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# 1. INTRODUCTION

- 1.1.1 EDF Energy is to submit an application for a Development Consent Order (DCO) to construct and operate a new nuclear power station, Sizewell C, near the town of Leiston in Suffolk. The proposal site lies within an area of high landscape and ecological sensitivity, within an Area of Outstanding Natural Beauty (AONB) and adjacent to the Minsmere to Walberswick Heaths and Marshes Special Area of Conservation (SAC), the Sandlings Special Protection Area (SPA) and the Outer Thames Estuary SPA. A small part lies within the Sizewell Marshes Site of Special Scientific Interest (SSSI).
- 1.1.2 A considerable amount of ecological survey work in relation to the proposed construction of Sizewell C was undertaken by Amec between 2007 and 2012. During this work, it was established that up to ten species of bats use the site and its immediate surroundings, including the rare barbastelle. Amec's work was designed to answer particular questions, adapting to new survey information and changing proposals, options and layouts as they arose. Therefore, while the work undertaken by Amec was both comprehensive and valuable for informing the impact assessment, it did not allow for the assessment of either the likely size of the barbastelle population or how its use of local habitats within and around the site, spatially and temporally, varies between years.
- 1.1.3 Arcadis (previously known as HyderCresswell) surveys in 2013 and 2014 were therefore designed to fill any identified gaps in survey coverage, to gain a better understanding of population size(s) and to develop a better understanding of natural temporal and spatial variability in the use of different habitats in order to better understand how barbastelle might be affected by the proposals.
- 1.1.4 The proposals included a comprehensive automated detector monitoring exercise and a further period of radio-tracking. The survey approach and methodology were presented to and agreed with key stakeholders in 2013 (HyderCresswell, 2013).
- 1.1.5 The radio-tracking surveys are described in a separate report (Corylus, 2015). The automated detector surveys, designed to provide a better understanding of natural temporal and spatial variability in the use of different habitats, are described here. Whilst targeted to barbastelle, the automated bat detector surveys also enabled a similar assessment to be undertaken for other species / species groups.
- 1.1.6 Data gathered from automated detector surveys was intended to inform the impact assessment, and to also enable the comparison of the data collected pre-construction, to that collected during construction, and in the post-construction period, as appropriate.

## 2. APPROACH AND METHODOLOGY

### 2.1 Automated Static Detector Surveys, 2013 and 2014

- 2.1.1 Automated detector surveys were undertaken in 2013 and 2014 to determine how variable barbastelle are in their use of the main development site and the surrounding area, spatially, seasonally, and between years.

- 2.1.2 In particular, automated detector surveys were intended to provide information on:
- the spatial and temporal patterns of barbastelle activity within the area directly affected by, and in the immediate vicinity of, the proposals;
  - areas of high importance for barbastelle within these areas at different times of the year; and
  - whether observed patterns differ between years.
- 2.1.3 Automated detector surveys were undertaken using Wildlife Acoustic SM2 detectors. Static surveys previously undertaken by Amec had used Anabat detectors; however, the decision was made to change to SM2 detectors. This decision was based on unpublished research which indicated that the microphones (mics) would sample a larger volume of air (i.e. would detect barbastelle calls at greater distances from the mic than other bat detectors commercially available). In addition, static detectors in use are subject to harsh conditions and are vulnerable to disturbance/tampering from humans and animals; SM2 detectors (in protective cases) were considered likely to be robust, water-resistant and reliable.
- 2.1.4 Importantly, the use of SM2 detectors also allowed the use of auto-identification software (an essential tool, as described in later sections).

## 2.2 Survey effort

- 2.2.1 An initial 28 locations (hereafter referred to as monitoring stations (MS)), within the main development site and surrounding area, were surveyed by automated detectors in 2013. The number of MSs was increased to 30 in September 2013, and, following discussions with consultees, a further two MSs were added to the survey programme in 2014. The details of the rationale behind the placement of these MSs, and the years of surveying, are provided in Annex 2: A2.1, and maps displaying the locations of all surveyed MSs are illustrated as part of the results.
- 2.2.2 Each MS was surveyed for a period of two weeks three times a year: end May/June ('Season 1'), July/August ('Season 2') and September/October ('Season 3'). The three periods reflect key periods in the barbastelle annual lifecycle: maternity (largely pre-lactation<sup>1</sup>), maternity (lactation and dispersal of juveniles) and mating/pre-hibernation. The intention of a two-week recording period was to ensure that any short periods of poor weather did not overly influence overall the results.
- 2.2.3 Within each season, 14, later increased to 16, automated detectors were deployed at half of the MSs for an initial two-week period ('session 1') with the detectors then being relocated to the remaining MSs for a further two-week period ('session 2').
- 2.2.4 Details of the survey dates for 2013 and 2014 automated detector surveys are provided in Table 2-1 below.

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<sup>1</sup> Barbastelle give birth from the middle of June; the young are suckled for up to six weeks (Dietz *et al.*, 2009).

Table 2-1. Automated detector survey dates in 2013 and 2014.

Year	Season (S)	Session (s)	Survey Period Dates
2013	S1	s1	29/05/13 – 13/06/13
		s2	11/06/13 – 26/06/13
	S2	s1	15/07/13 – 29/07/13
		s2	30/07/13 – 13/08/13
	S3	s1	10/09/13 – 24/09/13
		s2	24/09/13 – 08/10/13
2014	S1	s1	28/05/14 – 12/06/14
		s2	11/06/14 – 26/06/14
	S2	s1	15/07/14 – 30/07/14
		s2	28/07/14 – 13/08/14
	S3	s1	03/09/14 – 16/09/14
		s2	16/09/14 – 30/09/14

'Season' is always denoted by upper-case; 'session' by lower-case. The sessions overlap as detectors were moved (collected and re-deployed) sequentially over a period of 1-2 days.

- 2.2.5 MSs were primarily surveyed by 'mono' SM2 detectors; that is, the majority of MSs were surveyed by SM2s with a single mic. However, ten MSs (identified in Annex 2: A2.1) were surveyed by stereo SM2 detectors: that is, detectors with two mics connected, one to the left channel and one to the right channel. Mics of stereo SM2 detectors were located up to 100m apart, allowing for the surveying of a wider range of potentially important landscape features.
- 2.2.6 SM2 mics (model SMX-US) were mounted on an aluminium bracket which was positioned at a height of 1.8 – 2m above ground, to a pre-existing feature (i.e. fence post) or garden pole. Mics were angled down at 45° and were orientated to be perpendicular to the feature being monitored (for example, track, hedge, tree-line, etc.).
- 2.2.7 Each SM2 was pre-programmed to record in the WAC0 form of the .wac format, a proprietary Wildlife Acoustics file format at a sampling rate of 192,000kHz. This programmed sampling rate remained the same regardless of whether the SM2 was set to be used as a mono (single mic) or stereo (two mic) detector.
- 2.2.8 Each SM2 was also pre-programmed to turn on 20 minutes prior to sunset and to record throughout the night until sunrise throughout each two-week survey period. The SM2 trigger settings were set such that a detector would start to record when triggered by a noise event above 6dB; recording would then continue until the triggering event was no longer detected. SM2 detectors were set to leave a window of one second between triggering events. Therefore **a bat pass is considered to be any call or series of calls separated by more than one second from another**

**recording**<sup>2</sup>. Note, however, that a single recording may contain the calls of multiple individuals of the same species or the calls of more than one species: on these occasions, each species or individual, where it was possible to determine this, would be considered as a separate pass.

## 2.3 Auto-identification

- 2.3.1 The manual identification of the recorded calls was not considered practicable, due to the large volumes of data and the need to consider all recorded bat calls within passes. Bat call auto-identification software was therefore used, with manual verification / validation as necessary.
- 2.3.2 A series of trials were undertaken in 2013 of the range of bat call auto-identification software available that would work with SM2-generated data. The methodology and results of these trials and the selection process that was undertaken are detailed in Annex 4: A4.4 and A4.5. Based on the trials undertaken, it was determined that SonoChiro bat call auto-identification software provided the most appropriate outputs based on the requirements of this analysis.
- 2.3.3 SM2 detectors provided recordings in the Wildlife Acoustic proprietary compressed file format known as '.wac'. Recordings made in .wac format require conversion to .wav format for further analysis in SonoChiro. The Wildlife Acoustic software Kaleidoscope, designed specifically for data recorded by Wildlife Acoustic detectors, was used to convert recordings from the .wac format used by SM2 detectors to the .wav format required for analysis by SonoChiro. During this conversion, Kaleidoscope Pro settings were set to their broadest range to ensure that no recordings potentially containing bat calls were lost. These settings and reasons for their use are described in detail in Annex 4: A4.6.7.
- 2.3.4 Converted recordings were then auto-analysed through SonoChiro and the outputs manually interpreted. The settings used for the conversion and analysis of recordings, and details of how SonoChiro undertakes its analyses, are provided in Annex 2: A4.6. A series of manual verifications of the identifications provided by SonoChiro was undertaken; details of the methodology and results of these manual verifications are also provided in Annex 2: A4.7.

## 2.4 Data interpretation

- 2.4.1 The analysis first considered the distribution of relative bat activity across the area of study. The parameter initially used to compare bat activity overall, and then at individual MSs between seasons and years, was 'passes per night'. This differs from that used by Amec (who used passes/hour). The main reason for using passes/night is that night-length varies, and the period during which bats are less active tends to increase on longer nights. The use of passes/hour therefore under-estimates activity in the periods during which bats are active. While this prevents a direct comparison between pass-rates recorded by Amec and pass-rates recorded in the

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<sup>2</sup> This definition of a call was used to avoid some bat calls being mis-classified as noise (see Annex 3) but it does mean that what an observer would record as a single pass by one bat making multiple calls can be split by the software into multiple 'passes'. This is one reason why 'relative activity' does not equate to numbers of bats (see also Para 3.1.4).

