp.</i>	ST1	0.09	0.11	0.19	0.12	0.22	0.51	0.14
	ST2	0.09	0.09	0.13	0.13	0.18	0.18	0.05
	ST4	0.07	0.08	0.11	0.11	0.13	0.13	0.03



2.10 SUMMARY STATISTICS: BAT PASSES PER HOUR GROUPED BY LOCATION

Table 12 shows the summary statistics of the *bat passes per hour by location*

Table 12: Summary Statistics: Bat Pass Rate (per hour)

Location	Species	Minimum	Q1	Mean	Median	Q3	Maximum	SD
ST1	<i>Barbastella barbastellus</i>	0.09	0.10	0.27	0.12	0.36	0.61	0.09
	<i>Eptesicus serotinus</i>	0.08	0.13	0.61	0.36	0.58	4.15	0.08
	<i>Myotis spp.</i>	0.07	0.12	0.23	0.13	0.21	2.17	0.07
	<i>Nyctalus leisleri</i>	0.07	0.09	0.16	0.12	0.21	0.36	0.07
	<i>Nyctalus noctula</i>	0.12	3.50	17.47	9.13	26.11	98.92	0.12
	<i>Nyctalus spp.</i>	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	<i>Pipistrellus nathusii</i>	0.12	0.12	0.32	0.13	0.22	1.19	0.12
	<i>Pipistrellus pipistrellus</i>	0.08	5.57	21.29	13.90	25.80	115.06	0.08
	<i>Pipistrellus pygmaeus</i>	0.08	0.24	0.90	0.53	1.03	6.81	0.08
	<i>Plecotus spp.</i>	0.09	0.11	0.19	0.12	0.22	0.51	0.09
ST2	<i>Eptesicus serotinus</i>	0.09	0.12	0.21	0.15	0.27	0.50	0.09
	<i>Myotis spp.</i>	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	<i>Nyctalus leisleri</i>	0.10	0.12	0.44	0.13	0.61	1.09	0.10
	<i>Nyctalus noctula</i>	0.12	1.19	31.37	18.28	41.02	231.22	0.12
	<i>Pipistrellus nathusii</i>	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	<i>Pipistrellus pipistrellus</i>	0.08	5.54	61.04	25.08	111.34	212.32	0.08
	<i>Pipistrellus pygmaeus</i>	0.08	0.12	0.36	0.20	0.43	1.55	0.08
	<i>Plecotus spp.</i>	0.09	0.09	0.13	0.13	0.18	0.18	0.09
ST3	<i>Eptesicus serotinus</i>	0.09	0.21	1.77	0.78	3.19	5.36	0.09
	<i>Myotis spp.</i>	0.11	0.13	0.23	0.18	0.28	0.45	0.11
	<i>Nyctalus noctula</i>	0.07	0.98	12.38	4.80	17.85	59.04	0.07
	<i>Nyctalus spp.</i>	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	<i>Pipistrellus pipistrellus</i>	5.17	45.55	106.72	107.61	149.78	254.99	5.17
	<i>Pipistrellus pygmaeus</i>	0.32	1.05	15.01	3.39	13.04	75.65	0.32
ST4	<i>Myotis spp.</i>	0.08	0.12	0.22	0.14	0.27	0.67	0.08
	<i>Nyctalus noctula</i>	0.09	0.13	0.18	0.15	0.19	0.38	0.09
	<i>Pipistrellus nathusii</i>	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	<i>Pipistrellus pipistrellus</i>	0.08	1.29	20.58	5.57	26.65	120.04	0.08
	<i>Pipistrellus pygmaeus</i>	0.07	0.19	0.51	0.33	0.53	5.39	0.07
	<i>Plecotus spp.</i>	0.07	0.08	0.11	0.11	0.13	0.13	0.07



2.12 LOCATIONS NEAR A BAT ROOST

Table 14 presents the bat observations, within the estimated emergence time, for a species to exit the roost; indicating that a roost for that species is nearby. The roost emergence times for the bat species is based on the work of (Russ 2012); the calculation has used the upper roost emergence time as the threshold to be included in the list of bats potentially near a roost.

Table 14: Locations Near a Bat Roost

Location	Bat Species	Bat Passes Near Roost
ST1	<i>Eptesicus serotinus</i>	7
	<i>Myotis spp.</i>	26
	<i>Nyctalus noctula</i>	17
	<i>Pipistrellus pipistrellus</i>	2449
	<i>Pipistrellus pygmaeus</i>	41
	<i>Plecotus spp.</i>	4
ST2	<i>Eptesicus serotinus</i>	1
	<i>Nyctalus noctula</i>	53
	<i>Pipistrellus pipistrellus</i>	206
	<i>Pipistrellus pygmaeus</i>	2
ST3	<i>Myotis spp.</i>	8
	<i>Nyctalus noctula</i>	8
	<i>Nyctalus spp.</i>	1
	<i>Pipistrellus pipistrellus</i>	275
	<i>Pipistrellus pygmaeus</i>	2
ST4	<i>Myotis spp.</i>	9
	<i>Nyctalus noctula</i>	2
	<i>Pipistrellus pipistrellus</i>	73
	<i>Pipistrellus pygmaeus</i>	9
	<i>Plecotus spp.</i>	1

Table 15 details the roost emergence time range (Russ 2012) for the bat species recorded at the site. The lower and upper columns show the roost emergence time range (Russ 2012), in minutes, for the bat species relative to sunset; in practice the calculation for the table above only used the upper limit, listing bats recored before this time; any observation nearer or before sunset is likely to be a stronger indication that a roost is nearby.

Table 15: Roost Emergence Times for Bats Observed

Species	lower	upper
<i>Nyctalus noctula</i>	5	9
<i>Pipistrellus pipistrellus</i>	22	32
<i>Myotis spp.</i>	30	70
<i>Pipistrellus pygmaeus</i>	22	28
<i>Plecotus spp.</i>	40	60
<i>Eptesicus serotinus</i>	20	25
<i>Nyctalus spp.</i>	5	18



2.13 DATE LOCATION AND ROOST EMERGENCE

Table 16 details the date location and potential roost emergence for each species of bat

Table 16: Locations, Survey Date and Roost Emergence

Location	Night	Bat Species	Passes Near Roost (No.)
	14 May 2020	<i>Pipistrellus pipistrellus</i>	38
	15 May 2020	<i>Pipistrellus pipistrellus</i>	79
	15 May 2020	<i>Pipistrellus pygmaeus</i>	2
	16 May 2020	<i>Eptesicus serotinus</i>	1
	16 May 2020	<i>Myotis spp.</i>	1
	16 May 2020	<i>Pipistrellus pipistrellus</i>	14
	16 May 2020	<i>Pipistrellus pygmaeus</i>	2
	16 May 2020	<i>Plecotus spp.</i>	1
	17 May 2020	<i>Eptesicus serotinus</i>	1
	17 May 2020	<i>Myotis spp.</i>	2
	17 May 2020	<i>Nyctalus noctula</i>	1
	17 May 2020	<i>Pipistrellus pipistrellus</i>	58
	17 May 2020	<i>Pipistrellus pygmaeus</i>	3
	18 May 2020	<i>Eptesicus serotinus</i>	2
	18 May 2020	<i>Pipistrellus pipistrellus</i>	58
	18 May 2020	<i>Pipistrellus pygmaeus</i>	4
	10 June 2020	<i>Pipistrellus pipistrellus</i>	6
	10 June 2020	<i>Pipistrellus pygmaeus</i>	1
	11 June 2020	<i>Pipistrellus pipistrellus</i>	1
	12 June 2020	<i>Pipistrellus pipistrellus</i>	5
	13 June 2020	<i>Pipistrellus pipistrellus</i>	30
	14 June 2020	<i>Pipistrellus pipistrellus</i>	1
	15 June 2020	<i>Pipistrellus pipistrellus</i>	72
	16 June 2020	<i>Pipistrellus pipistrellus</i>	62
	17 June 2020	<i>Pipistrellus pipistrellus</i>	121
	18 June 2020	<i>Pipistrellus pipistrellus</i>	12
	20 June 2020	<i>Pipistrellus pipistrellus</i>	205
	21 June 2020	<i>Pipistrellus pipistrellus</i>	18
	13 July 2020	<i>Eptesicus serotinus</i>	1
	13 July 2020	<i>Pipistrellus pipistrellus</i>	35
	14 July 2020	<i>Pipistrellus pipistrellus</i>	1
	15 July 2020	<i>Pipistrellus pipistrellus</i>	15
	16 July 2020	<i>Pipistrellus pipistrellus</i>	3
	18 July 2020	<i>Pipistrellus pipistrellus</i>	59
	18 July 2020	<i>Plecotus spp.</i>	1
	19 July 2020	<i>Pipistrellus pipistrellus</i>	29
	20 July 2020	<i>Pipistrellus pipistrellus</i>	12
	21 July 2020	<i>Nyctalus noctula</i>	1
	21 July 2020	<i>Pipistrellus pipistrellus</i>	7
	19 August 2020	<i>Eptesicus serotinus</i>	1
	19 August 2020	<i>Pipistrellus pipistrellus</i>	2
	20 August 2020	<i>Plecotus spp.</i>	1
	21 August 2020	<i>Eptesicus serotinus</i>	1
	22 August 2020	<i>Plecotus spp.</i>	1
	23 August 2020	<i>Pipistrellus pipistrellus</i>	7
	24 August 2020	<i>Pipistrellus pipistrellus</i>	3
	24 August 2020	<i>Pipistrellus pygmaeus</i>	1
	25 August 2020	<i>Pipistrellus pipistrellus</i>	2
	26 August 2020	<i>Pipistrellus pipistrellus</i>	2
	08 September 2020	<i>Myotis spp.</i>	1
	08 September 2020	<i>Nyctalus noctula</i>	5
	08 September 2020	<i>Pipistrellus pipistrellus</i>	8
	09 September 2020	<i>Pipistrellus pipistrellus</i>	9
	09 September 2020	<i>Pipistrellus pygmaeus</i>	1
	10 September 2020	<i>Pipistrellus pipistrellus</i>	1
	11 September 2020	<i>Pipistrellus pipistrellus</i>	7
	12 September 2020	<i>Myotis spp.</i>	1
	12 September 2020	<i>Pipistrellus pipistrellus</i>	7
	12 September 2020	<i>Pipistrellus pygmaeus</i>	2
	13 September 2020	<i>Nyctalus noctula</i>	2
	13 September 2020	<i>Pipistrellus pipistrellus</i>	1
	13 September 2020	<i>Pipistrellus pygmaeus</i>	2
	14 September 2020	<i>Pipistrellus pipistrellus</i>	65
	15 September 2020	<i>Myotis spp.</i>	2
	15 September 2020	<i>Nyctalus noctula</i>	1
	15 September 2020	<i>Pipistrellus pipistrellus</i>	18



Table 16: Locations, Survey Date and Roost Emergence (continued)

Location	Night	Bat Species	Passes Near Roost (No.)
	07 October 2020	<i>Pipistrellus pipistrellus</i>	13
	08 October 2020	<i>Pipistrellus pipistrellus</i>	5
	08 October 2020	<i>Pipistrellus pygmaeus</i>	2
	10 October 2020	<i>Pipistrellus pipistrellus</i>	1
	11 October 2020	<i>Pipistrellus pipistrellus</i>	2
	11 October 2020	<i>Pipistrellus pygmaeus</i>	1
	13 October 2020	<i>Pipistrellus pipistrellus</i>	1
	23 June 2021	<i>Pipistrellus pipistrellus</i>	88
	24 June 2021	<i>Pipistrellus pipistrellus</i>	170
	25 June 2021	<i>Pipistrellus pipistrellus</i>	3
	26 June 2021	<i>Pipistrellus pipistrellus</i>	129
	29 June 2021	<i>Nyctalus noctula</i>	5
	29 June 2021	<i>Pipistrellus pipistrellus</i>	84
	30 June 2021	<i>Pipistrellus pipistrellus</i>	215
	01 July 2021	<i>Pipistrellus pipistrellus</i>	90
	02 July 2021	<i>Pipistrellus pipistrellus</i>	209
	02 July 2021	<i>Pipistrellus pygmaeus</i>	1
	23 July 2021	<i>Pipistrellus pipistrellus</i>	1
	24 July 2021	<i>Pipistrellus pipistrellus</i>	25
	25 July 2021	<i>Pipistrellus pipistrellus</i>	58
	26 July 2021	<i>Pipistrellus pipistrellus</i>	66
	10 August 2021	<i>Nyctalus noctula</i>	1
	10 August 2021	<i>Pipistrellus pipistrellus</i>	2
	11 August 2021	<i>Myotis spp.</i>	19
	14 August 2021	<i>Pipistrellus pipistrellus</i>	21
	21 September 2021	<i>Pipistrellus pipistrellus</i>	12
	22 September 2021	<i>Pipistrellus pipistrellus</i>	6
	22 September 2021	<i>Pipistrellus pygmaeus</i>	1
	23 September 2021	<i>Nyctalus noctula</i>	1
	23 September 2021	<i>Pipistrellus pipistrellus</i>	6
	23 September 2021	<i>Pipistrellus pygmaeus</i>	2
	24 September 2021	<i>Pipistrellus pipistrellus</i>	7
	25 September 2021	<i>Pipistrellus pipistrellus</i>	26
	25 September 2021	<i>Pipistrellus pygmaeus</i>	2
	13 October 2021	<i>Pipistrellus pipistrellus</i>	26
	14 October 2021	<i>Pipistrellus pipistrellus</i>	11
	15 October 2021	<i>Pipistrellus pipistrellus</i>	4
	15 October 2021	<i>Pipistrellus pygmaeus</i>	2
	16 October 2021	<i>Pipistrellus pipistrellus</i>	5
	17 October 2021	<i>Pipistrellus pipistrellus</i>	8
	17 October 2021	<i>Pipistrellus pygmaeus</i>	1
	18 October 2021	<i>Pipistrellus pipistrellus</i>	11
	18 October 2021	<i>Pipistrellus pygmaeus</i>	5
	19 October 2021	<i>Pipistrellus pipistrellus</i>	71
	19 October 2021	<i>Pipistrellus pygmaeus</i>	3
ST2	14 May 2020	<i>Pipistrellus pipistrellus</i>	5
	15 May 2020	<i>Nyctalus noctula</i>	1
	15 May 2020	<i>Pipistrellus pipistrellus</i>	5
	16 May 2020	<i>Nyctalus noctula</i>	2
	16 May 2020	<i>Pipistrellus pipistrellus</i>	41
	17 May 2020	<i>Eptesicus serotinus</i>	1
	17 May 2020	<i>Nyctalus noctula</i>	3
	17 May 2020	<i>Pipistrellus pipistrellus</i>	22
	17 May 2020	<i>Pipistrellus pygmaeus</i>	1
	18 May 2020	<i>Pipistrellus pipistrellus</i>	118
	18 May 2020	<i>Pipistrellus pygmaeus</i>	1
	10 June 2020	<i>Pipistrellus pipistrellus</i>	2
	13 July 2020	<i>Pipistrellus pipistrellus</i>	3
	14 July 2020	<i>Nyctalus noctula</i>	1
	15 July 2020	<i>Pipistrellus pipistrellus</i>	1
	08 September 2020	<i>Nyctalus noctula</i>	39
	08 September 2020	<i>Pipistrellus pipistrellus</i>	3
	11 September 2020	<i>Pipistrellus pipistrellus</i>	1
	15 September 2020	<i>Nyctalus noctula</i>	7
	08 October 2020	<i>Pipistrellus pipistrellus</i>	1
	09 October 2020	<i>Pipistrellus pipistrellus</i>	1
	11 October 2020	<i>Pipistrellus pipistrellus</i>	2
	13 October 2020	<i>Pipistrellus pipistrellus</i>	1
	23 June 2021	<i>Pipistrellus pipistrellus</i>	48
	24 June 2021	<i>Pipistrellus pipistrellus</i>	74
	25 June 2021	<i>Pipistrellus pipistrellus</i>	28