HyderCresswell surveys, this is considered appropriate because different equipment was used.

2.4.2 Interpretation considered mean pass rates (number of passes per night for the following species/species group levels:

- barbastelle;
- 'big bats' (i.e. noctule, Leisler's bat and serotine);
- *Myotis* spp;
- Nathusius' pipistrelle; and
- pipistrelles recorded as a combined group (all calls identified as belonging to the pipistrelle genus or as a pipistrelle species).

2.4.3 These groups are defined in more detail in Annex1:A1.1.

2.4.4 For these groups, an overall mean pass rate was calculated for each season (across all MSs), taking into account the number of nights each MS was operational.

2.4.5 Bat activity – as measured by bat passes – was then analysed to determine whether there were statistically significant seasonal differences in the total number of recorded bat passes per night (*total bat passes*). The analysis was repeated using a figure for *bat pass rate* (defined as the number of bat passes divided by night length (effectively, bat passes per hour), to determine whether the total number of bat passes was influenced by night length.

## 2.5 Relative activity by MS

2.5.1 The mean pass rate (mean passes/night) was also calculated for each MS in each season. The distribution of mean pass rates for four species/species groups over each survey season and year was used to identify potential areas of importance to that species/species group. The species/species groups analysed in more detail did not include common/soprano pipistrelle or brown long-eared bat, as these are all considered to be common and wide-spread throughout the Estate as a result of the earlier work undertaken.

2.5.2 In addition, individual sites were highlighted where overall bat activity (i.e. mean passes per night (mppn) for a single recording season from all species combined) exceeded 300<sup>3</sup>. These were classified as 'bat hotspots'.

2.5.3 As noted above and illustrated in Graph 2, the number of bat passes recorded are not normally distributed, and are heavily skewed by large numbers of zeros. Nights with very high numbers of passes could therefore raise the mean disproportionately, and potentially render an examination of activity levels relative to the mean less meaningful. The means themselves also do not illustrate how variable the data is.

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<sup>3</sup> 300 passes in a ten-hour night equates to one bat pass every two minutes (30 passes/hour in a ten-hour night). Nights in S1 were shorter than this; nights in S3 longer than this, but the same figure has been used through to denote a 'bat hotspot'. Bat passes do not relate to numbers of bats, but to bat activity. This is an arbitrary threshold, on the basis of levels of activity recorded at Sizewell (an arbitrary threshold is necessary because levels of activity vary considerably between projects, geographies, equipment and the definition of activity (passes) used).

Three of the data-sets (barbastelle; Myotis species; 'big bats') were therefore plotted as box plots to illustrate variability around the mean. Nathusius' pipistrelle were excluded from this analyses because of the low number of calls.

- 2.5.4 To look at activity levels, the same three data-sets were also examined for levels of activity above the 75<sup>th</sup> and 90<sup>th</sup> percentile values for the season as a whole. These results are plotted in Annex 2: Section A3 and described in Section 3.6 below. The analysis reveals whether activity exceeded these percentiles and, if so, the number of nights this occurred.
- 2.5.5 Bat activity tends to peak in the hours after sunset and before sunrise, with a period of lower activity in the middle of the night. The 2014 data were therefore divided into a series of time-codes to identify where in the night activity had taken place.
- 2.5.6 The allocation of the data to individual time-codes (TC) is outlined in Table 2-2.

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Table 2-2. Time codes considered for species groups in relation to time after sunset and before sunrise (following Amec).

Time code	Description
0	Before sunset
1	0-20 minutes after sunset
2	20-40 minutes after sunset
3	40-60 minutes after sunset
4	60-80 minutes after sunset
5	80-100 minutes after sunset
6	100-120 minutes after sunset
7	Middle of the night
8	120-100 minutes before sunrise
9	100-80 minutes before sunrise
10	80-60 minutes before sunrise
11	60-40 minutes before sunrise
12	40-20 minutes before sunrise
13	20-0 minutes before sunrise

- 2.5.7 A number of factors influence bat activity: age; gender; breeding status; season; roost location; prey availability; and weather, amongst others. This may result in some areas being of increased importance for limited periods of time (for example, to exploit a seasonal item of prey, or in order to feed somewhere sheltered at times of high wind). As relative bat activity calculated over a two-week period can obscure such peaks, peaks of activity within individual time-codes were also identified. This analysis was undertaken for barbastelle only.
- 2.5.8 For this analysis, the number of passes recorded for barbastelle within each time band was calculated, and the highest 25% of pass rates was identified for each session. This information was used to identify the time codes for that session which demonstrated the highest number of passes.

- 2.5.9 Zeale *et al.* (2012) noted that the average emergence time from barbastelle day roosts was 24 minutes after sunset (range 12–36 min), and that this species typically remained within woodland roost areas for  $28 \pm 17$  min before commuting<sup>4</sup> to foraging areas. On leaving woodland roost sites, they found that bats initially made use of treelines and hedgerows for commuting but moved freely across open landscapes thereafter. It was therefore anticipated that, were a roost or an early commuting route to be present, MSs would pick up this activity within the first hour after sunset. For *Myotis* bats which emerge slightly later (see Jones & Rydell, 1994), activity within the first 80 mins post-sunset was considered.
- 2.5.10 Using the time-code information, MSs were therefore identified where activity had taken place in the first hour after sunset (80 minutes for *Myotis*). The exercise was completed for all four species/species groups of interest. This information is presented in Annex 2: Section A3, and described in Section 3.6. A visual assessment was also made to determine where there was regular or high early activity over a number of days, as the percentage alone of high activity did not provide information on how that activity was distributed across the recording session.

## 3. RESULTS

### 3.1 Overall bat activity

- 3.1.1 Automated detectors were operational for a period of 2,715 survey nights over the two years of automated detector surveys. All recordings were analysed using the auto-identification software SonoChiro resulting in the identification of 1,768,177 bat passes over the two years of automated detector surveys, 944,918 of these to the species or group level<sup>5</sup>.
- 3.1.2 Mean passes by survey season/year (across all MSs) for each of the four groups and for pipistrelle spp. are set out in Table 3-1. Temperatures (average low temperatures and range) during each recording season are provided in Table 3-2. Temperature data (highest and lowest by day) are provided in Table A4 - 2 to Table A4 - 4.
- 3.1.3 The mean numbers of passes in Table 3-1 below should not be compared between species, as the passes captured are not independent of species. Natterer's bats issue quieter calls and will therefore be picked up over shorter distances than those of pipistrelles and 'big bats' which have loud calls. Barbastelle calls vary significantly in volume according to activity (they reduce call loudness to catch prey). Bats also vary their calls in different habitats (for example, according to the degree of clutter) and for different activities (fast flight or foraging). Calls may also vary in directionality (which affects the ability of mics to capture them) and sound attenuates differently with changes in temperature and humidity. Finally, some calls are easier for auto-

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<sup>4</sup> 'Commuting' describes the behaviour of travelling more-or-less directly from one to another place to another, i.e. largely without foraging. It is assumed that this behaviour allows bats to reach more productive feeding areas in the shortest possible time. However, there is obviously a continuum of activity between direct fast flight with no foraging to flight time spent predominantly foraging, and behaviour often cannot be neatly categorised into one or the other, nor is foraging always preceded by a period of commuting.

<sup>5</sup> The reason for bat passes not being allocated to a species or species group are set out in Annex 3: paragraph A4.7.27 *et seq.*

identification software to identify with certainty. (See also 4.A1.1.3*et seq.*) for additional explanation.

- 3.1.4 The numbers of passes recorded demonstrate only relative bat activity, and not bat numbers. It is not possible, from automated recorders, to distinguish between twenty bats passing once, and one bat passing twenty times. Relative bat activity is used to determine the importance of different areas to bat species / species groups, and should not be used to infer where the greatest number of individuals may be found.
- 3.1.5 In addition, the total passes recorded at a given location on a given night was found to have a highly skewed non-normal distribution, that is, with a very large number of cases with low values and a small number of cases with very high values (this is further illustrated in Annex 4.A2). These high values have a disproportionate influence on any means values calculated, and therefore, these 'raw averages' should be cautiously interpreted.

Table 3-1. Mean passes per night (mppn) by survey season/year (across all MSs) for each of the four species/species groups; expressed as mean passes per operational night of monitoring.

Species / group	Barbastelle mppn			'Big bat' mppn			<i>Myotis</i> sp(p) mppn			Nathusius' pipistrelle mppn			All pipistrelle mppn		
Season	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
2013	11.9	6.0	9.9	6.3	22.2	2.2	5.7	8.8	8.7	3.2	2.0	1.8	378	294	333
2014	11.3	5.2	8.5	8.6	8.3	4.2	3.6	6.7	7.0	3.5	2.4	2.9	302	306	334

Table 3-2. Low temperature (mean and range) in force during each monitoring season.

Year	Dates and temperatures	S1	S2	S3
2013	Season dates	29 May - 26 Jun	15 July - 13 Aug	10 Sept - 8 Oct
	Average low temperatures	8.8°C (range 3-14)	13.2°C (range 9-17)	8.9 °C (range 7-13)
2014	Season dates	28 May - 26 Jun	15 Jul - 13 Aug	3 Sept - 30 Sept
	Average low temperatures	9.7 °C (range 4-13)	13.5 °C (range 9-17)	10.9 °C (range 4-16)

- 3.1.6 There were no periods of prolonged cooler weather which might have significantly reduced bat activity (as set out in Table A4 - 2 to Table A4 - 4). The coolest period was experienced in 2013, in the first recording session of S1 (average low temperature of 7.8 °C compared to the 2013 average of 8.8°C for the whole of S1). Nonetheless, barbastelle activity was the highest recorded in S1 of 2013.
- 3.1.7 Barbastelle numbers are highest in S1 and lowest in S2; higher (season by season) in 2013 than 2014. *Myotis* activity is also higher in 2013 than for the corresponding seasons in 2014. In contrast, the activity of 'big bats' shows a very high peak S2 in 2013, but activity in S1 and S3 is higher in 2014. There appears to be no consistency to pipistrelle activity between years/season. There is, therefore, no overall pattern to bat activity discernible from the raw means, which again suggests that periods of poor weather have not significantly influenced the results.
- 3.1.8 The high overall mean for 'big bats' in S2 2013 arose largely from an exceptional peak of activity at a single MS (MS12), discussed below in Section 3.6.27. A random sample of these passes (10%) were therefore manually verified to ensure this result

did not arise from noise misidentified as 'big bat'. All passes allocated to the 'big bat' category were confirmed to have been correctly identified as 'big bat' (see para 3.6.27 for species-specific comments).