Table 16: Locations, Survey Date and Roost Emergence (continued)

Location	Night	Bat Species	Passes Near Roost (No.)
ST3	26 June 2021	<i>Pipistrellus pipistrellus</i>	93
	22 July 2021	<i>Pipistrellus pipistrellus</i>	1
	24 July 2021	<i>Pipistrellus pipistrellus</i>	2
	25 July 2021	<i>Pipistrellus pipistrellus</i>	2
	26 July 2021	<i>Nyctalus noctula</i>	1
	09 August 2021	<i>Pipistrellus pipistrellus</i>	3
	10 August 2021	<i>Myotis spp.</i>	2
	10 August 2021	<i>Pipistrellus pipistrellus</i>	13
	11 August 2021	<i>Pipistrellus pipistrellus</i>	1
	12 August 2021	<i>Nyctalus noctula</i>	2
	14 August 2021	<i>Pipistrellus pipistrellus</i>	1
	21 September 2021	<i>Nyctalus noctula</i>	1
	23 September 2021	<i>Nyctalus noctula</i>	1
	24 September 2021	<i>Pipistrellus pipistrellus</i>	1
	25 September 2021	<i>Pipistrellus pygmaeus</i>	2
	13 October 2021	<i>Nyctalus noctula</i>	2
	13 October 2021	<i>Pipistrellus pipistrellus</i>	7
	15 October 2021	<i>Myotis spp.</i>	6
	15 October 2021	<i>Nyctalus noctula</i>	1
	15 October 2021	<i>Nyctalus spp.</i>	1
	15 October 2021	<i>Pipistrellus pipistrellus</i>	1
ST4	23 June 2021	<i>Pipistrellus pygmaeus</i>	1
	24 June 2021	<i>Pipistrellus pipistrellus</i>	5
	26 June 2021	<i>Pipistrellus pipistrellus</i>	4
	29 June 2021	<i>Pipistrellus pipistrellus</i>	18
	30 June 2021	<i>Pipistrellus pipistrellus</i>	21
	01 July 2021	<i>Pipistrellus pipistrellus</i>	5
	02 July 2021	<i>Pipistrellus pipistrellus</i>	17
	22 July 2021	<i>Pipistrellus pipistrellus</i>	1
	23 July 2021	<i>Pipistrellus pipistrellus</i>	1
	10 August 2021	<i>Pipistrellus pygmaeus</i>	1
	21 September 2021	<i>Pipistrellus pygmaeus</i>	2
	22 September 2021	<i>Pipistrellus pygmaeus</i>	1
	23 September 2021	<i>Pipistrellus pygmaeus</i>	1
	23 September 2021	<i>Plecotus spp.</i>	1
	25 September 2021	<i>Pipistrellus pygmaeus</i>	1
	27 September 2021	<i>Pipistrellus pygmaeus</i>	1
	13 October 2021	<i>Myotis spp.</i>	2
	13 October 2021	<i>Nyctalus noctula</i>	2
	13 October 2021	<i>Pipistrellus pipistrellus</i>	1
	14 October 2021	<i>Myotis spp.</i>	1
	15 October 2021	<i>Pipistrellus pygmaeus</i>	1
	16 October 2021	<i>Myotis spp.</i>	3
	17 October 2021	<i>Myotis spp.</i>	3



2.14 BAT PASSES EACH HOUR AFTER SUNSET BY LOCATION

Table 17 give the number of bat passes each hour after sunset by location

Table 17: Bat Passes Each Hour after Sunset

Location	Species	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
ST1	<i>Barbastella barbastellus</i>			5		1					1				
	<i>Eptesicus serotinus</i>		7	80	79	55	40	20	4	1	1				
	<i>Myotis spp.</i>		1	28	8	7	5	6	3	11	3				
	<i>Nyctalus leisleri</i>			2			2	1	1	2	1				
	<i>Nyctalus noctula</i>	3	85	1,558	2,954	2,614	2,339	1,445	698	309	101	15	14	13	2
	<i>Nyctalus spp.</i>				1										
	<i>Pipistrellus nathusii</i>				2	9	2	2							
	<i>Pipistrellus pipistrellus</i>	74	2,170	3,337	2,743	2,419	1,605	1,467	1,251	804	302	38	57	56	52
	<i>Pipistrellus pygmaeus</i>		43	180	125	164	74	40	31	11	10	3	6	10	10
	<i>Plecotus spp.</i>		2	4	5	4	4	2			2				
ST2	<i>Eptesicus serotinus</i>		1	2	4	5	2	2	3						
	<i>Myotis spp.</i>				1					1					
	<i>Nyctalus leisleri</i>			12			1	1							
	<i>Nyctalus noctula</i>	5	72	1,056	2,009	1,818	1,832	1,776	981	514	309	43	2		
	<i>Pipistrellus nathusii</i>			1											
	<i>Pipistrellus pipistrellus</i>		201	979	4,207	4,232	3,783	3,820	2,264	351	84	19	16		
	<i>Pipistrellus pygmaeus</i>		2	19	22	17	15	11	7	1	1		1		
	<i>Plecotus spp.</i>				3		2			1		1			
ST3	<i>Eptesicus serotinus</i>			1	61	45	22	12	2						
	<i>Myotis spp.</i>	3	3	2			2								
	<i>Nyctalus noctula</i>	1	17	164	404	780	742	492	310	169	62	25	1	2	
	<i>Nyctalus spp.</i>	1													
	<i>Pipistrellus pipistrellus</i>		252	3,537	6,496	4,799	4,123	3,978	2,323	1,967	583	157	100	2	
	<i>Pipistrellus pygmaeus</i>		2	631	432	697	549	773	845	223	28	181	70	8	1
ST4	<i>Myotis spp.</i>		1	8	6	7	3	6	5	4					
	<i>Nyctalus noctula</i>		6	2	3		2	2							
	<i>Pipistrellus nathusii</i>					2									
	<i>Pipistrellus pipistrellus</i>		67	2,534	1,230	695	562	350	346	187	7				
	<i>Pipistrellus pygmaeus</i>		9	88	31	6	10	7	8	8	2			1	
	<i>Plecotus spp.</i>			2	3	1	1	1							



3 GRAPHS

3.1 BAT COLOURS

Figure 1 show the colour assigned to each species of bat used for the the figures in this report

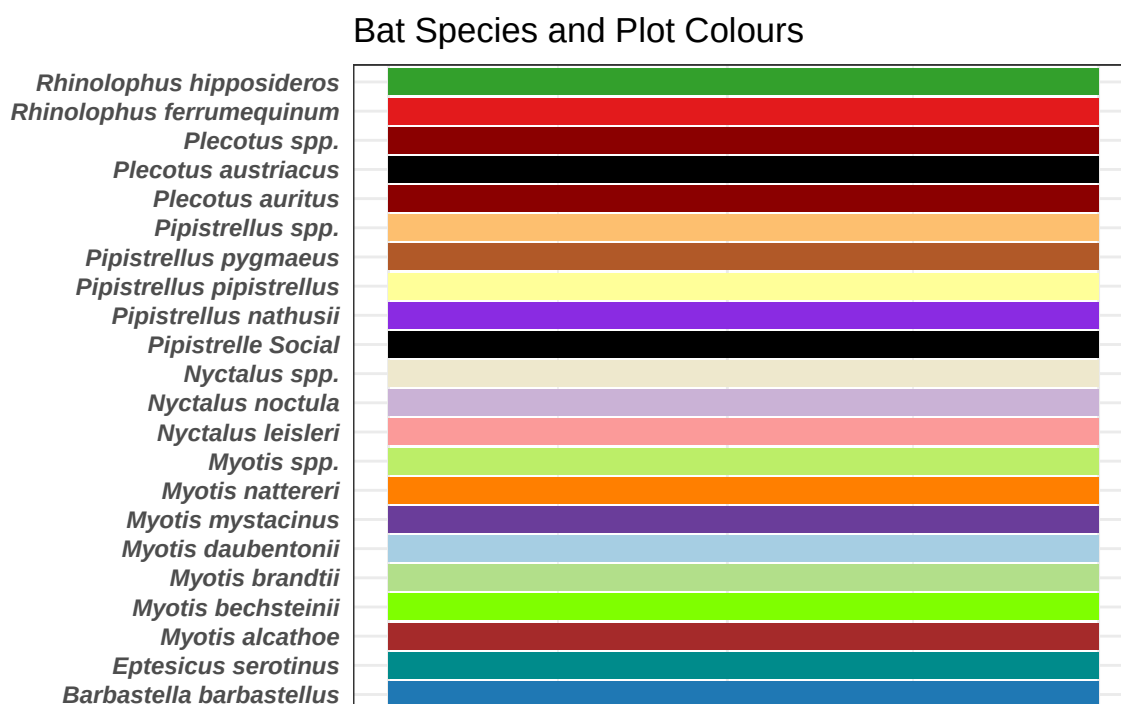


Figure 1: Bat Colours



3.2 ROOST EMERGENCE TIMES AFTER SUNSET

Figure 2 illustrates the potential roost emergence times for each species of bat relative to the sunset time; the times are based on the work of (Russ 2012)

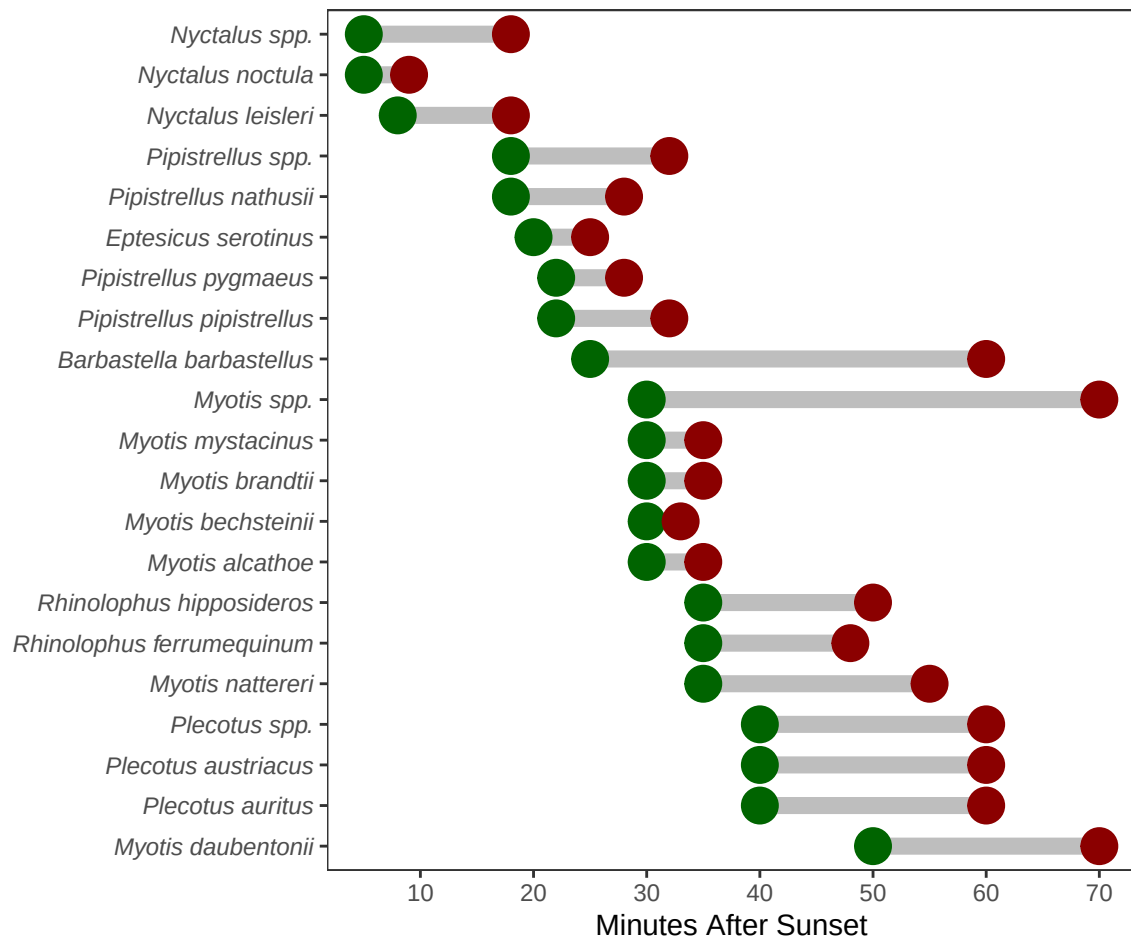


Figure 2: Roost Emergence Times After Sunset



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3.3 PERIOD DETECTOR RECORDED BATS

Figure 3 shows the period the detector was placed in the field recording bats

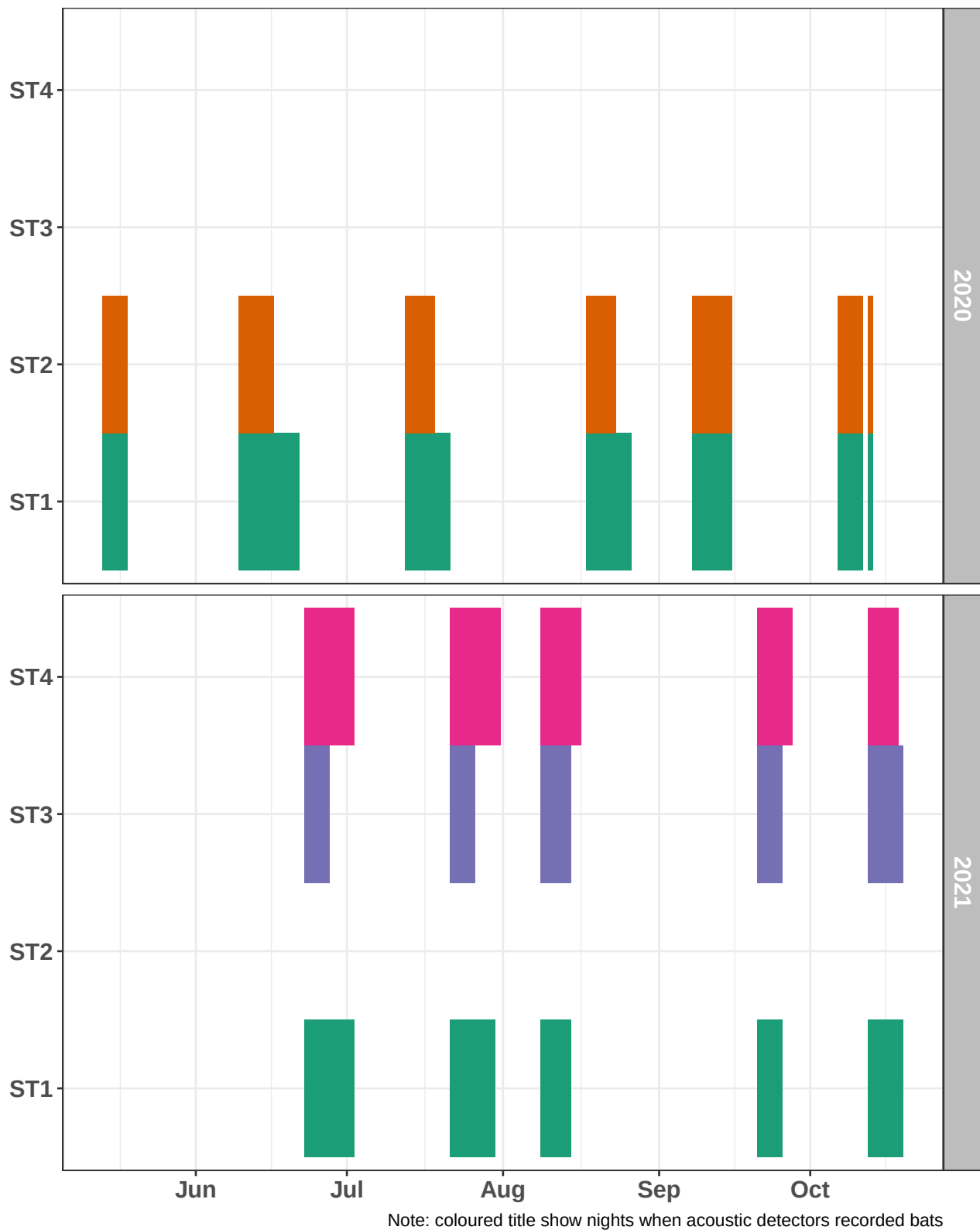


Figure 3: Period Detector Recorded Bats



3.4 DOT CHART: COUNT OF ALL SPECIES OBSERVATIONS

Figure 4 shows the count of all the species observations as a dot chart

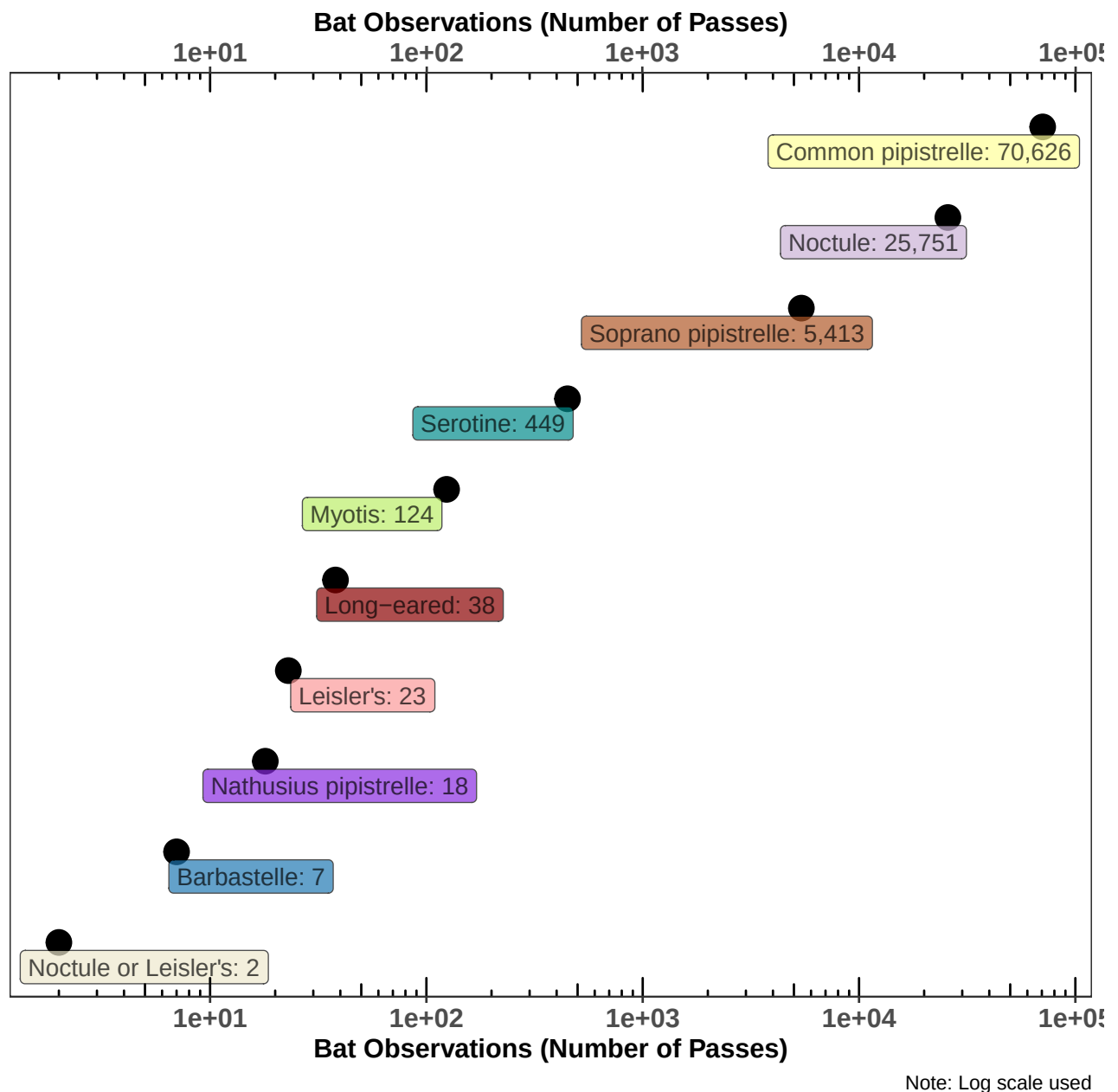


Figure 4: Count of All Species Observations



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3.5 DOT CHART: COUNT OF SPECIES OBSERVATIONS BY LOCATION

Figure 5 shows the count of all the species observations by location as a dot chart

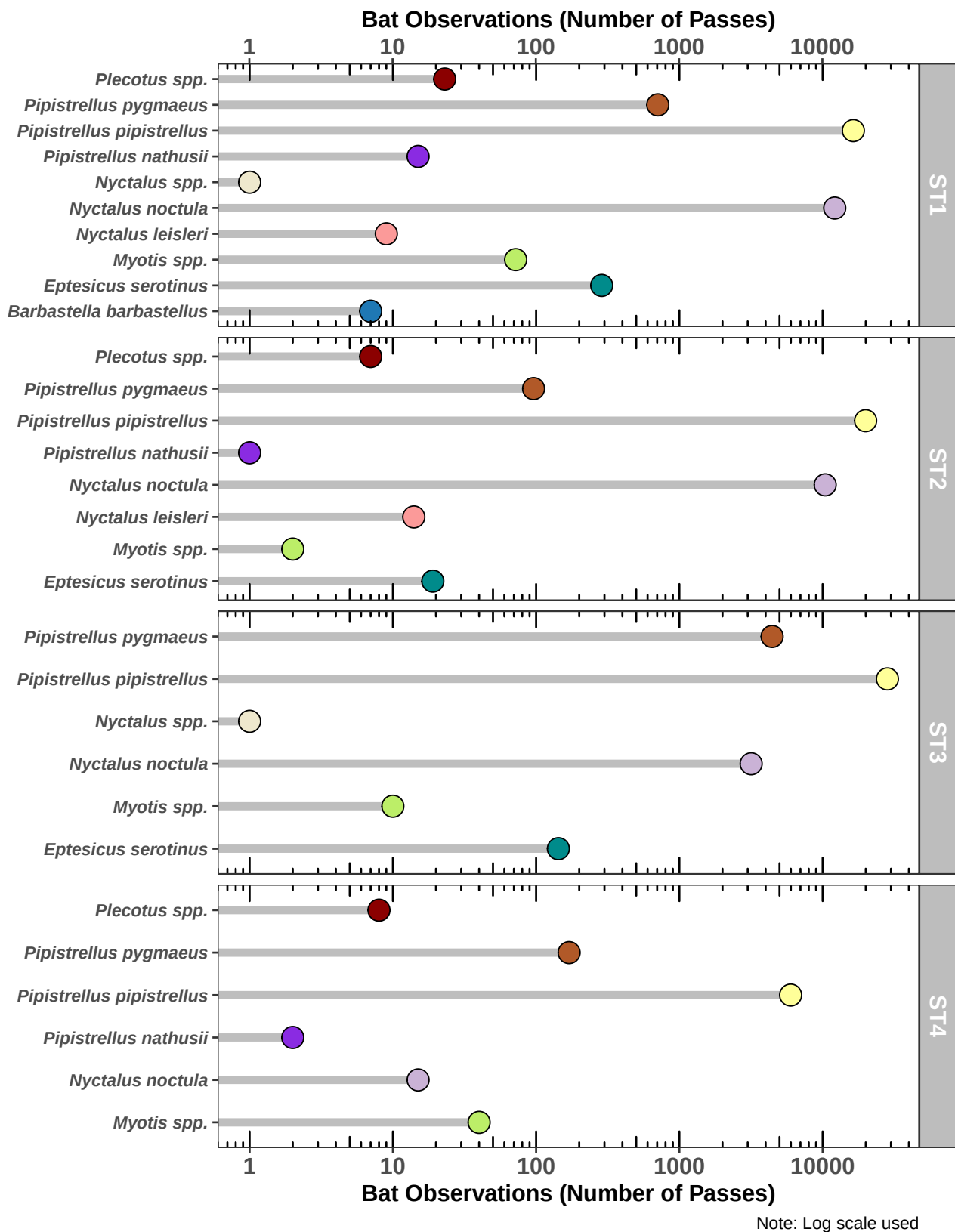


Figure 5: Count of Species Observations by Location



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3.6 ROOST AND OBSERVED EMERGENCE BY LOCATION



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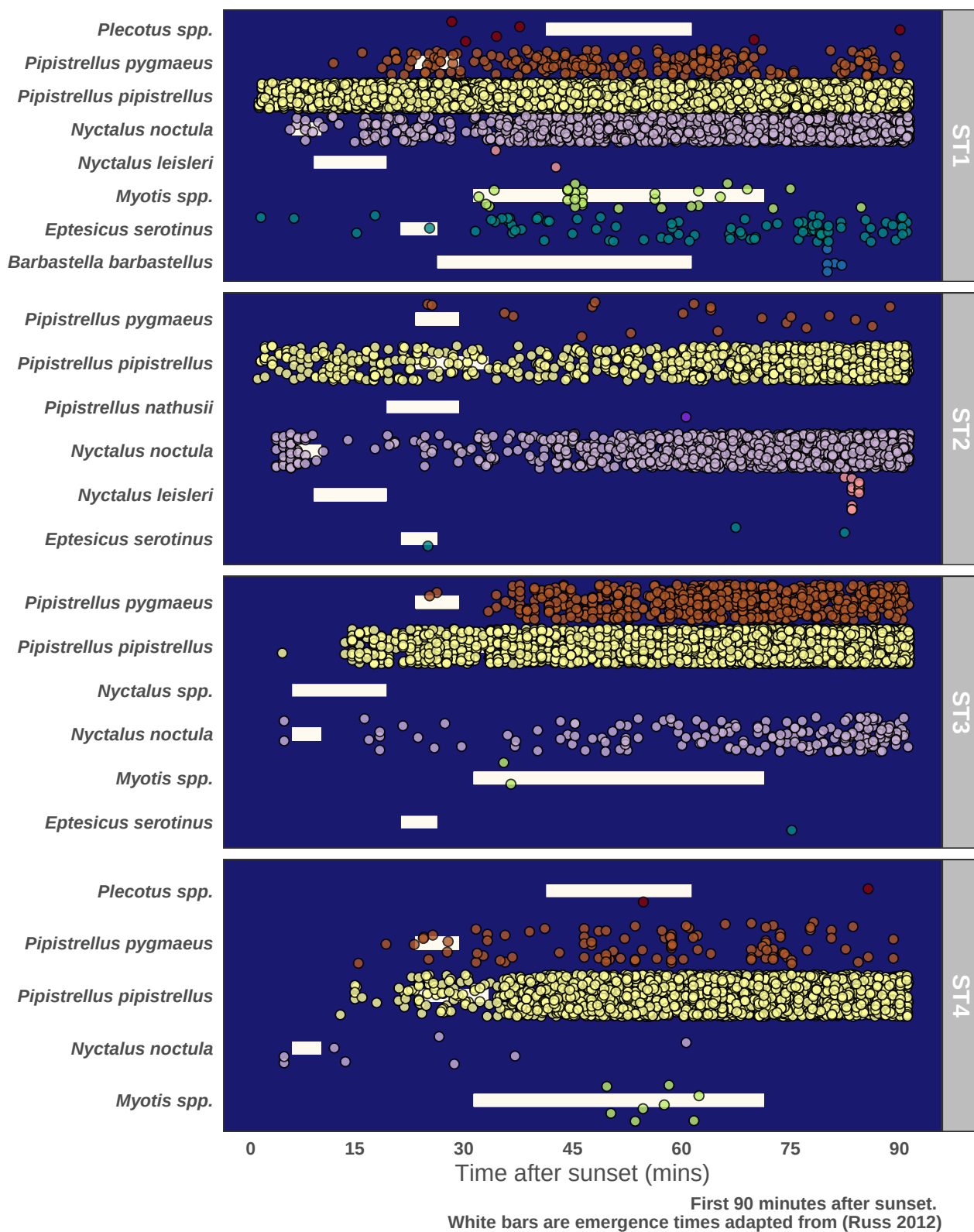


Figure 6: Roost and Observed Emergence by Location



3.7 ROOST AND OBSERVED EMERGENCE BY LOCATION AND YEAR

Figure 7 shows the potential nearness of a roost based on an observed emergence time of less than 90 minutes after sunset. The white bars show the emergence time for the species based on (Russ 2012). The results are shown for location and year



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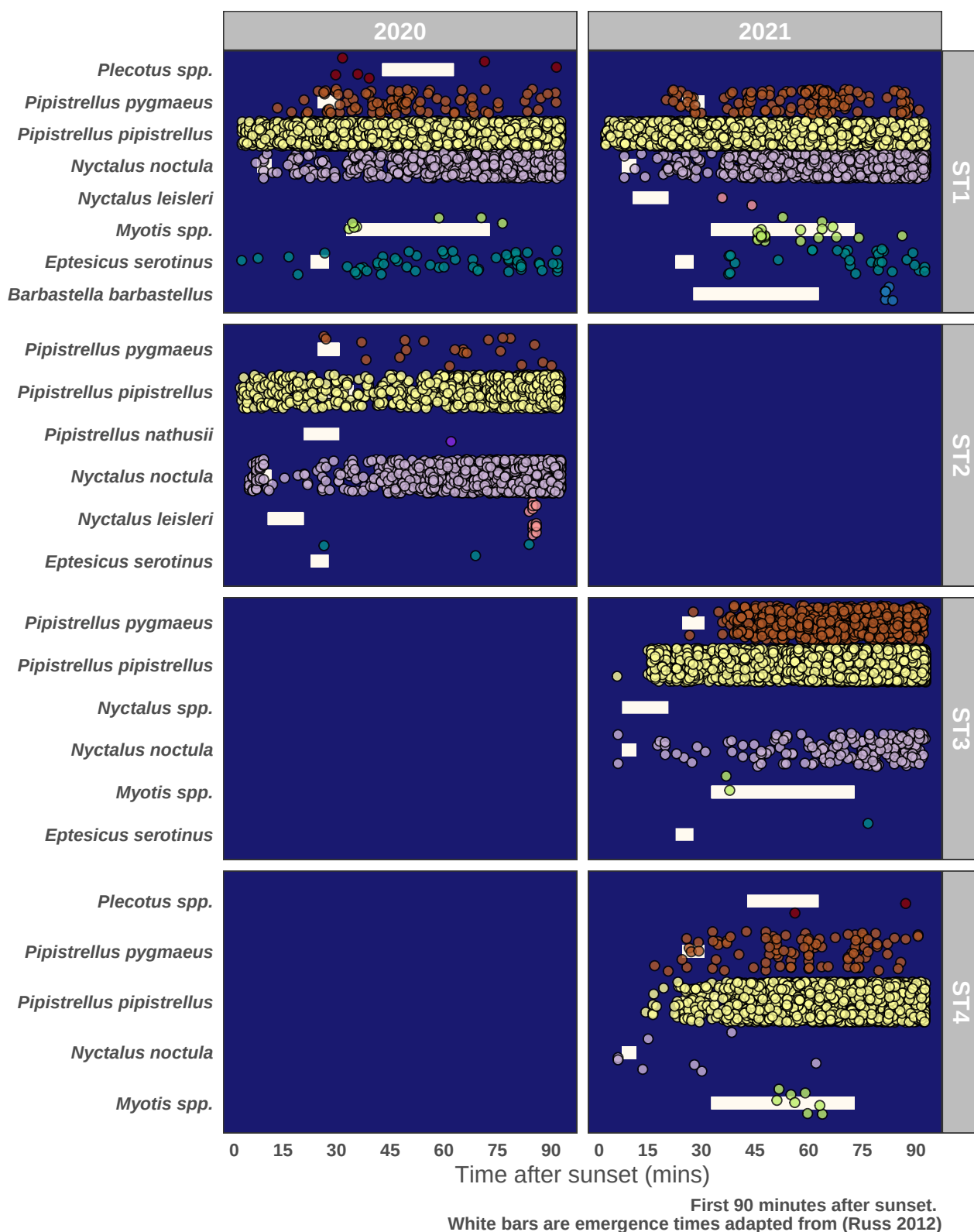