- 3.1.9 In relation to *Nathusius' pipistrelle*, earlier work suggested that numbers peaked in Spring and late Summer/early Autumn (Amec, 2011), and that this may have been related to migration. The SM2 monitoring programme started after any potential Spring peak, but there is no indication in 2013 of an Autumn peak, with only a slight rise between S2 and S3 in 2014. Relative activity in S1 (June) is higher than in the other two seasons.

## 3.2 Analysis of overall bat activity

- 3.2.1 The analysis to determine whether bat activity – as measured by bat passes – differed significantly by season is summarised below and described in full in Annex A2. The analysis to determine whether the total number of bat passes was influenced by night length – as measured by bat pass rate – is also summarised below and described in full in Annex A2.

### *Barbastelle*

- 3.2.2 There was a significant seasonal difference in the number of *barbastelle total bat passes* recorded. The number of bat passes was highest in S1, with a significantly lower number in S3 (53% relative to S1) and the lowest number in S2 (74% relative to S1). *Total bat passes* were significantly higher in S3 than S2. There was no significant effect of year on the number of bat passes.
- 3.2.3 *Barbastelle bat pass rate* also varied significantly with season, indicating that strong seasonal effects persist even when night length is considered. As with *total bat passes*, the highest *bat pass rate* was observed in S1, with lower values in S2 and S3. However, in contrast to *total bat passes*, *bat pass rate* in S2 and S3 were very similar, suggesting that the higher *total bat passes* values observed in S3 (relative to S2) are partly the result of night length.

### *'Big bats'*

- 3.2.4 There was a significant seasonal difference in the number of 'Big bat' spp. passes recorded. The number of bat passes increased from S1 to S2 (32% increase) and then declined steeply in S3 (74% relative to S1). The number of *total bat passes* was significantly higher in S2 than S3. There was no significant effect of year on the number of bat passes.
- 3.2.5 The 'Big bat' spp. *bat pass rate* also varied significantly with season, indicating that strong seasonal effects persist even when night length is considered. Seasonal patterns in *bat pass rate* observed were generally similar to that of *total bat passes*, with higher values in S2 (relative to S1), and the lowest values in S3.
- 3.2.6 The number of 'Big bat' spp. passes recorded were particularly high for the location MS12, discussed below in para 3.6.25. However, excluding this location from the analyses had marginal effects on the results. Seasonal differences were still significant for *total bat passes* and *bat pass rate* (see Annex A2 for full details).

### *Myotis spp.*

- 3.2.7 There was a significant seasonal difference in the number of *Myotis* spp. passes recorded. The number of bat passes was lowest in S1, and increased in S2 and S3, with the highest values recorded in S2 (62% higher than in S1). Activity in S3 was 50% higher than in S1. S2 had a significantly higher number of *total bat passes* than S3.
- 3.2.8 Numbers of bat passes were significantly lower (8%) in 2014 than 2013 for this group of species.
- 3.2.9 The *Myotis* sp. *bat pass rate* also varied significantly with season, again indicating that strong seasonal effects persist even when night length is considered. In contrast with the results for *total bat passes*, the lowest *bat pass rate* was observed in S3 (rather than S1), with slightly higher values in S1 and the highest values in S2. In a direct comparison, S1 and S3 did not differ in their *bat pass rate*. As with other species, the higher *total bat passes* values observed in S3 relative to S1 are partly the result of night length.

### *Nathusius' pipistrelle*

- 3.2.10 There was a significant seasonal difference in the number of *Nathusius' pipistrelle* passes recorded. The overall pattern was similar to that of *barbastelle*, with the number of bat passes highest in S1, lower in S3 (40% of those in S1) and lowest in S2 (37% of those in S1). *Total bat passes* were significantly higher in S3 than S2. There was no significant effect of year on the number of bat passes.
- 3.2.11 The *Nathusius' pipistrelle bat pass rate* also varied significantly with season, indicating that strong seasonal effects persist even when night length is considered. As with *total bat passes*, the highest *bat pass rate* was observed in S1, with lower values in S2 and S3. However, in contrast to *total bat passes*, the analyses indicated that *bat pass rate* was only slightly higher in S3 than S2 (though the difference was still significant). As for other species/groups, the higher *total bat passes* values observed in S3 (relative to S2) are partly the result of night length.

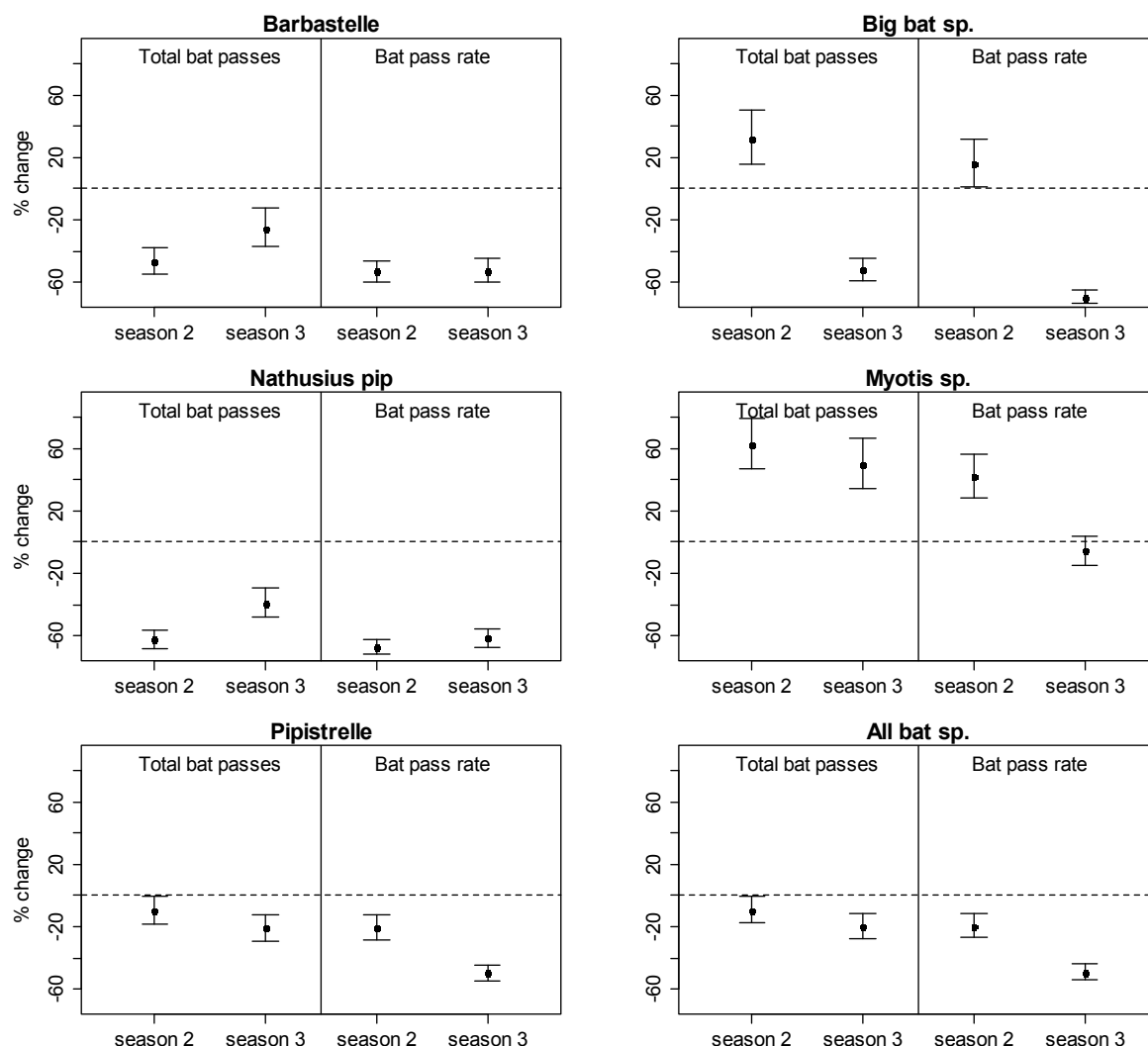
### *All pipistrelle species*

- 3.2.12 There was a significant seasonal difference in the number of *pipistrelle* passes recorded. The number of bat passes was highest in S1, decreased in S2 (90% relative to S1) and further declined in S3 (79% relative to S1). Despite the different average effects of S2 and S3, they did not differ significantly in the number of *total bat passes*. Numbers of bat passes were significantly higher (27%) in 2014 than 2013.
- 3.2.13 The *pipistrelle bat pass rate* also varied significantly with season, again indicating that strong seasonal effects persist even when night length is considered. Seasonal patterns in bat pass rate observed were generally similar to that of *total bat passes* (Graph 9), with higher values in S2 (relative to S1), and the lowest values in S3; the bat pass rate was significantly lower in S3 than S2. Again the difference observed for S3 is greater than the difference in *total bat passes*, most likely due to the longer nights in S3 (which act to lower bat pass rate).