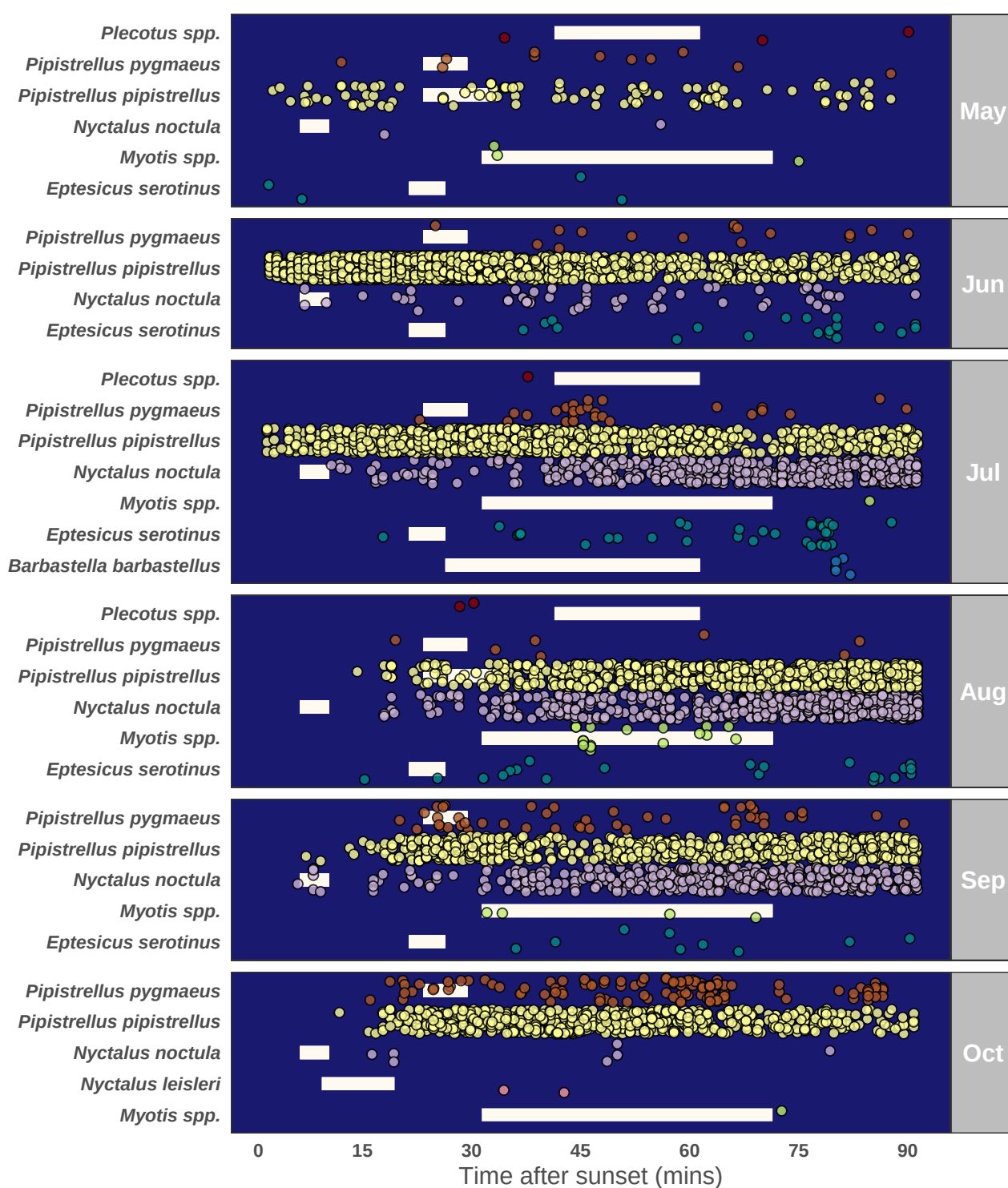
Figure 7: Roost and Observed Emergence by Location and Year



3.8 LOCATION AND OBSERVED EMERGENCE BY MONTH

The Figures below show the potential nearness of a roost based on an observed emergence time of less than 90 minutes after sunset for each month. The white bars show the emergence time for the species based on (Russ 2012).

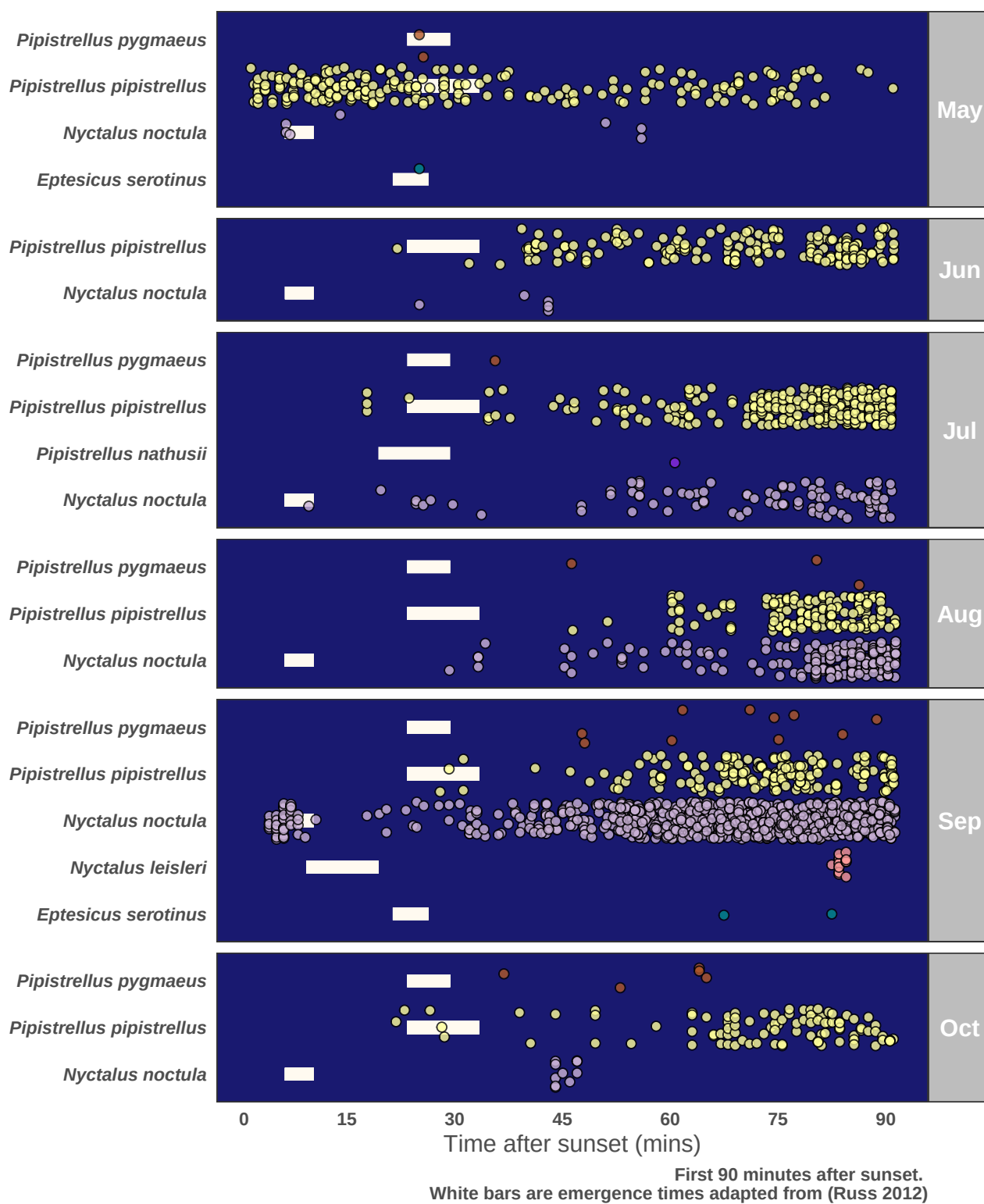
3.8.1 Location :ST1



First 90 minutes after sunset.
White bars are emergence times adapted from (Russ 2012)

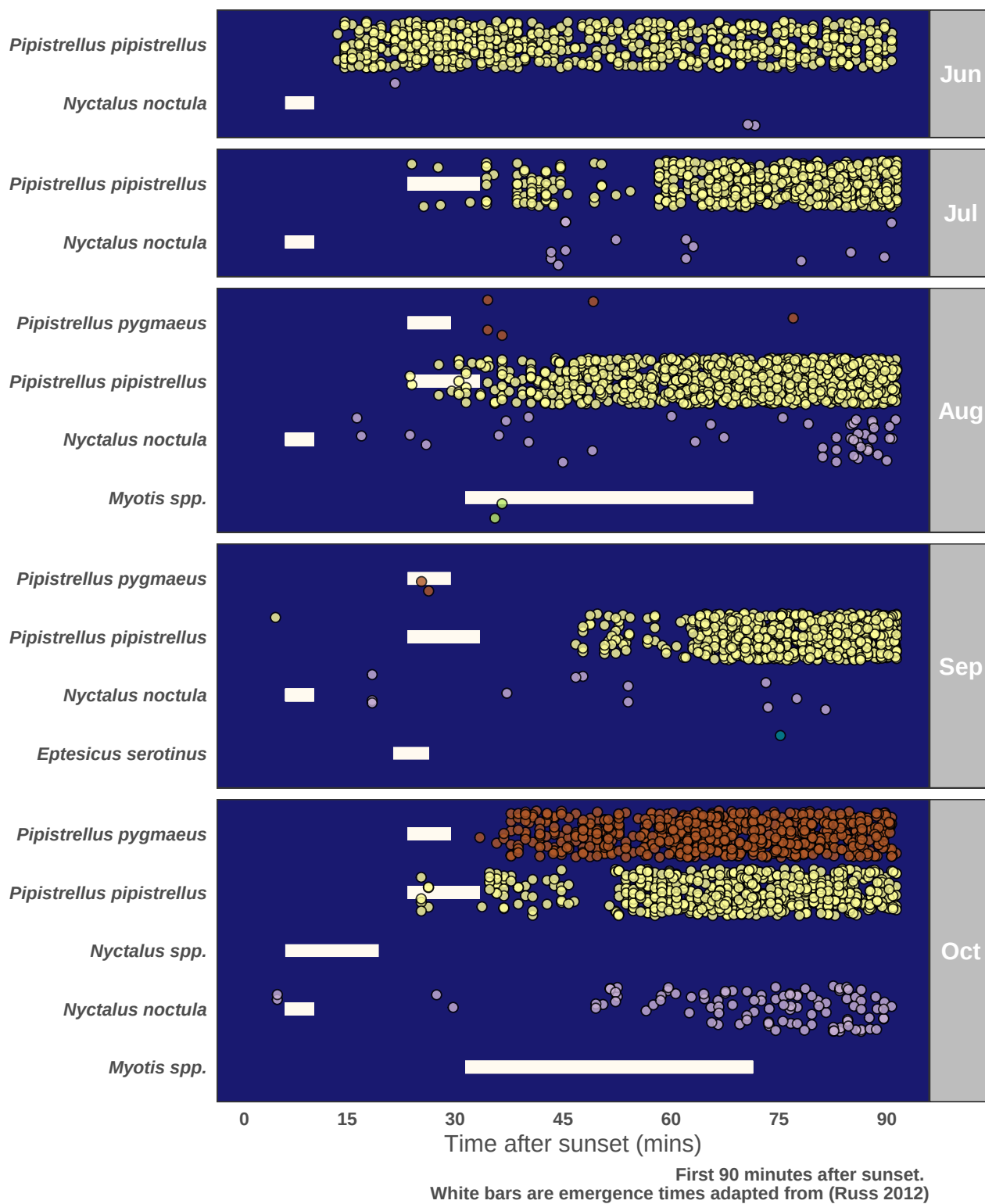


3.8.2 Location :ST2





3.8.3 Location :ST3





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3.8.4 Location :ST4

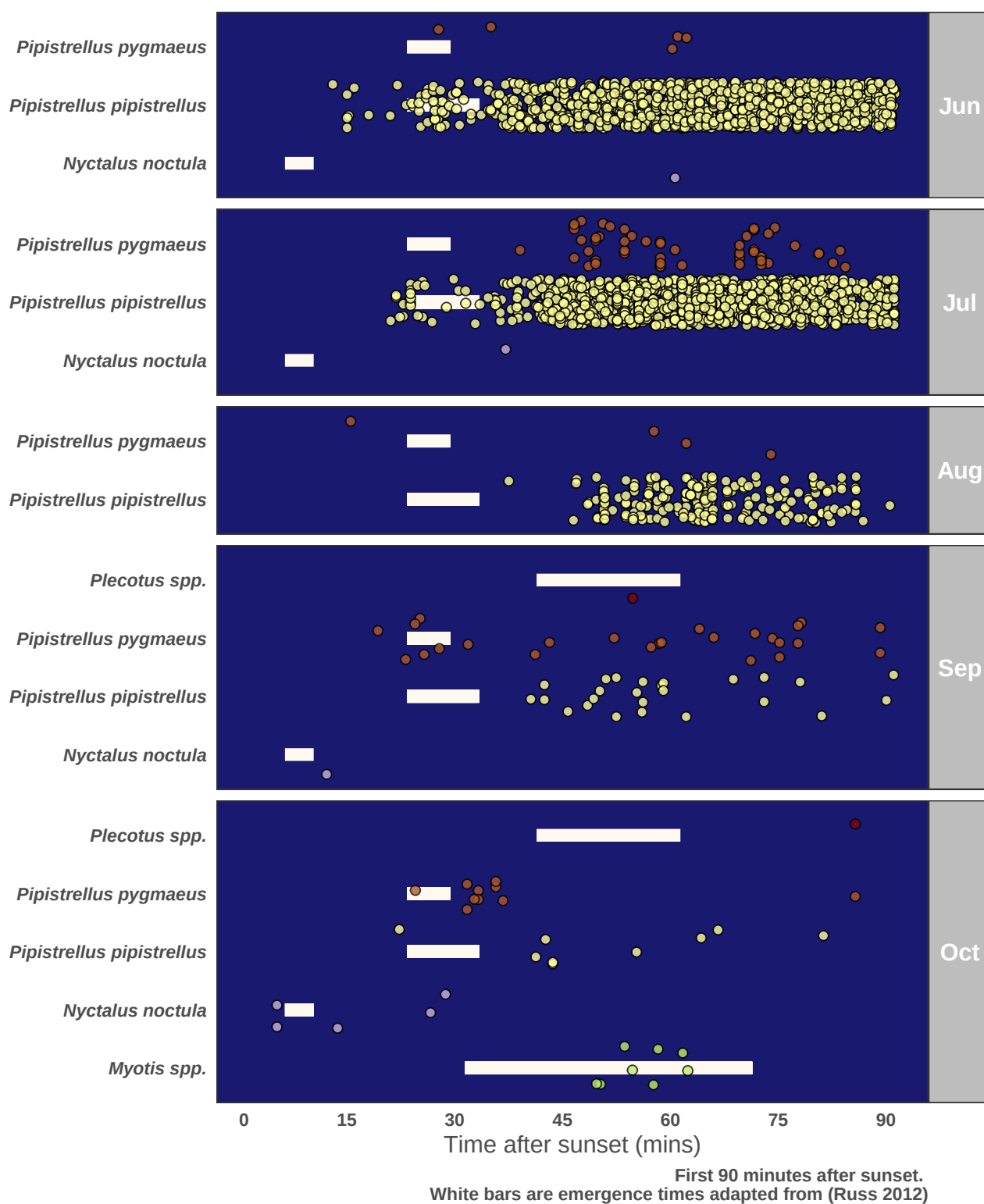


Figure 8: Roost and Observed Emergence by Month



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3.9 OBSERVED DAWN ACTIVITY BY LOCATION

Figure 9 shows the observed dawn activity by location; potentially indicating the nearness of a bat roost.

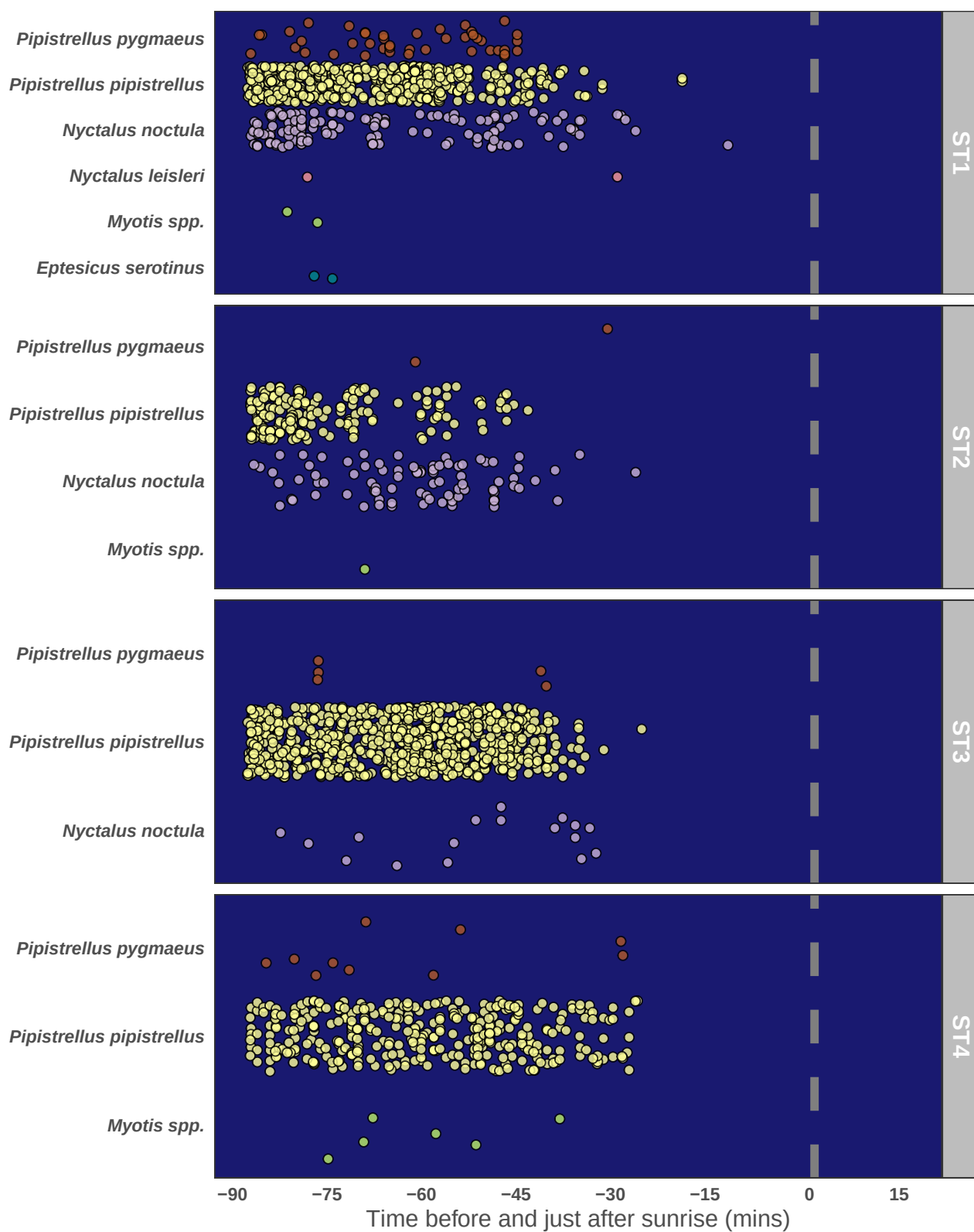
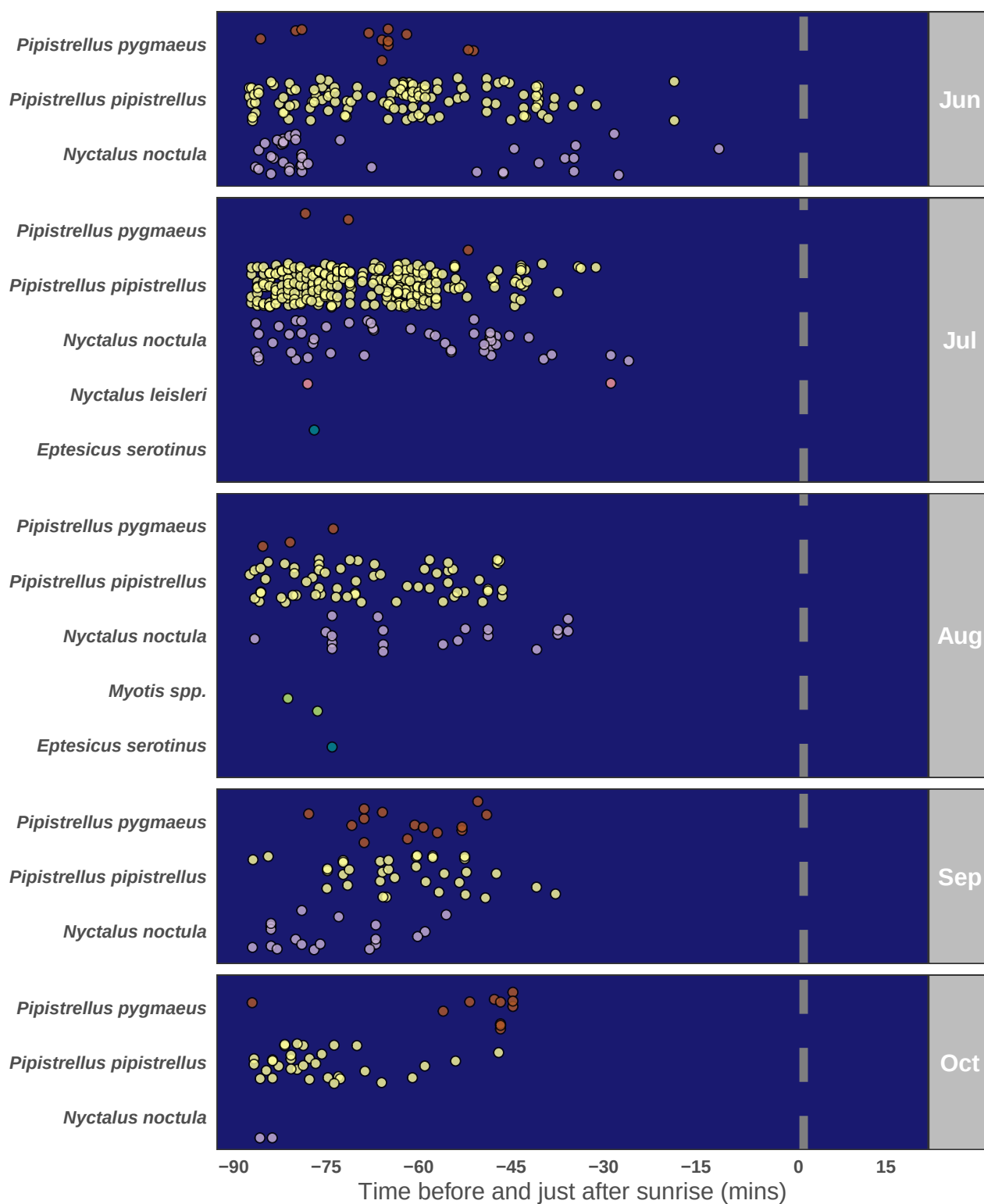


Figure 9: Observed Dawn Activity by Location



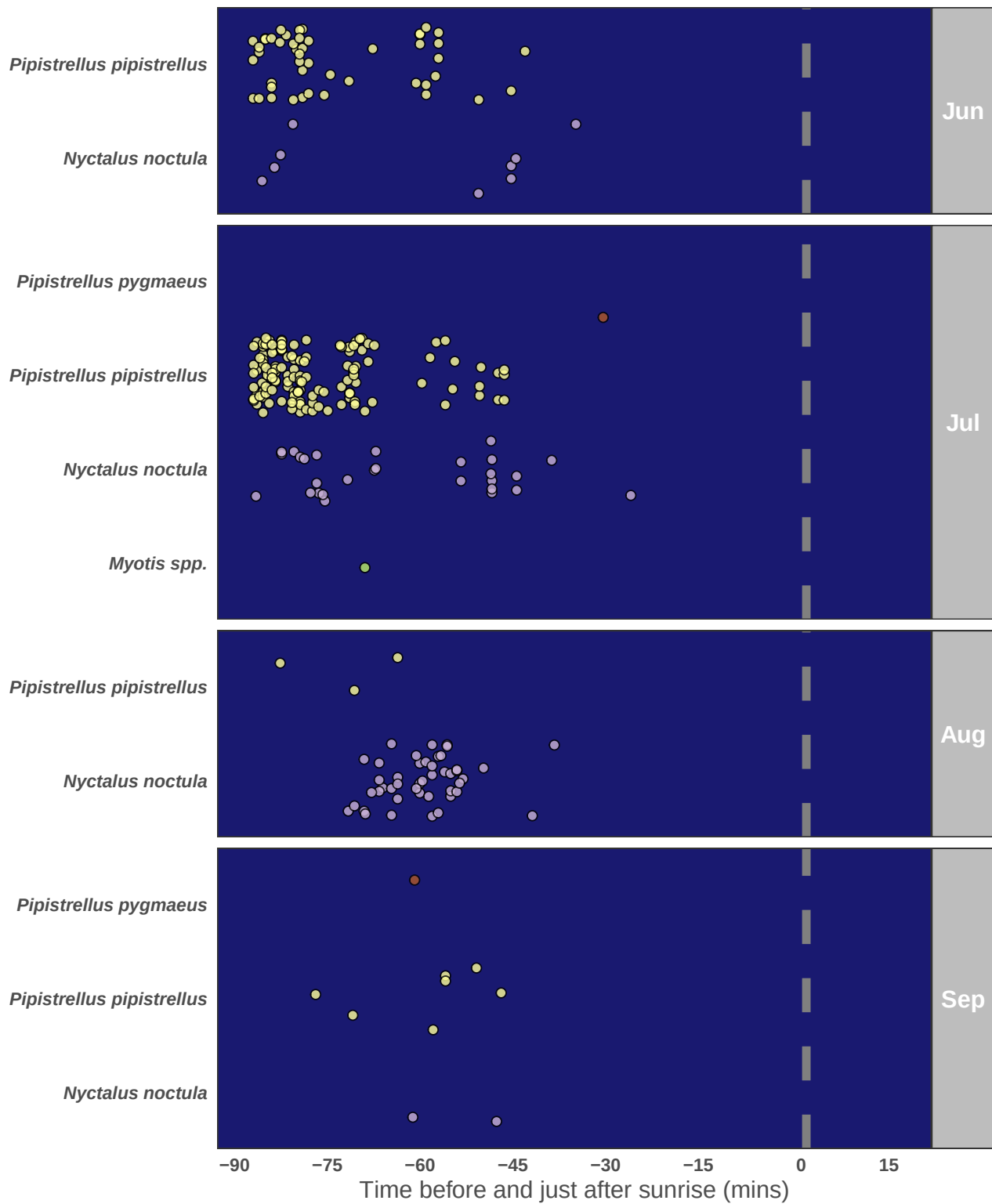
3.10 OBSERVED DAWN ACTIVITY BY LOCATION & MONTH