### *All bats combined*

- 3.2.14 This analysis was undertaken for completeness, but the pattern observed for ‘all bat species’ was very similar to that for the pipistrelle group, as the large majority of bat passes recorded overall were pipistrelles). For detailed results, see Annex A2.
- 3.2.15 These results are illustrated in Graph 1 below.

Graph 1. Average seasonal change in total bat passes and bat pass rate for all species and groups analysed, as estimated from GLMM analysis.



The y axis is the average change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table A2 - 1 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals) for the effects.

## 3.3 Relative activity by MS

### *Mean passes per night*

- 3.3.1 Summaries of the mppn, by species or species group, recorded at each MS in 2013 and 2014 are provided in Table A1- 2 to Table A1- 13. These are shown in Figure 1(a-f) to Figure 4 (a-f), and a summary of the spatial and temporal distribution is shown in Figure 5(a-d). MS identified as being without records on these figures are those MS that suffered technical failures or that were not monitored during the season under consideration.

- 3.3.2 The data were examined as follows: firstly, to pick out MSs which demonstrated elevated levels of passes in any season, nominally over 20 mppn<sup>6</sup>. The distribution of these higher levels of activity is clearly demonstrated in Figures Figure 5(a-d). However, as overall levels of bat activity (as set out in Table 3-1 above) vary between season and year, the distribution of activity was also compared to the mean activity for that season and year (these data are set out in Table A1- 14 to Table A1- 17). These results are set out in the context of different areas of the site in Section 3.6.

#### *Variation by MS*

- 3.3.3 In addition, the distribution of the data for each MS was examined through boxplots of each year and season by species/species group. Boxplots are provided in Figure 7 and show the number of bat passes recorded at each location in each season. The dark bar in the centre of each box is the median (middle value or 50<sup>th</sup> percentile), the boundaries of the box encompass the 25<sup>th</sup> – 75<sup>th</sup> percentile (i.e. half of the distribution). The 'whiskers' or lines extend to the minimum / maximum. In some cases the maximum value extends off the figure (>150), the maximum value for these locations is displayed next to the line for reference. These figures demonstrate the distribution of the data for each MS in each season/year.
- 3.3.4 The most striking feature of the barbastelle boxplots is the narrow spread of the data recorded for each MS in each year (as demonstrated by the length of the 'box' around the median). There are only four instances where the 25<sup>th</sup> to 75<sup>th</sup> percentiles display high variability: MS07 in The Grove (S1 2013 only); MS22 along the edge of Kenton Hills (S1 2014 only); MS03 at Black Walks (S3 2013 only) and MS31 near Broom Covert (S3 2013 only).
- 3.3.5 There was some overlap with the MSs which recorded the very highest levels of activity, even if briefly (i.e. where the maximum value exceeds 200 passes on any night), though this did not always happen in the same seasons listed above. These were: MS03 (S3 2014: 419 passes in a single night); MS02 (S1 2014: 359 passes); MS03 (S3 2013: 357 passes); MS07 S1 2013: 330 passes).
- 3.3.6 The boxplots for 'big bats' are harder to read for 2013, due to the large spike of activity at MS12 in S2. These have been presented against two scales. It is important to take the scale into account when comparing S1 and S3 with S2 (for example, although the bars look of similar length on the first boxplot, activity in S1 is a tenth of that seen in S2). The data is a little more variable than for barbastelle (i.e. fewer MS show a narrow spread around the median), though only a few MSs show that variability across all three seasons (MS17; MS21 (2013)). There was less variation in 2104 than 2013.
- 3.3.7 The boxplots for *Myotis* bats show greater variation around the median than either barbastelle or 'big bats' (though again it is importance to be aware of the scales used in plotting each graph). Peak pass numbers are also lower than for either barbastelles or 'big bats', though caution needs to be exercised in comparing directly between species that have different 'detectabilities' (as set out in Annex A1).

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<sup>6</sup> As for bat hotspots, this is an arbitrary threshold, on the basis of levels of activity recorded at Sizewell (an arbitrary threshold is necessary because levels of activity vary considerably between projects, geographies, equipment and the definition of activity (passes) used).

3.3.8 Higher levels of activity are presented in two bar-charts as follows:

- A barchart showing the number of nights where the number of bat passes was more than **75<sup>th</sup> percentile** (i.e. the top 25% or ¼ of the distribution of activity in the boxplot) at each location in each season. On the x axis it specifies how many bat passes this relates to.
- A barchart showing the number of nights where the number of bat passes was more than **90<sup>th</sup> percentile** (i.e. the top 10% of the distribution of activity in the boxplot) at each location in each season. On the x axis it specifies how many bat passes this relates to (for that species/year/season).

The values for the median, and 75<sup>th</sup>/90<sup>th</sup> percentiles are provided in Table 3-3 below. The percentiles are arbitrary, but commonly used in statistics, and seemed appropriate to the data.

Table 3-3. Values for the 75<sup>th</sup> and 90<sup>th</sup> percentiles for the different species/groups in each year. The use of percentiles takes into account the skewed nature of the data

Species/group	Barbastelle		'Big bats'		<i>Myotis</i>	
Year	2013	2014	2013	2014	2013	2014
Median	2	2	2	2	4	2
75 <sup>th</sup> percentile	11	13	6	8	7	4
90 <sup>th</sup> percentile	28	30	18	19	14	9

3.3.9 These results are set out in the context of different areas of the site in Section 3.6.

*Bat 'hotspots'*

3.3.10 Three-quarters of the MSs were classified as a 'bat hotspot' in one or more season (i.e. mean passes per night for a single recording season from all species combined) exceeded 300), as highlighted by green shading in Table A1- 2 to Table A1- 13. For the majority, pipistrelle activity accounted for 90% or more of the bat passes recorded. Of those MSs which met the criterion for a 'bat hotspot', pipistrelle activity comprised less than 90% of the total on at least one occasion for fourteen. These fourteen MSs were: MS02, MS03, MS07, MS10, MS12, MS14, MS16, MS17, MS19, MS21, MS22, MS29, MS31 and MS36. These are highlighted by blue shading in Table A1- 2 to Table A1- 13 and are illustrated on Figure 6.

3.3.11 For the reasons outlined in paragraph 3.1.3, references to the percentage contribution of each species to the overall passes recorded at each site are indicative only.

3.3.12 Three MSs, MS07 (The Grove), MS15 (tree-line extending from Kenton Hills into arable field) and MS22 (Fiscal Policy), met the criterion for a bat hotspot most often (though MS15 recorded almost exclusively pipistrelle activity). These results are set out in the context of different areas of the site in Section 3.6.

## 3.4 Time-code data

- 3.4.1 The time-code data for both years were inspected to determine where early activity (activity in TC 0 – 3 (the first hour after sunset) had taken place (TCs 0-4 for *Myotis*). The initial analysis (as set out in Annex 2: Section A3) identified where a high percentage of activity had taken place in the first three (or four) TCs. In addition, the distribution of activity in each monitoring period was identified by species (to identify (by eye) elevated levels of passes, with particular emphasis on activity in TCs 0, 1 and 2, and on consecutive days. Less weight was given to low-level activity, particularly if taking place over scattered non-consecutive days and with no activity in TCs 0 - 2. These results are set out in the context of different areas of the site in Section 3.6. Example time-code scenarios are illustrated in Table A1- 21.
- 3.4.2 The TCs with the highest peaks of barbastelle activity were also identified (again by eye); these results are also set out in the context of different areas of the site in Section 3.6.

## 3.5 Species-specific considerations

### *Barbastelle*

- 3.5.1 Barbastelle were recorded at every MS (in each of the two years, where deployed in both years). However, with the exception of a few key areas (and even in apparently key areas), activity varied (sometimes considerably) between years and between seasons.
- 3.5.2 Across the two years of automated detector surveys, recorded barbastelle activity rarely accounted for more than 10% of total recorded activity. As for *Myotis* spp. (described below), this was often more to do with the prevalence of pipistrelle spp, which frequently comprised 90% or more of the recorded passes.
- 3.5.3 MSs where barbastelle comprised more than 10% of the recorded activity varied between seasons/years, with no obvious trends in location, season or year. MSs which recorded >10% barbastelle passes included:
- MS03 (once), MS14 (twice), MS26 (once) and MS31 (once) in 2013 (though not all of these instances met the criterion for a 'bat hotspot'); and
  - MS06; MS08; MS10; MS11; MS16; MS22; MS26 in 2014 (though only on one occasion for each MS, and only at MS16 and MS22 did overall bat activity met the criterion for a 'bat hotspot'.

These MSs are scattered widely across the study area.

- 3.5.4 Activity which suggested the presence of a roost, in addition to the previously identified roosts, was recorded in Goose Hill (though the previously identified roosts are relatively close), and possibly in the vicinity of Broom Covert (MS31).

### *'Big bat' spp.*

- 3.5.5 The 'big bats' group comprises serotine, noctule and Leisler's bat. There is much overlap between the parameters of these calls and, as for all bat species, they vary their calls according to the habitat in which they are flying. Definitive identification of these species is therefore difficult and often not possible. Only 16 passes – all from 2014 – were given an auto-identification of Leisler's bat: all of these were manually

examined, and it was considered that a more conservative estimate of '*Nyctalus* sp.' (i.e. either noctule or Leisler's bat) was appropriate in each case.

- 3.5.6 For most of the analyses, the 'big bats' were assessed as a group. However, as it was important to determine the potential presence of roosts of these species, over 250 passes from TCs 1 and 2 that were assigned to 'big bats' but not to a species were manually verified. Of these, 124 were considered to be noctule and 86 were considered more likely to be noctule (81%) than Leisler's bat or serotine. 48 were classified as '*Nyctalus* sp.'. A single pass was considered, potentially, to better fit the parameters for Leisler's bat than noctule, but the evidence was equivocal. Importantly, none of these early passes were considered to be serotine, suggesting that roosts of this species were not present within the Estate.
- 3.5.7 In the whole dataset (i.e. all time-codes), very few passes were specifically identified as serotine (39 in 2013; 81 in 2014): a very small percentage indeed of the overall (and again almost none of these in TCs 1-3). It is possible that further serotine passes have been included within the non-specific 'big bat' group (as demonstrated at MS12 in S2 2013); however, on the basis of the TC-targeted verification described above, and the previous work undertaken by Amec, no further attempt was made to separate the 'big bats' into *Nyctalus* and serotine. For those passes specifically identified as serotine (summarised above), 43 passes arose from MS21, and 13 from MS16; other MSs recorded only 1-4 passes.
- 3.5.8 Similarly, in view of the difficulty of separating noctule from Leisler's bat and on the basis of a comprehensive reassessment of previous work undertaken by Amec (see Section 4.A6.7.23 *et seq.*), it was considered likely that few calls could be assigned to Leisler's bat, and no further attempt was made to separate *Nyctalus* into species.
- 3.5.9 Activity levels of recorded species assigned to the 'big bat' species group was very variable between MSs, accounting for up to 45% of the total activity recorded over the two years of automated detector surveys when 'big bat' species were recorded.
- 3.5.10 Activity levels were noted to be more variable than those recorded for barbastelle or *Myotis* spp., with an activity peak of 357mppn in S2 of 2014, a high in activity over double that of the next most frequented MS at any point across the two years. The majority (within the verified sample) were thought to be more likely noctule, but with a proportion more likely serotine (see para 3.6.27).
- 3.5.11 Activity which suggested the presence of a roost nearby was identified near MS05 and/or MS06, and MS07 (The Grove); MS12 (the eastern part of Goose Hill) and MS21 (Leiston Old Abbey Woods).

#### *Myotis* spp.

- 3.5.12 *Myotis* spp. have very similar calls, and are often not distinguishable through their echolocation alone (though there can be characteristic features that are more indicative of (a) particular species). Although there are seven species of *Myotis* in the UK, only two are considered to be present at Sizewell: Natterer's bat and Daubenton's bat.
- 3.5.13 From previous work (Amec, 2011), and from trapping returns from 2014 (Corylus, 2014), it is considered likely that more of the passes recorded are Natterer's bat than Daubenton's bat. For the SM2 monitoring exercise (with one exception at MS36

which proved inconclusive), no attempt was made to distinguish between bat passes assigned to the *Myotis* group.

- 3.5.14 Across the two years of automated detector surveys, recorded *Myotis* spp. activity rarely accounted for more than 10% of total recorded activity. On the two occasions where *Myotis* activity accounted for more than 30% of total recorded activity (MS19 – the peripheral ride to the south of Kenton Hills; MS28 – along Lover’s Lane), overall bat activity was low.
- 3.5.15 Activity which suggested the presence of a roost nearby was consistent with the known roosts in The Grove, Leiston Abbey ruins, and the bat boxes in Kenton Hills.

#### *Pipistrellus* spp.

- 3.5.16 For the reasons given above, few of the detailed analyses were undertaken on pipistrelle species, and none on individual species other than Nathusius’ pipistrelle. A number of MSs produced very high numbers of passes; it was striking that the majority of these calls were recorded more than one hour after sunset (see Annex 2: Section A3 Figure 8e). For the 18 monitoring events (one event being one MS in one particular season/year) that recorded over 10,000 passes, the mean number of passes recorded in the first hour after sunset was under 10% (range 2-25%). Although one hour after sunset is only a small proportion of a night (and therefore the proportion of calls fitting into that hour might also be small), it is also one of the most ‘productive’ hours, with species generally less active in the middle of the night. This suggests that the majority of individuals were not arising from roosts in the immediate vicinity.

#### *Brown long-eared bats*

- 3.5.17 Although detailed analyses of the brown long-eared bat data were not undertaken, it was noted that a few MSs had relatively higher mppn. Those MS with >5mppn in at least one season of either year were: MS03 (Black Walks), MS07 (The Grove), MS10 (the linear feature running south from the known brown long-eared bat roost to the south of Ash Wood), MS16 (the field on the eastern edge of Goose Hill), MS20 (the ‘SSSI triangle’), MS21 (Leiston Abbey Woodland), MS23 (on the edge of Sizewell Belts), MS26 and MS31 (WP) (fields to the south), MS27 (Coronation Wood), and MS29 (bordering Grimsey’s). Of these, higher levels of activity were seen in three or more seasons (of six) in MS07, MS10, MS21 and MS23. Of these, the highest number of early passes (i.e. in TCs 1-3) were recorded at MS10, suggesting continued use of the roost in Ash Wood Cottages, and MS07, which may suggest an as-yet unidentified roost in The Grove (the pass rate here was particularly high for this species in 2014 S3).

### 3.6 Summary by area

- 3.6.1 For clarity, the following descriptions do not include specific references to all levels of bat activity described (these are illustrated in Annex 1: Figures 1 to 5, and set out numerically in Annex 2).

#### *Potential commuting routes leaving Ash Wood [MS05, MS06]*

- 3.6.2 Ash Wood is an area known to be of importance from the work undertaken between 2007 and 2011. There are now five known barbastelle roosts in Ash Wood (the latest identified in 2014), which also has the highest number of trees identified as having ‘high’ or ‘very high’ potential for supporting bat (rather than specifically barbastelle)

roosts (Amec, 2010). Only two MSs (both stereo) were used, all four mics were located on the outer edges of the wood (which measures approximately 8.6ha). These were designed to pick up bats leaving the wood, and would not have picked up all activity linked to barbastelle (or other) roosts within the interior.

- 3.6.3 Barbastelle activity levels were highest in S3 for MS06 on the north-eastern corner of Ash Wood, on a line between Black Walks and Stonewall Belts, suggesting barbastelle were more likely to be commuting north-south than east-west). Very little was recorded in any session from either of the MS05 stereo mics on the south-west corner, suggesting that the linear feature heading west from this corner is not particularly important for commuting or foraging. Early activity was also recorded for MS06 in S1/S3 in 2013 and S3 in 2014; over a week in 2014, the passes per night rose to a peak and then fell. It is likely, therefore, that barbastelle were roosting nearby for a week in early September 2014 close to this location. This was the only season/year on which levels of activity were greater than the mean. When looking at the percentile analysis, raised activity (at this location compared to bat activity overall) was seen in S3 in both years, again for about a week, much of this above the 90<sup>th</sup> percentile.
- 3.6.4 Data for 'big bats' shows raised levels of activity in S2 in both years, for both MS05 and MS06, though this is only greater than the mean for MS06 (it is worth noting that the mean in S2 2013 was inflated by a peak of activity at MS12, so activity in fewer areas exceeds the mean). A peak of early activity at MS05 was recorded in S2 2013 (both mics) exceeding 20 passes per TC in TC2; suggesting occupation of a roost in this vicinity (less early activity was recorded in S1/S3). In 2014, this early activity was recorded in 2014S1 with less early activity in S2/S3. Scattered early activity was also recorded by MS06 in both years, with a slight increase in S2 2013, again suggesting a roost. As 'big bats' are loud, and the passes were not picked up on all detectors, it is possible than more than one roost was occupied rather the passes being generated by bats from a single roost foraging in the vicinity of both. Few nights of activity exceeded the 75<sup>th</sup> percentile at these four locations, though more so in 2014 S2. At this time, activity regularly exceed the 75<sup>th</sup> percentile on the east side of Ash Wood, and the 90<sup>th</sup>, on four occasions.
- 3.6.5 There was scattered and low level *Myotis* activity recorded from MS06 (north side), other than in S2 2013, which included 10 nights of early TC activity, including two nights with single passes in TC1. This is likely to indicate a roost, as *Myotis* bats tend to emerge later. MS06 was identified as a 'bat hotspot' for overall bat activity. At MS05, although pipistrelle pass numbers were not as high here as in some other locations, the proportion of calls in the first hour of the night on one occasion was particularly high (approaching 60%).

#### *The Grove [MS07]*

- 3.6.6 This is an area known to be of importance from the work undertaken between 2007 and 2011. There are four known barbastelle roosts in The Grove (the latest identified in 2014), which also has a high number of trees identified as having 'high' or 'very high' potential for supporting bat (rather than specifically barbastelle) roosts.
- 3.6.7 This area is used by several bat species. High relative barbastelle activity was seen in both years in S1. An analysis of activity in the hour after sunset suggests a roost or roosts were occupied in S1 in both years; the evidence is less strong in S2 and S3. This is one of the three MSs exhibiting very high relative activity in a single time-code in S1, and activity was more than twice the mean for the season/year in S1 in both

years. The area of the Grove monitored by MS07 appears to be less important to barbastelle (less well used) in S2 and S3 in both years of monitoring. When looking at the percentile analysis, raised activity (at this location compared to bat activity overall) was seen in S1 in both years, and to a lesser extent in S2. The boxplots (Figure 7) additionally show (by the length of the bar displayed) that MS07 has one of the most variable levels of activity of any MS, particularly in S1 each year.

- 3.6.8 Data for 'big bats' also shows raised levels of activity in S1 and S2 (and activity is greater than twice the mean activity for the season in all except 2013 S3). There is some early activity in each of TCs 1-3 in most days in all seasons except S3 2013. With the exception of S2 2013 (when higher but also highly variable activity was recorded in each day, activity was regular but low-level (<10 passes in the first hour. This may be indicative of roosting or commuting (or indeed both, given The Grove's structure and composition). As for barbastelle, the boxplots show wide variation in activity at this MS, with high levels (exceeding 90<sup>th</sup> percentile) regularly over the monitoring period in all seasons/years except 2013 S3.
- 3.6.9 Raised levels of activity were also recorded for *Myotis* bats in five of six sessions (and, as for 'big bats', activity is high in relation to mean activity for the season in all except 2013 S3). Early activity (TCs 1-4) seen for four or more consecutive nights (4-14) was recorded in all seasons except 2013 S3. Activity exceeding 10 passes in the 80 minutes post-sunset (including some activity in TCs1) were recorded in S1 2013, and S1/S2 2014. This is consistent with Natterer's bats using an identified roost in The Grove. The percentile analyses show high levels (exceeding 90<sup>th</sup> percentile) regularly over the monitoring period in all seasons/years except 2013 S3 (thus, as for 'big bats' activity was regularly high rather than briefly peaking here).
- 3.6.10 The Grove was identified as a 'bat hotspot' for overall bat activity, important to barbastelle, *Myotis* sp(p). and 'big bats'.