3.10.1 Location :ST1



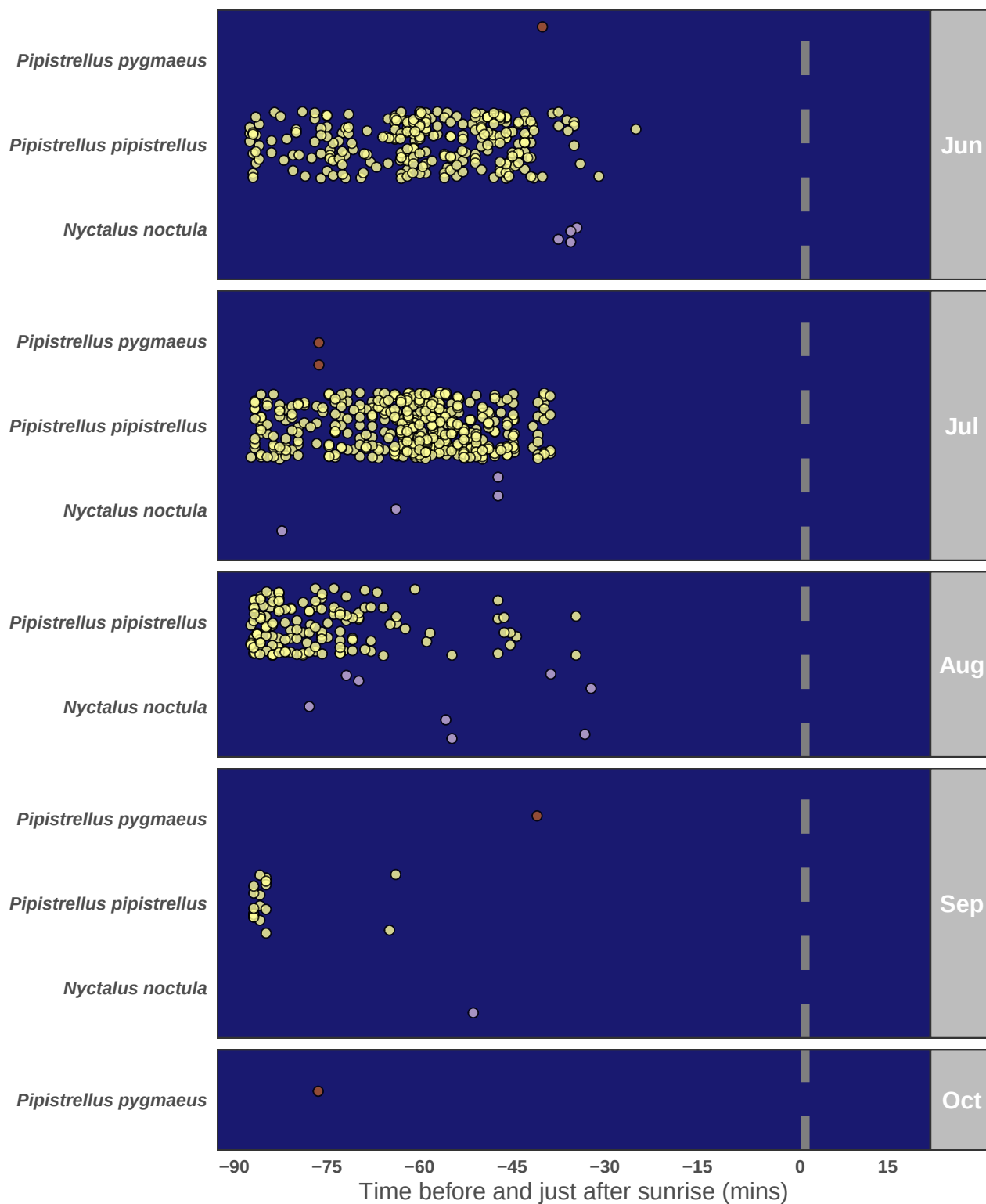


3.10.2 Location :ST2





3.10.3 Location :ST3





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3.10.4 Location :ST4

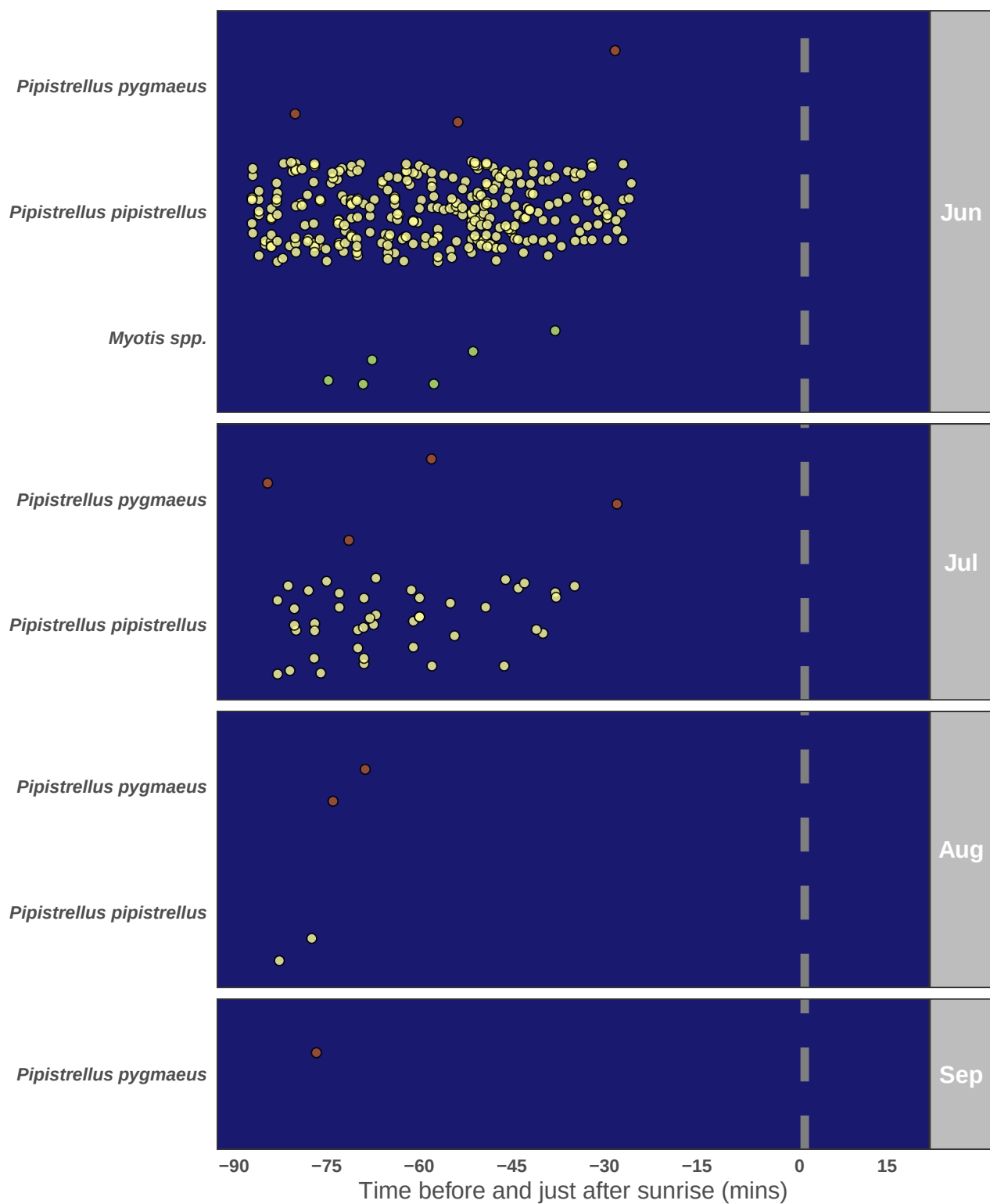


Figure 10: Observed Dawn Activity by Location & Month



3.11 SPECIES AND LOCATION WITH THE NUMBER OF PASSES

Figure 11 shows the species and location with the number of passes



Figure 11: Species and Location with the Number of Passes



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3.12 HOURLY ACTIVITY BY LOCATION AND MONTH

Figure 12 shows the hourly activity by location and month



Figure 12: Hourly Activity by Location and Month



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4 STATISTICS



4.1 COMPARISON OF LOCATION ACTIVITY BY SPECIES

The average bat pass rate has been calculated for the night at each survey location; ST1, ST2, ST3, and ST4 using the formula:

$$\frac{\text{Batpasses}}{\text{Nightlength}}$$

Where:

Batpasses = number of bat pass during the night at the location

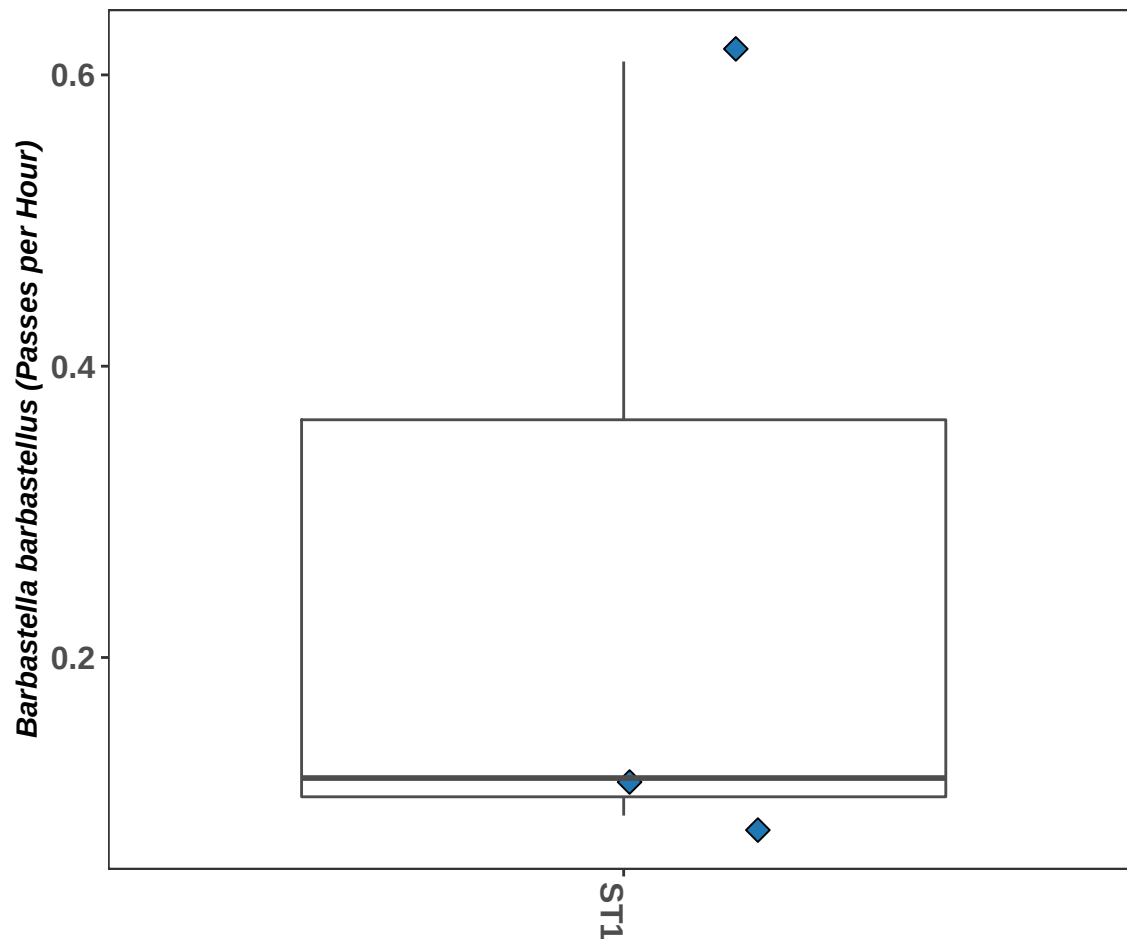
Nightlength = Length of the night in decimal hours

The comparison of locations is undertaken with the Mann-Whitney-Wilcoxon or Kruskal-Wallis test. The Kruskal-Wallis test is a rank-based test that is similar to the Mann-Whitney-Wilcoxon test, but can be applied to one-way data with more than two groups. If there are just two locations the Mann-Whitney-Wilcoxon test is applied. The Kruskal-Wallis test *may* be used when there are only two samples, but the Mann-Whitney-Wilcoxon is more powerful for two samples and is preferred. Both tests assume that the observations are independent. The probability threshold for *statistical significance* used in the tests is: 0.05

- **The Null Hypothesis:** *bat pass rates per hour* are from distributions with the same median.
- **The Alternative Hypothesis:** *bat pass rates per hour* are from distributions with a different median.



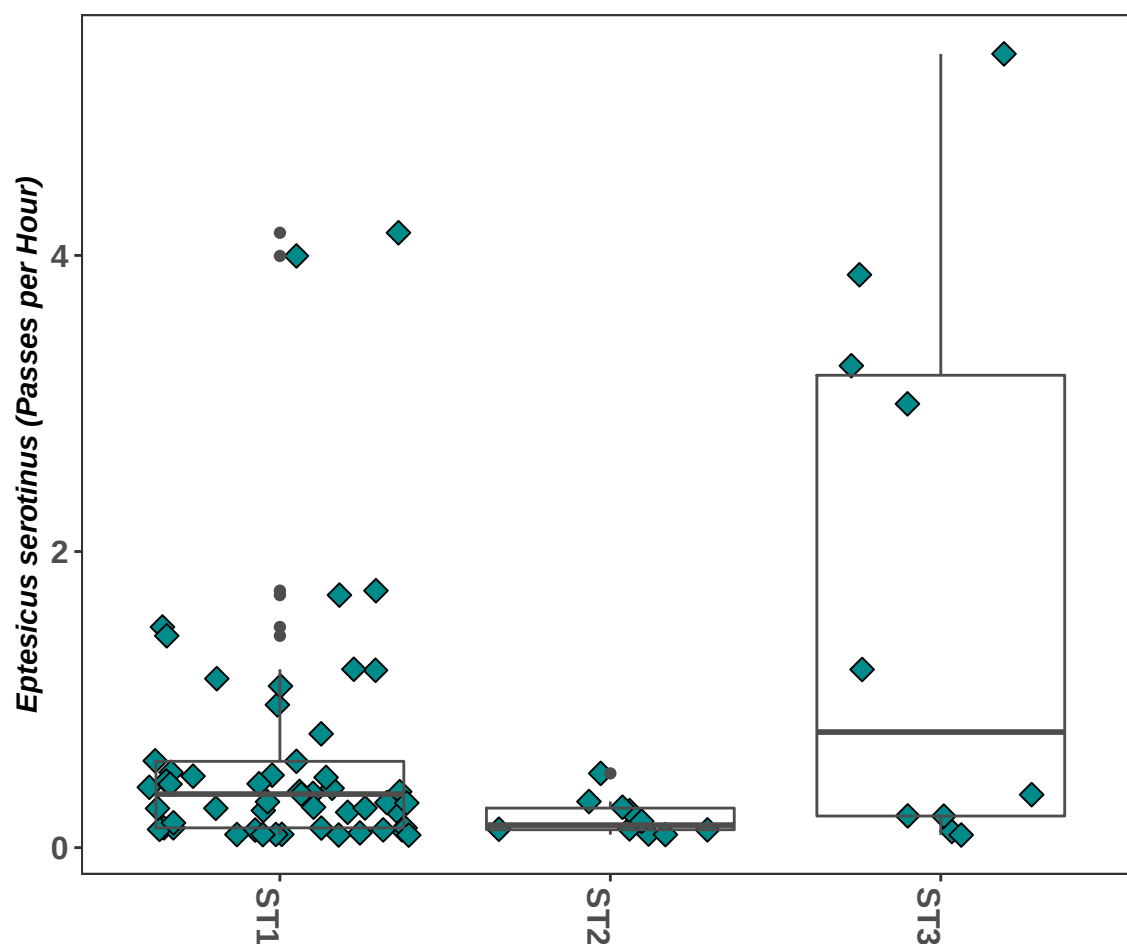
4.1.1 *Barbastella barbastellus*: Statistical Comparison of Activity Between Locations



There is insufficient data to undertake the Kruskal-Wallis or Mann-Whitney-Wilcoxon test



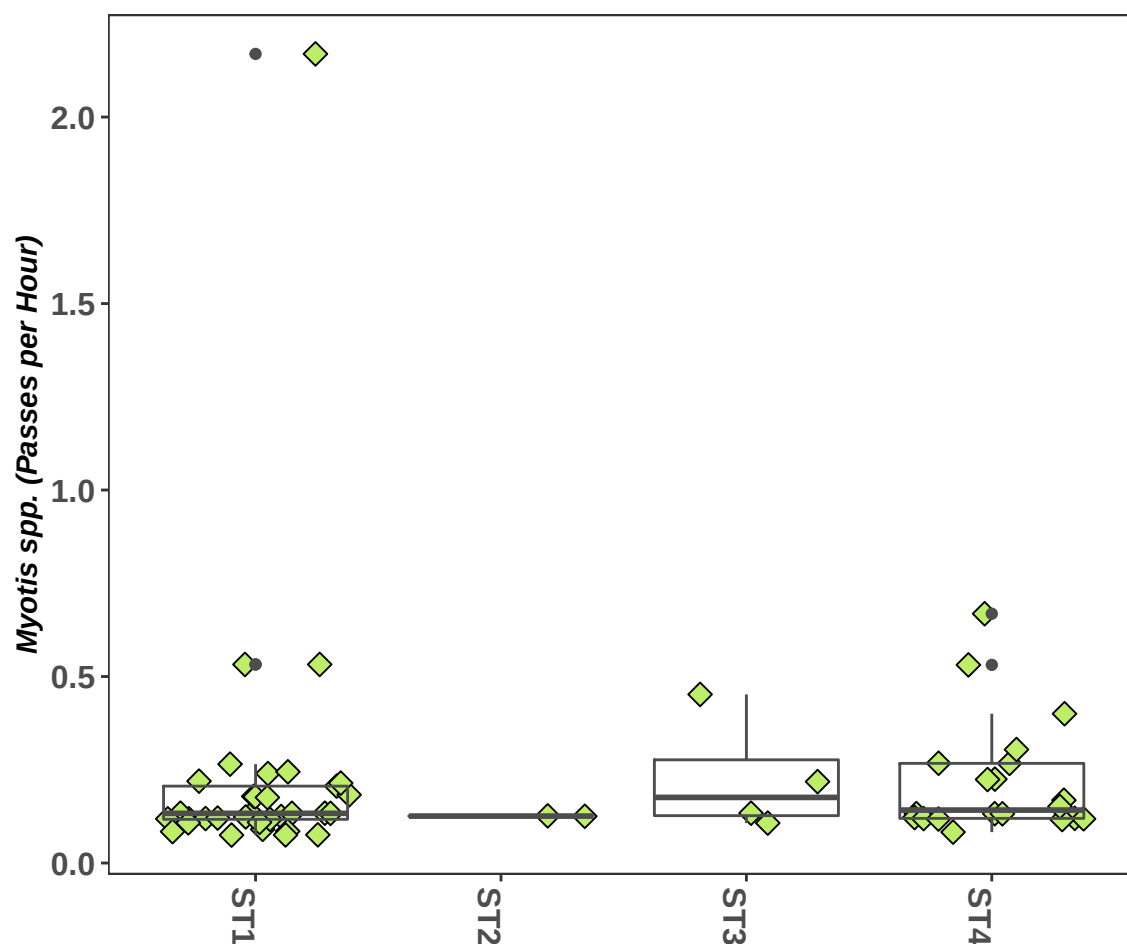
4.1.2 *Eptesicus serotinus*: Statistical Comparison of Activity Between Locations



The Kruskal-Wallis test was undertaken for *Eptesicus serotinus* between the following locations: ST1, ST2, and ST3. The null hypothesis is accepted at $P < 0.05$. Activity between the locations is unlikely to be different.