#### *Plantation Cottages [MS01, MS34]*

- 3.6.11 This is an area known to be of importance from previous work, but consent for use of the 2013 data (MS01) was withheld by the landowner. In 2014, MS34 was installed in a slightly different location (further from the known roosts) to address this issue.
- 3.6.12 There are two known barbastelle tree-roosts in this area, confirmed to be used in August during the 2011 radio-tracking. Early recorded activity of barbastelle in 2014 in S3 indicated that barbastelle roosts (not necessarily in the same trees) were occupied at that time (and activity is high in relation to mean activity for the season). When looking at the percentile analysis in 2014, raised activity (at this location compared to bat activity overall) was also seen in S3, and to a lesser extent in S2.
- 3.6.13 Very high levels of pipistrelle activity may indicate roosts of this species as well as of barbastelle. Low-level early activity may indicate small numbers of roosting or commuting 'big bats' (likely noctule), though activity is much lower than the mean, and only rarely above the 75<sup>th</sup> percentile (in S1 2014 only).

#### *Flightpaths heading north [MS02, MS03, MS04]*

- 3.6.14 MS02 is at the end of a linear feature connected to The Grove; MS03 is located between Plantation Cottages and Ash Wood; MS04 is located on the Eastbridge Road, to the west of the northern end of the Upper Abbey track.

- 3.6.15 For MS02, barbastelle activity was generally low, but increased in S1 (2014). This was one of the MSs that exhibited very high levels of activity in an individual time-code (also in S1), at a time when roosts in The Grove were thought likely to be occupied. MS03 recorded the highest level of barbastelle relative activity seen, both in terms of mean passes per night (136mppn in 2013), and in an individual time-code, but only in S3 (also high in S3 2014 at 72mppn). There is low-level early activity at MS03 in S3 in both years, and unusually (given the extent of pipistrelle activity throughout), barbastelle comprised over 40% of the recorded bat passes in S3 2013. This increase in activity is also demonstrated by the analysis of the percentile data.
- 3.6.16 Activity at MS04 was lower throughout; nonetheless, activity exceeded the mean for the season/year on four occasions (2013 S1 and all seasons in 2014 – by twice the mean in S1 and S3 in 2014). This was also demonstrated by the percentile data, the number of passes exceeding the 90<sup>th</sup> percentile for one or two nights in all three seasons of 2014. There was only a scattering of early activity for this MS though, as for MS03, this was one of the MSs that exhibited higher levels of activity in an individual time-code in S3 (2014 TC data analysed only).
- 3.6.17 There is therefore evidence (reinforced by the 2014 radio-tracking study, see Corylus, 2014), that barbastelle are moving between Sizewell and Minsmere more often in S3 than in the other seasons in each year (more so from MS03 than for MS02 and MS04).
- 3.6.18 Data for ‘big bats’ for MS02 indicated activity throughout, raised in S1 (2013), and exceeding the mean on four occasions. The percentile analyses showed activity regularly exceeded the 90<sup>th</sup> percentile in S1 in 2013 and S3 2014, but not in S2 (either year) and occasionally in S3 2013 and S1 2014. There was some early activity in most seasons including TC0 in S3 2013). In 2013, this included some activity in TC0/1, but not in 2014. A high number of passes was also seen in TCs 2/3 in all seasons of 2014 and in S1 of 2013. The same was true for MS03, but with higher levels of activity also in S3 (2014), and again exceeding the mean on four occasions. Activity exceeded the 90<sup>th</sup> percentile in S1/S3 both years, though more often in 2014. There was much less ‘big bat’ activity, and little early activity, for MS04, except in S2 2014, and activity only exceed the 90<sup>th</sup> percentile briefly in S2 2014 and, briefly, the 75<sup>th</sup> percentile in S1 2014.
- 3.6.19 With the exception of S3 2013, the mppn from these MSs did not suggest significant activity for *Myotis* at these locations. However, activity exceeded the 75<sup>th</sup> percentile regularly at all three MSs in S1/S3 (though not at all MSs in all years). There was less activity in both years in S2 (none exceeding 75% in 2013). There was little early activity for *Myotis* spp., with the exception of MS03 2013 S2 (8 consecutive nights) and both years in S3. Activity briefly exceeded the 75<sup>th</sup> percentile and almost never the 90<sup>th</sup> in 2013 for MS02; more so in 2014.
- 3.6.20 There was some early activity from Nathusius’ pipistrelle at MS04 in 2014 S1 (69% of 29 calls).
- 3.6.21 MS02, MS03 and MS04 were all identified as ‘bat hotspots’ for overall bat activity in at least one season (species other than pipistrelle varied in importance). As noted above, of note for MS03 is that, in 2013 S3, pipistrelles comprised only 48% of the passes, and barbastelle 42% (this corresponded to a slightly raised level of activity in Ash Wood).

### *Goose Hill [MS11, MS12]*

- 3.6.22 MS11 was located in a central cross-roads of obvious rides, and lies within an area of Goose Hill that is proposed to be lost. MS12 is located towards the eastern edge of Goose Hill, also on a junction between tracks (it lies outside the area that is proposed to be lost, to the north of the area of the proposed new site access bridge).
- 3.6.23 Barbastelle were continually active in the area of MS11, with higher levels seen in 2014 in the first two seasons; activity was reduced later in the year (both years). There was significant early activity in all seasons in both years, including activity in the 20 minutes after sunset (more so in 2014). There are identified roosts in the southern end of The Grove (three) and Nursery Covert (three); it is also possible that a roost exists in the immediate vicinity (i.e. trees within Goose Hill itself). There were 38 trees of 'medium' potential and 13 trees of 'high' potential identified in 2010 (Amec, 2010). This was one of three MSs in S1 (2014) exhibiting very high activity in one or more individual time-codes.
- 3.6.24 Activity in a season/year that was more than twice the mean of that season/year was recorded in three monitoring periods at MS11 and MS16 (discussed below). This was also demonstrated by the percentile data, with the number of passes exceeding the 90<sup>th</sup> percentile at M11 on three occasions (2013 S2; 2014 S2, S3). Barbastelle were also continually active at MS12 (which lies between these two points), but with no peaks and little early activity. This illustrates the variability of recorded activity, even within a few hundred metres and within similar habitat.
- 3.6.25 'Big bats' were continually active in the area of MS11, with activity levels higher than the mean in all but S3 2013. Higher levels were seen in S2; activity was reduced earlier and later in the year. The percentile analyses show that although activity was very high at MS12 (see below), activity exceeded the 75 percentile for more nights at MS11 than MS12 in 2013 in every season, suggesting regular foraging, though pass rates were lower. Variable early activity was recorded in all seasons in both years (for TC1, more so in 2013); activity in the first hour after sunset was highest in S2 2014. This scattered low-level activity does not provide strong evidence of a roost/early commuting route. *Myotis* spp. were similarly active throughout, sometimes exceeding the 75<sup>th</sup> percentile (more so in 2014) with raised activity in S3 in both years, briefly exceeding the 90<sup>th</sup> percentile.
- 3.6.26 There was some early activity from Nathusius' pipistrelle at MS11 in 2013 S2 (42% of 45 calls).
- 3.6.27 For MS12, an exceptional peak of activity in S2 2013 (over 350 mppn) was recorded of 'big bats' (a random sample (10%) of these calls were manually validated to ensure these were genuine bat calls). The majority (within the verified sample) were thought to be more likely noctule, but with a proportion more likely serotine. This resulted from high activity on almost all nights of the monitoring period (exceeding the 90<sup>th</sup> percentile), perhaps indicating exploitation of a localised prey emergence (there was little activity in the first hour after sunset or first two hours before sunrise which might have indicated a roost). In fact, 79% of the activity was recorded in TC7, a period

when bats tend to be less active<sup>7</sup>. Activity levels were twice the mean for the season/year in S1 and S2 in both years (and exceeded the mean in S3 2014, but activity was much lower in S3). Only scattered low-level activity was recorded in TCs 0/1 in all season/years; early activity was occasionally high in S1 and S2 (both years), but not consistently so (not even in S2 2013 which recorded high levels across the monitoring period). *Myotis* spp. activity was generally lower (and lower than in the adjacent MS11), with little early activity.

- 3.6.28 MS11 met the criteria for a 'bat hotspot' in one session (2014, S2). In contrast, MS12 met the criteria for a 'bat hotspot' in four sessions (S1 and S2 in 2013; S1 and S2 in 2014). In 2013 S2, 43% of the recorded MS12 passes were from 'big bats'; in 2014 S1, 21%.

#### *Eastern 'corridor' [MS16, MS35]*

- 3.6.29 MS16 was located on the eastern edge of Goose Hill, with one mic located on the junction of two rides, and the second located in the field to the east, in suitable foraging habitat. Barbastelle were always more active along the rides than in the adjacent field (with one exception where activity levels were similar), with higher levels in particular in S1 2014. Early and scattered (but not high) levels of activity were seen in several seasons, but only notably in 2014 S2 on a single night of raised activity in TC3 (cross-roads mic only). The junction of the rides was one of the two which displayed higher levels of passes in individual time-codes in 2014 (S1 and S2). Looking at the percentile data from the rides (MS16), activity always exceeded the 75<sup>th</sup> percentile, and exceeded the 90<sup>th</sup> percentile on five out of six occasions.
- 3.6.30 For 'big bats', higher levels were seen in S1 2014 only from the mic positioned closer to the crossroads rather than that monitoring the foraging habitat. In the same season/year, early activity (from the same mic) was recorded. The field mic recorded sporadic early activity in all seasons/years, but only notably in S2 2013 (and less so than for the cross-roads mic). The data from this MS illustrates how different the results from the mean and mean can be; the raw means in 2014 indicate that there is higher activity at the crossroads (23.27 mppn) compared to the field (4.27 mppn), whereas the median data point for the field mic is higher (17 passes compared to 2). Neither method of examining the data gives the 'right' answer; both, together with an idea of how the data is distributed, provide some insight into the way bats use each part of the site. The percentile analyses show only a little activity above the 75<sup>th</sup> percentile in 2013; almost none above the 90<sup>th</sup> percentile. There was more activity above the 75<sup>th</sup> percentile in 2014, more so in the field than the cross-roads, exceeding the 90<sup>th</sup> percentile for a week in S1.
- 3.6.31 For *Myotis* spp., activity was slightly raised within the foraging habitat in S1 and S2 in 2013; little early activity recorded. The boxplot for 2013 shows an unusually high peak for *Myotis* in S1 for the field mic. The percentile analyses showed activity exceeding the 75<sup>th</sup> percentile for both mics in S1; the field mic only in S2; and not in

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<sup>7</sup> TC7 is the variable time-code covering 'the middle of the night' i.e. from two hours post-sunset to two hours pre-dawn, so it is a much longer period than the other 20-minute time-codes. As the extent of activity in TC07 seemed unusual (high numbers of passes over 10 consecutive days comprising 79% of activity at this MS in 2013 S2), a further 20% (over 600 sound files) of the calls in TC7 were re-checked and confirmed to be 'big bat'.

S3 in both years. Activity only briefly exceeded the 90<sup>th</sup> percentile, following the same pattern.

- 3.6.32 MS16 was one of a handful that recorded higher levels of Nathusius' pipistrelle (in S1 2014, from both mics; in S1 2013, more so from the foraging habitat). The timing of this activity did not indicate the presence of a roost.
- 3.6.33 MS16 was also identified as a 'bat hotspot' for overall bat activity in both years, on four occasions at the crossroads, and once within the adjacent field. In 2014 S1 (crossroads), 10% of the recorded passes were from barbastelle and 5% Nathusius' pipistrelle.
- 3.6.34 MS35, closer to the location of the proposed bridges and monitored in 2014 only, recorded much less activity than MS16. Of note was only early activity for 'big bats' in S1 in 2014.

*SSSI and related habitat [MS20, MS23, MS24, MS29, MS36]*

- 3.6.35 MS20 is located in the north-western corner of Goodrum's Fen; M24 to its west; M29 to the south. MS36 was to the south-west of all three, in similar habitat Goodrum's Fen, whilst M23 was much further to the west, south of Kenton Hills and on the edge of Leiston Carr (MS23 is also close to M18).
- 3.6.36 MS20 recorded a peak of barbastelle activity in S1 of 2013; this peak was not repeated to the same extent in the following year, though barbastelle were active here<sup>8</sup>. There were moderate levels of activity in S2 in both years. Activity that was greater than the overall mean for the season/year was recorded in MS20 in S1 and S2 in both years (more than twice the mean in S1 2013 (70mppn) and S2 2014 (20mppn)). Looking at the percentile data, activity exceeded the 90<sup>th</sup> percentile for bat activity in S1 and S2 2013, and S2 2014; and the 75<sup>th</sup> percentile in all seasons other than S3 2013.
- 3.6.37 In 2013, early activity was recorded on all nights in S1, corresponding to the peak of activity recorded here. Early activity began in TC1, and within the hour, the highest levels of activity were seen in TC2, suggesting an early feeding bout. In fact, 88% of the passes were recorded within 1 hour 40 minutes of sunset. In 2014 in S1, early activity (within an hour of sunset) was seen in TC3 on a number of occasions (and to a lesser extent within TC2), but activity was not concentrated into the first few TCs (as seen in 2013), but spread through the night. There is a group of 'inaccessible *Salix*' (Amec, 2010) directly to the south which may support a roost or roosts (as well as known roosts in Grimseys). Early activity declined as the year progressed in both years. In S2 2014, MS20 was one of those recording higher levels of passes in one or more time-codes.

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<sup>8</sup> Throughout this report, it is important to note that it is not possible to relate the number of passes to the number of bats generating these passes (the number of passes created is, in part, a function of the settings used to define passes (as set out earlier in this report)). Large numbers of passes can be generated by a small number of bats repeatedly passing the microphone. Thus, as the number of barbastelle passes had been very high at MS20 in 2013 (70 mppn), manual surveys were undertaken in 2014 to 'ground-truth' the numbers of bats using this habitat in mid-June. Unfortunately, passes at MS20 in S1 2014 were much reduced (15mppn) compared to 2013 (and distributed throughout the night), so it was not possible to infer how many bats might have been using the habitat in the previous year.

- 3.6.38 Of the other four MSs, there was less evidence of raised levels of barbastelle activity in most recording periods. Activity at MS23 was a little higher than the mean in S1 2013 and S2 2014, but otherwise less than the mean; less than the mean at MS24; raised in S3 2013 and S2 2014 at MS29 (but otherwise very low); and very low at MS36. The raised levels of activity at MS23 in S1 2013 briefly exceeded the 90<sup>th</sup> percentile. There was early barbastelle activity (raised levels in TCs 2/3) in the early part of S1 2013 which comprised 50% of the activity at this MS; less so in S2; none in S3, and very little in most of 2014.
- 3.6.39 With the exception of MS36 (monitored in 2014 only), these areas similarly did not appear to be of great importance for 'big bats', with no sites showing particularly high levels of activity or exceeding the mean for the season/year on more than one occasion. However, activity in most sites was highest in S1, and lowest in S3; activity at MS36 was twice the mean in S1 and S2 in 2014. The percentile analyses provided a varied picture, with the greatest activity above the 75<sup>th</sup> percentile seen at MS24/29 S1 (and to a lesser extent in S3) in 2013; and at MS20/24/29 S1, MS20/29 S2, and MS20/23/29 in S3. None of these periods were extensive. MS36 showed longer periods of activity, with activity greater than the 90<sup>th</sup> percentile – for over a week in 2014. Scattered early activity was seen at all four MSs, but generally of low-level, with one exception: MS23, S3 in 2014. Early activity was seen on ten consecutive days, with activity in the 20 minutes after sunset on each of those days; nonetheless, activity was low overall for this MS. A very similar pattern was seen at MS36; both may be from a roost in Grimseys, as little 'big bat' activity was noted within Kenton Hills.
- 3.6.40 For *Myotis* spp., raised activity was seen for MS20 (S2 2013; S3 2014); moderate activity throughout for MS23/MS24/MS29; and raised activity in S2 both years and S3 2013. Activity greater than the 75<sup>th</sup> percentile was recorded in 2013 in MS20 S1/S2, MS23/24/29 all seasons, with activity raised over an extended period in MS29 in S2 and S3; there was little activity over the 90<sup>th</sup> percentile (odd nights only). Activity greater than the 75<sup>th</sup> percentile was recorded in 2014 in MS20 (all seasons, for extended periods in S2/S3), MS23 (all seasons), MS24 (S2/S2), MS29 (all seasons, but particularly in S2, and MS36 (S1/S3). Again, activity rarely exceeded the 90<sup>th</sup> percentile, other than in MS29 for a week. At MS23, periods of consecutive early TC (TCs 3&4) activity were recorded in all but one season across both years. However activity in all seasons was generally low level with occasional peaks reaching 6-7 passes in the hour and 20 minutes after sunset. Regular low-level activity was seen in MS36 in TC3 in S3 2014, suggesting the possible presence of a roost in Grimseys, or a commuting route. These *Myotis* calls from TCs 1-3 were manually inspected to determine species (given their proximity to wetland), but there was no indication that these calls could be assigned to Daubenton's bat rather than Natterer's bat.
- 3.6.41 There was some early activity from Nathusius' pipistrelle at MS24 in 2013 S3 (69% of 68 calls).
- 3.6.42 In relation to overall bat activity, MS20 was classified as a bat 'hotspot' on two occasions (S1 2013; S3 2014). MS23 was similarly classified in S1, S2 2013; S1, S3 2014; MS24 in S1, S3 2013; MS29 in S2 2014; and MS36 in S1 2014. The activity relating to the hotspot in each case related to pipistrelle activity, with two exceptions: MS29 in S2 2014 recorded 6% *Myotis* activity and 3% barbastelle and MS36 in 2014 S1 recorded 8% 'big bat' activity. MS29 did not meet the criterion of a bat hotspot in any season/year. On two occasions (2013 S3; S1 2014), a high proportion of the pipistrelle activity at MS23 occurred in the first hour after sunset.