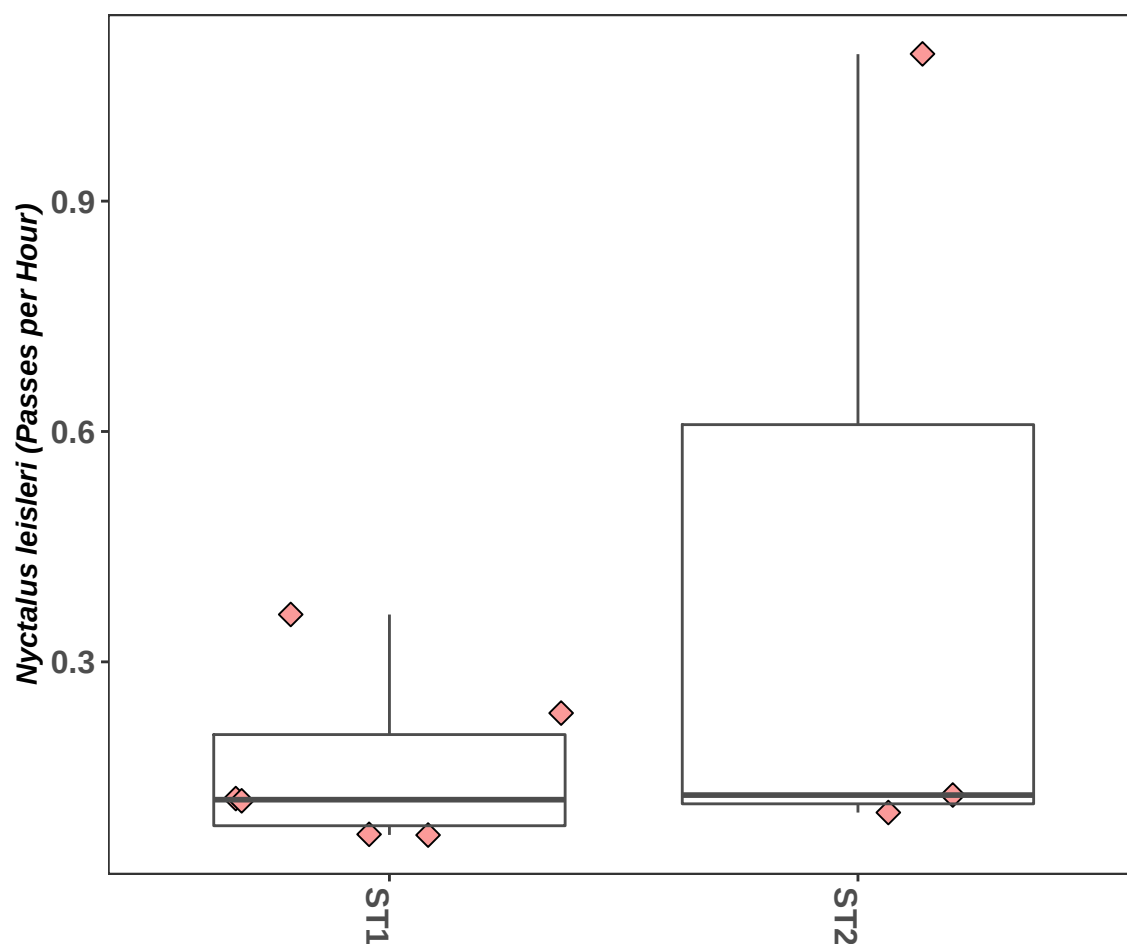
4.1.3 *Myotis spp.*: Statistical Comparison of Activity Between Locations



The Mann-Whitney-Wilcoxon test was undertaken for *Myotis spp.* between the following locations: ST1 and ST4. The null hypothesis is accepted at $P < 0.05$. Activity between the two locations is unlikely to be different.



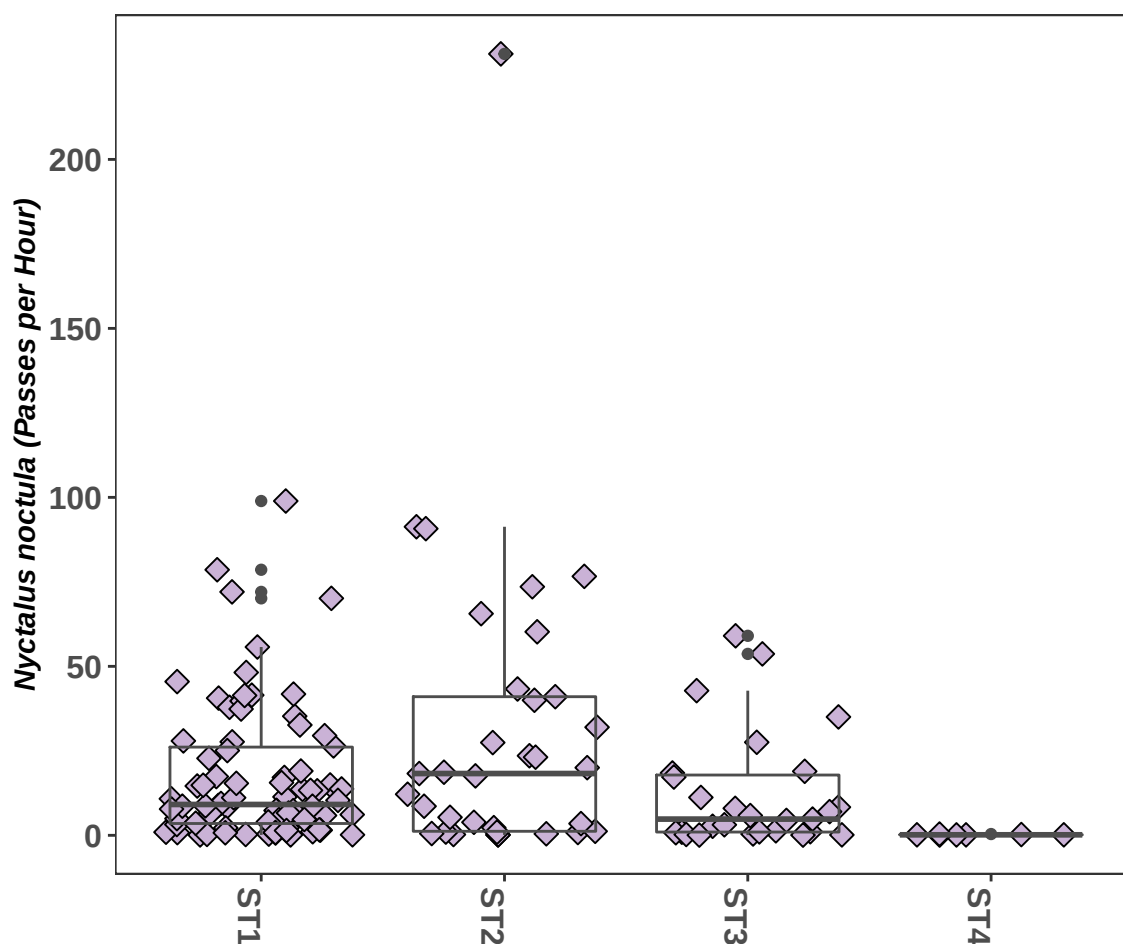
4.1.4 *Nyctalus leisleri*: Statistical Comparison of Activity Between Locations



There is insufficient data to undertake the Kruskal-Wallis or Mann-Whitney-Wilcoxon test



4.1.5 *Nyctalus noctula*: Statistical Comparison of Activity Between Locations



The Kruskal-Wallis test was undertaken for *Nyctalus noctula* between the following locations: ST1, ST2, ST3, and ST4. The null hypothesis is rejected at $P < 0.05$. Activity between some locations is likely to be different. *Post hoc* testing with the Dunn's Test, has been applied to determine which locations are different; the results are shown below.

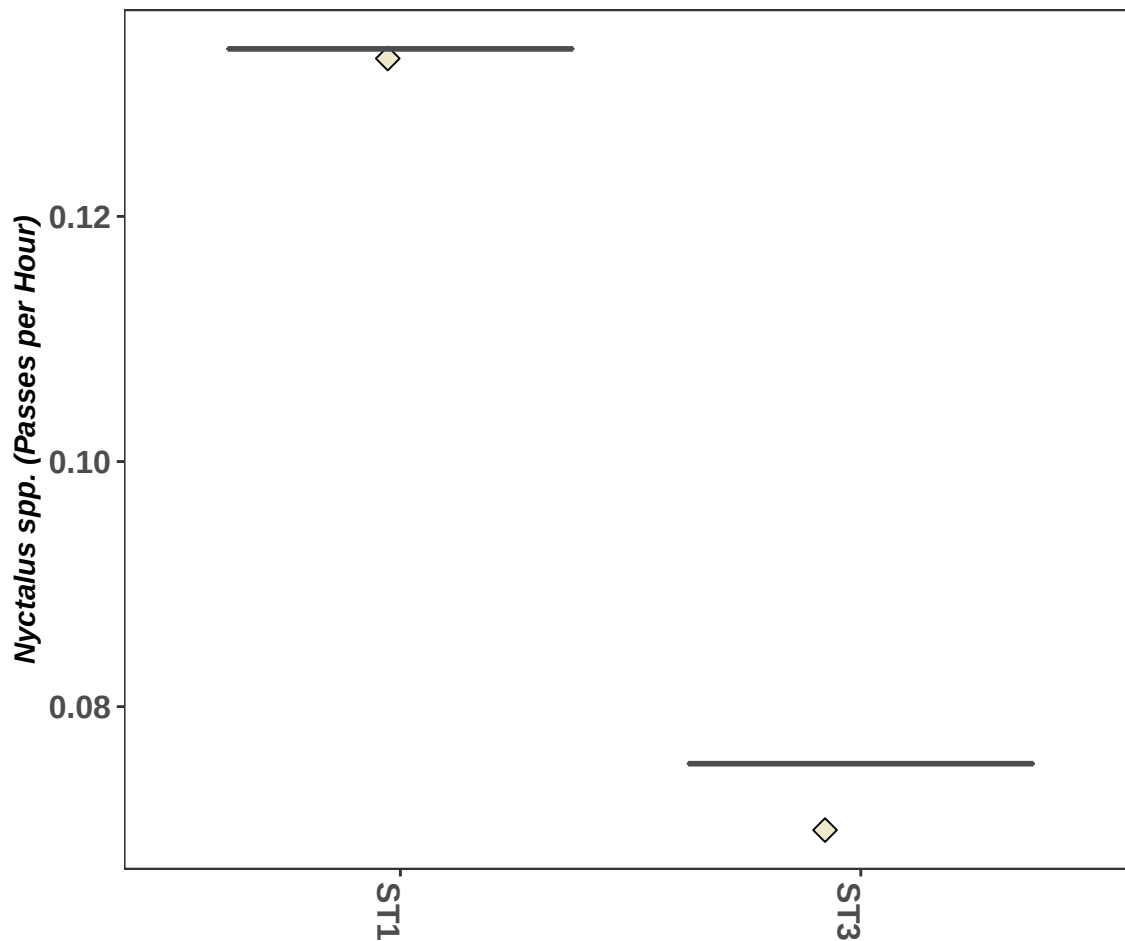
Table 18: Post hoc Test Results (Dunn's Test) for *Nyctalus noctula*

Locations with a significant difference	adjusted P
ST1 - ST4	0.0001743
ST2 - ST4	0.0000965
ST3 - ST4	0.0111868

The P value adjustment has been made with the Bonferroni method. The Bonferroni method is a simple technique for controlling the overall probability of a false significant result when multiple comparisons are to be carried out.



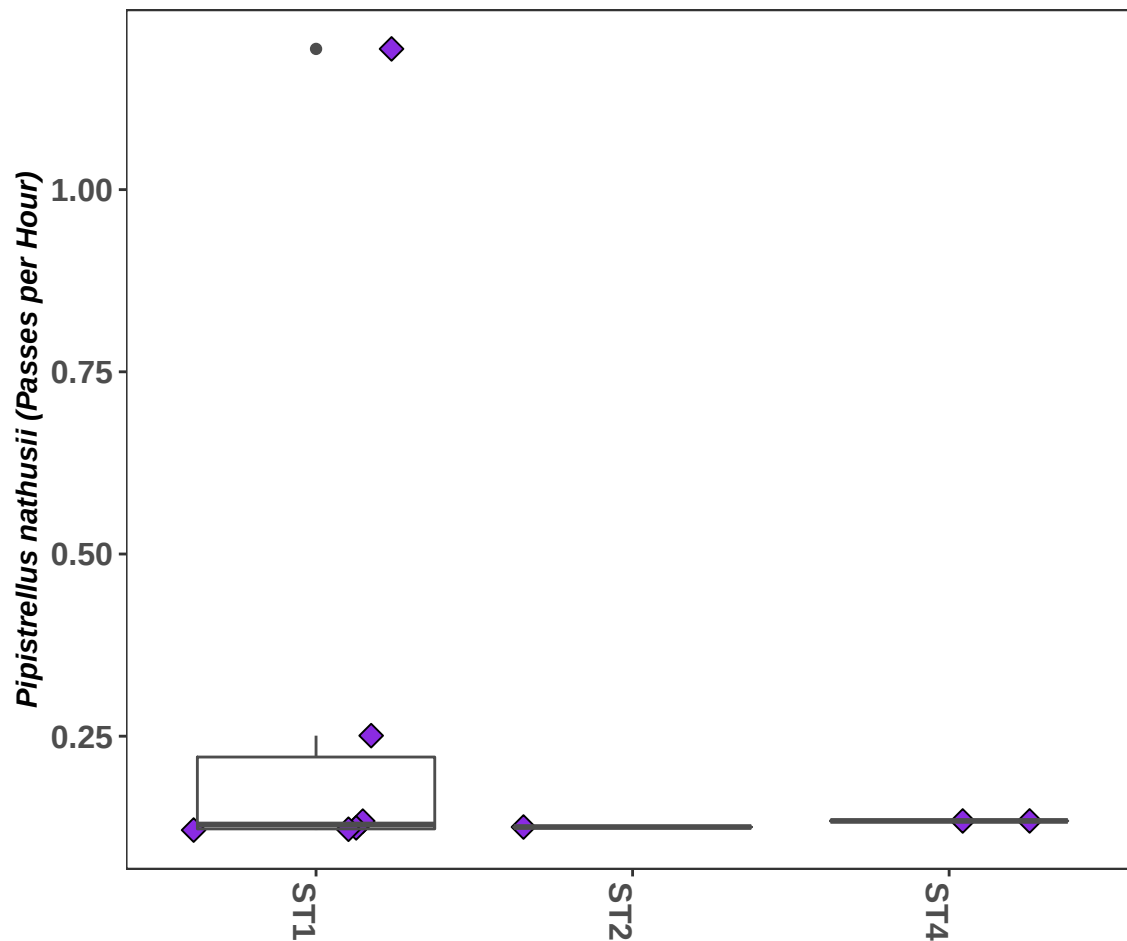
4.1.6 *Nyctalus spp.*: Statistical Comparison of Activity Between Locations



There is insufficient data to undertake the Kruskal-Wallis or Mann-Whitney-Wilcoxon test



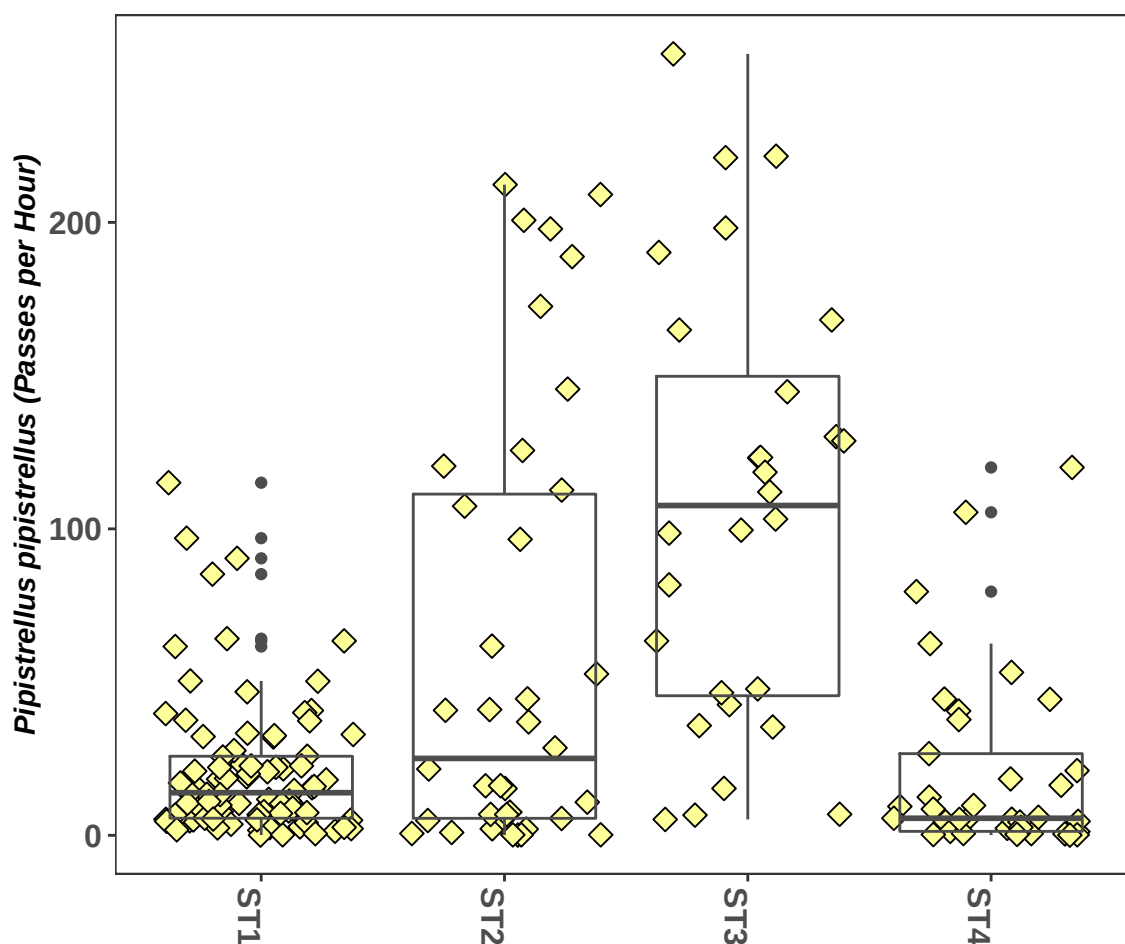
4.1.7 *Pipistrellus nathusii*: Statistical Comparison of Activity Between Locations



There is insufficient data to undertake the Kruskal-Wallis or Mann-Whitney-Wilcoxon test



4.1.8 *Pipistrellus pipistrellus*: Statistical Comparison of Activity Between Locations



The Kruskal-Wallis test was undertaken for *Pipistrellus pipistrellus* between the following locations: ST1, ST2, ST3, and ST4. The null hypothesis is rejected at $P < 0.05$. Activity between some locations is likely to be different. *Post hoc* testing with the Dunn's Test, has been applied to determine which locations are different; the results are shown below.

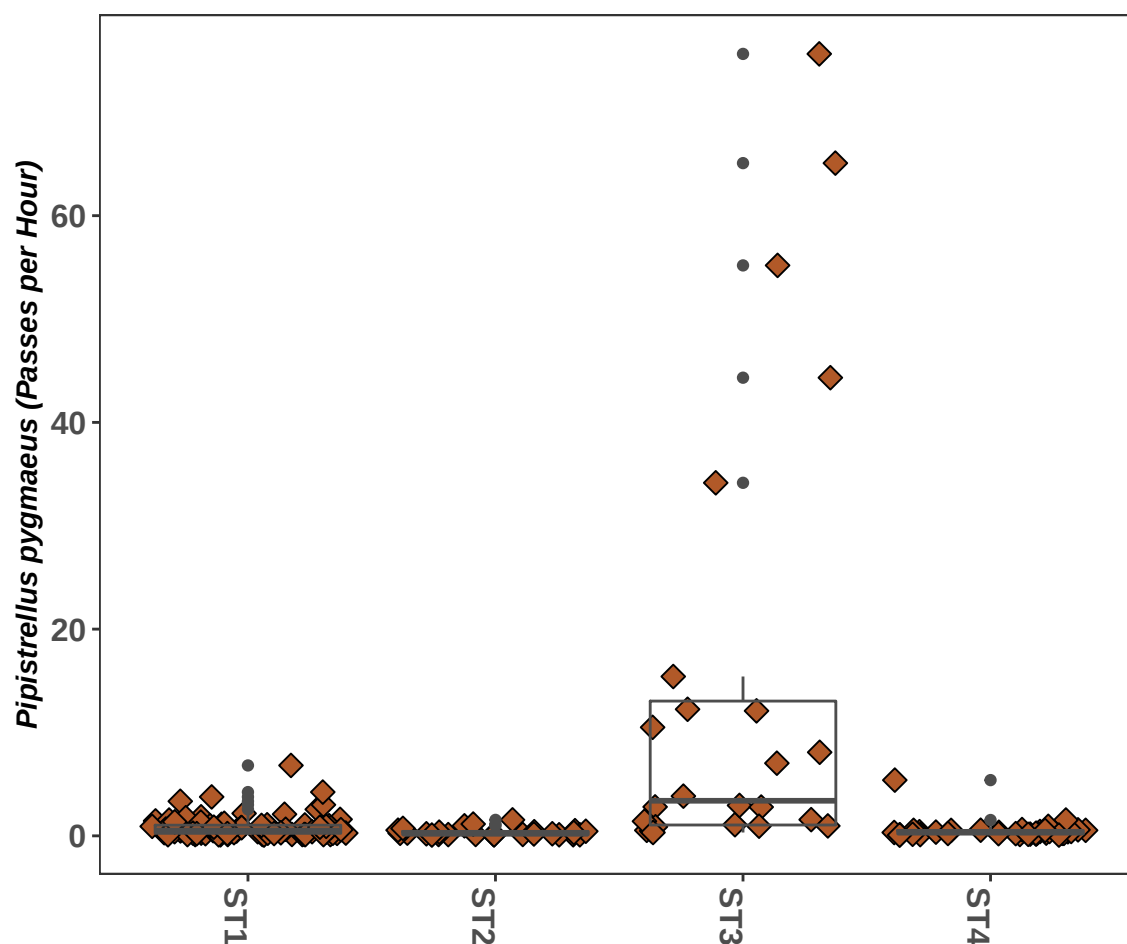
Table 19: Post hoc Test Results (Dunn's Test) for *Pipistrellus pipistrellus*

Locations with a significant difference	adjusted P
ST1 - ST3	0.0000002
ST2 - ST3	0.0022263
ST2 - ST4	0.0195696
ST3 - ST4	0.0000000

The P value adjustment has been made with the Bonferroni method. The Bonferroni method is a simple technique for controlling the overall probability of a false significant result when multiple comparisons are to be carried out.



4.1.9 *Pipistrellus pygmaeus*: Statistical Comparison of Activity Between Locations



The Kruskal-Wallis test was undertaken for *Pipistrellus pygmaeus* between the following locations: ST1, ST2, ST3, and ST4. The null hypothesis is rejected at $P < 0.05$. Activity between some locations is likely to be different. *Post hoc* testing with the Dunn's Test, has been applied to determine which locations are different; the results are shown below.

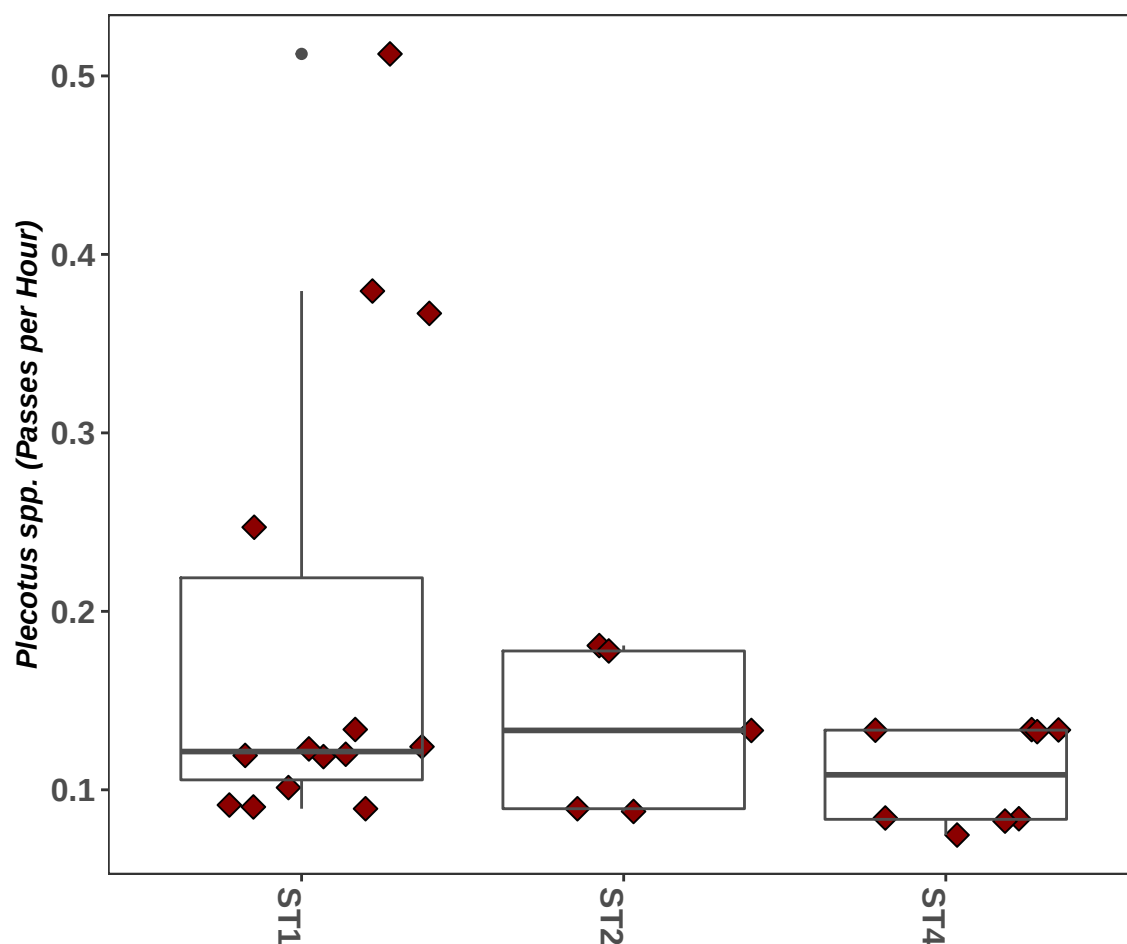
Table 20: Post hoc Test Results (Dunn's Test) for *Pipistrellus pygmaeus*

Locations with a significant difference	adjusted P
ST1 - ST2	0.0068638
ST1 - ST3	0.0000053
ST2 - ST3	0.0000000
ST3 - ST4	0.0000000

The P value adjustment has been made with the Bonferroni method. The Bonferroni method is a simple technique for controlling the overall probability of a false significant result when multiple comparisons are to be carried out.



4.1.10 *Plecotus spp.*: Statistical Comparison of Activity Between Locations



The Kruskal-Wallis test was undertaken for *Plecotus spp.* between the following locations: ST1, ST2, and ST4. The null hypothesis is accepted at $P < 0.05$. Activity between the locations is unlikely to be different.



5 REFERENCES

The visualisation and analysis has been undertaken in R (R Core Team 2018) using R version 3.6.1 (2019-07-05); R is an open-source statistical programming language. This document has been produced dynamically using `knitr` (Xie 2015) and `rmarkdown` (Allaire et al. 2019), integrating the data, analysis and reporting. For clarity the R script that generates the analysis is not shown. The graphics have been produced using the R package `ggplot2` (Wickham, Chang, et al. 2019). The wrangling of data was undertaken with `dplyr` (Wickham, François, et al. 2019) and `tidyr` (Wickham and Henry 2019) packages. The data in `csv` and `Excel` files has been imported with `readr` (Wickham, Hester, and Francois 2018) and `readxl` (Wickham and Bryan 2019) packages respectively. The computation with dates and times has been accomplished with `lubridate` (Spinu, Golemund, and Wickham 2018) package. Suntimes have been obtained with the `suncalc` (Thieurmél and Elmarhraoui 2019) package. The manipulation of text was through the `stringr` (Wickham 2019) package. Summary statistics have been produced with the `mosaic` (Pruim, Kaplan, and Horton 2019) package. Tables have been enhanced and made more readable with the `kableExtra` (Zhu 2019) package. The `broman` (Broman and Aimee Teo Broman 2018) package provided some useful R functions. The `scales` (Wickham 2018) package improves the clarity of scales on `ggplot` graphics.

Allaire, JJ, Yihui Xie, Jonathan McPherson, Javier Luraschi, Kevin Ushey, Aron Atkins, Hadley Wickham, Joe Cheng, Winston Chang, and Richard Iannone. 2019. *Rmarkdown: Dynamic Documents for R*. <https://CRAN.R-project.org/package=rmarkdown>.

Broman, Karl W, and with contributions from Aimee Teo Broman. 2018. *Broman: Karl Broman's R Code*. <https://CRAN.R-project.org/package=broman>.

Pruim, Randall, Daniel T. Kaplan, and Nicholas J. Horton. 2019. *Mosaic: Project Mosaic Statistics and Mathematics Teaching Utilities*. <https://CRAN.R-project.org/package=mosaic>.

R Core Team. 2018. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <http://www.R-project.org/>.

Russ, Jon. 2012. *British Bat Calls a Guide to Species Identification*. Pelagic Publishing.

Spinu, Vitalie, Garrett Golemund, and Hadley Wickham. 2018. *Lubridate: Make Dealing with Dates a Little Easier*. <https://CRAN.R-project.org/package=lubridate>.

Thieurmél, Benoit, and Achraf Elmarhraoui. 2019. *Suncalc: Compute Sun Position, Sunlight Phases, Moon Position and Lunar Phase*. <https://CRAN.R-project.org/package=suncalc>.

Wickham, Hadley. 2018. *Scales: Scale Functions for Visualization*. <https://CRAN.R-project.org/package=scales>.

———. 2019. *Stringr: Simple, Consistent Wrappers for Common String Operations*. <https://CRAN.R-project.org/package=stringr>.

Wickham, Hadley, and Jennifer Bryan. 2019. *Readxl: Read Excel Files*. <https://CRAN.R-project.org/package=readxl>.

Wickham, Hadley, Winston Chang, Lionel Henry, Thomas Lin Pedersen, Kohske Takahashi, Claus Wilke, and Kara Woo. 2019. *Ggplot2: Create Elegant Data Visualisations Using the Grammar of Graphics*. <https://CRAN.R-project.org/package=ggplot2>.

Wickham, Hadley, Romain François, Lionel Henry, and Kirill Müller. 2019. *Dplyr: A Grammar of Data Manipulation*. <https://CRAN.R-project.org/package=dplyr>.

Wickham, Hadley, and Lionel Henry. 2019. *Tidyr: Easily Tidy Data with 'Spread()' and 'Gather()' Functions*. <https://CRAN.R-project.org/package=tidyr>.

Wickham, Hadley, Jim Hester, and Romain Francois. 2018. *Readr: Read Rectangular Text Data*. <https://CRAN.R-project.org/package=readr>.

Xie, Yihui. 2015. *Dynamic Documents with R and Knitr*. 2nd ed. ISBN 978-1498716963. Chapman; Hall/CRC.



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Zhu, Hao. 2019. *KableExtra: Construct Complex Table with 'Kable' and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>.