*Potential central commuting corridor [MS10, MS32]*

- 3.6.43 The Stonewall Belt corridor links Ash Wood to woodland contiguous with Goose Hill, and contains a small number of trees with the potential to support roosts. In 2013, this corridor was monitored by MS10 at the southern end of Stonewall Belt. In 2014, a stereo monitor (MS32) was added at the northern end of Stonewall Belt (either side of the tree-line).
- 3.6.44 This corridor was suggested to be an important commuting route as a result of previous work. To determine its importance, the relative activity of bats using this corridor was examined, as well as evidence of activity in the first hour after sunset.
- 3.6.45 Barbastelle were always active in the vicinity of MS10 in both 2013 and 2014 (between 6 and 14 mppn), but data from MS32 in 2014 was much lower in comparison (0.25 to 5.33 mppn). These data are illustrated Table A1- 20. In relation to the mean for a particular season/year, activity recorded at MS10 was above the mean in S2 in 2013, and in S1 and S2 in 2014. However, in 2014 (the period when MS32 was in place), activity was well below the mean.
- 3.6.46 The percentile analysis showed a similar picture. Activity at MS10 in 2013 exceeded the 75<sup>th</sup> percentile in all three seasons, but only for one or two nights in S1/S3, and briefly exceeded the 90<sup>th</sup> percentile in S2. Activity was consistently above the 75<sup>th</sup> percentile for five-seven days each season in 2014. In contrast, at MS32 on the west side, activity exceeded the 90<sup>th</sup> percentile for one night each in S2/S3; and not at all on the east side.
- 3.6.47 For MS10, there was consistent barbastelle activity in 2013, over largely consecutive nights in S1 and S2 (18% and 47% of all barbastelle records here), with activity in TC1 as well as TCs 2/3. In contrast, there was no TC 1 activity in 2014, and most of the early activity was in S3.
- 3.6.48 MS32 recorded only scattered early activity from barbastelle (in S1, only 4 calls were in TCs 1-3; in S2, only 3 calls). In S3, there was more early activity, but with no little obvious correspondence with calls recorded at MS10. These data do not suggest that this belt of vegetation is a strong commuting route for barbastelle, at least not early in the evening when this species is said to be more likely to use linear features (Zeale *et al.*, 2012).
- 3.6.49 Higher numbers of 'big bats' were recorded by MS10 in S2 in both years (particularly in 2013, with activity greater than the 75<sup>th</sup> percentile throughout the monitoring period in both years, and above the 90<sup>th</sup> percentile for about a week in both). The percentile analysis largely echoed this finding, but MS32 (west side) did briefly record activity above the 90<sup>th</sup> percentile in S3. Early activity comprised a high proportion of the passes in 2013 S1 (37%); 2013 S2 (61%); 2014 S1 (27%) and 2014 S2 (39%). Given the raised levels of activity in S2 in both years, this represents a high number of early passes, particularly in 2013. However, early activity of 'big bats' at MS10 in 2014 (on nine days) did not correspond well to that recorded at MS32 (odd passes on four days only).
- 3.6.50 For *Myotis* bats, there was consistent low-level activity throughout S1 and S2 in both years, comprising 18-49% of the activity recorded here, suggesting roosting or commuting, but this did not correspond at all to early activity at MS32, where very low levels of activity on only a few days were recorded.

### *Upper Abbey Farm bridleway [MS09, MS14]*

- 3.6.51 MS14 is located in the vicinity of Upper Abbey Farm; MS09 to its north on the same track. This area was previously identified (by Amec) as 'a strong commuting corridor', and appeared to be of importance for barbastelle, *Myotis* spp. and pipistrelle.
- 3.6.52 For barbastelle, MS14 was the only MS where activity levels were high (~>20 passes per night) in five seasons of six (all except 2014, S2). Activity was particularly high in 2014 S3 (74.08mppn). No other MS recorded more than 20 passes per night in more than two sessions of six. This area also consistently recorded barbastelle activity in a year/season that was more than twice the mean of that season/year in five of the six monitoring periods, though activity was much reduced in the remaining season (2014, S2).
- 3.6.53 In the percentile analysis, all seasons showed activity beyond the 75<sup>th</sup> percentile: 2013 S1 for 12 nights (greater than 90<sup>th</sup> percentile for 7 of these); S2 for 14 nights (i.e. the entire monitoring period; and greater than the 90<sup>th</sup> percentile for 13 of these) and S3 for three nights (greater than the 90<sup>th</sup> percentile for two of these). In other words, the use of this area of the track was consistently high and regularly so.
- 3.6.54 Early-activity records at MS14 (up to 37 passes in individual TCs 2 and 3, and including some records from TC1) suggest the use of this track by 'commuting' barbastelle, though this assumption is challenged by the data from MS09 (i.e. it is not clear that bats are travelling from MS14 to points beyond MS09, or vice versa). MS14 is also one of the three MSs in 2014 S3 which recorded very high passes in an individual time-code.
- 3.6.55 Although MS09 is only a short distance to the north of the point at which consistently high levels of activity were recorded, only low levels of activity were recorded here in at least three sessions (in a fourth session, the MS failed for an unknown reason). In only one case, S3 2013, did levels of activity at MS09 seem comparable to those at MS14. It is perhaps the case that barbastelle enter the track from the south (or reach this point across the open fields), and forage back-and-forth in the more sheltered/over-grown sections, continuing up the lane at a later point without lingering in the areas where the track is less sheltered. Daily pass-rates for MS14, MS09 and MS04 are compared across both years/all seasons in Table A1- 18.
- 3.6.56 Activity at MS09 in 2013 did not exceed the 75<sup>th</sup> percentile in 2013 S1, did so for a single night in S2, and for a week in S3. Activity only exceeded the 90<sup>th</sup> percentile in S3, and only briefly. These are much lower activity levels than at MS14; results were similarly lower 2014.
- 3.6.57 'Big bats' do not appear to be using this corridor to any great extent, though activity is a little higher at MS09 than MS14 (and higher still at MS04). Neither MS09 nor MS14 recorded activity greater than the 75<sup>th</sup> percentile except for MS09 S3 2013, MS09 S1 2014 and MS14 S3 – each briefly.
- 3.6.58 For *Myotis* spp, for MS14, activity was varied: much lower in 2013 than 2014, and higher in S3 in both years (72.67 mppn in S3 2014). Analysis of early activity showed regular activity in S3 2013, S2 2014 and particularly in S3 2014, consistent with the use of the track as a commuting route (in S3 2014, early activity occurred on 12 consecutive days). Very little activity was recorded for *Myotis* spp at MS09 (though note the MS was not functioning in 2014 S3). Neither MS09 nor MS14 recorded *Myotis* activity greater than the 75<sup>th</sup> percentile in 2013 except for MS14 S3, briefly. In

contrast, both recorded activity greater than the 75<sup>th</sup> percentile in all seasons in 2014 except for MS09 S3, and MS14 showed periods of activity greater than the 90<sup>th</sup> percentile in all seasons, extended in S3. Again, the levels of activity at MS09 and MS14 do not correspond well.

- 3.6.59 There was little early activity for any species/group at MS09.
- 3.6.60 Both MS09 and MS14 were identified as 'bat hotspots' for overall bat activity, though largely for pipistrelle. For MS14, barbastelle comprised 11% of the passes in 2013 S2, and barbastelle and *Myotis* both contributed 9% of the passes in 2014 S3.
- 3.6.61 The data suggest that the lower part of the Upper Abbey bridleway is of importance for foraging barbastelle, *Myotis* and pipistrelle, but it is less clear that this is a route by which bats regularly travel directly north beyond the Sizewell Estate.

#### *Stations to the west [MS17, MS30]*

- 3.6.62 M17 and M30 were positioned on the Eastbridge Road (M30) and between the Eastbridge Road and Leiston Old Abbey Wood (i.e. within and around the site of the proposed campus).
- 3.6.63 Barbastelle activity was recorded throughout at MS17 in 2013, though much reduced (and in S3, zero) in 2014; little early activity recorded. There were no data for 2014 S2 (machine failure). Activity exceeded the 75<sup>th</sup> percentile in all three seasons in 2013 (and occasionally the 90<sup>th</sup> percentile), but not at all in 2014.
- 3.6.64 A similar pattern was seen for 'big bats' and for *Myotis* spp., though numbers were higher for *Myotis* spp. in S2 (2013). Big bat activity was greater than the 75<sup>th</sup> percentile in all seasons in 2013 and S1 2014; greater than the 90<sup>th</sup> in S1 and S3 2013 and S1 2014. Early activity was recorded for 'big bats' in S1 (both years) and S2 (S1 only as no records for 2014), with activity in early TCs comprising 40-69% of the activity, suggesting a commuting route (tying in with 'big bat' activity at Leiston Old Abbey Wood). High levels of early activity (TCs1-4) were also seen for *Myotis* in 2013 in S1 (18% of activity here) and even more so in S2 (33%), and in 2014 S1 (34%). The overall mean was similar in S1 and S3, but there was very little early activity in S3. *Myotis* activity was much lower in 2014 (note no data collected in S2 though).
- 3.6.65 MS17 met the criterion for a bat hotspot in 2013 S1, with non-pipistrelle passes split between barbastelle, 'big bats' and *Myotis* spp., and also in S3 2013.
- 3.6.66 MS30 recorded fewer bats in comparison, with little evidence of early activity to support a commuting route, and did not meet the criterion for a bat hotspot (though note that monitoring only started at this point in S3 2013). This was, however, one of the handful of sites that recorded higher numbers of *Nathusius* pipistrelle (S3, 2014). A good proportion of the passes at this time were recorded in early TCs (TCs 1-3: 29%), but not on consecutive nights; this might suggest a commuting roost or perhaps a mating roost, but this is entirely speculative. Barbastelle activity at MS30 exceeded the 75<sup>th</sup> percentile briefly in S3 both years, but only briefly and only on one mic in 2014. 'Big bat' activity exceeded the 90<sup>th</sup> percentile in S3 2013 (both mics), but rarely exceeded the 75<sup>th</sup> in 2014. *Myotis* activity only once exceed the 75<sup>th</sup> percentile, and that only briefly (and only one mic).
- 3.6.67 These data are illustrated in Table A1- 19.

*West-east corridor: Leiston Old Abbey [MS21], Fiscal Policy [MS22]*

- 3.6.68 MS21 is located within Leiston Abbey Woodland, west of the Upper Abbey bridleway. This woodland is just to the north, and at the end, of an east-west commuting corridor which links to the Leiston Abbey ruins, further to the west. MS22 was located to the east of the Upper Abbey bridleway: one microphone adjacent to a broad track recognised as a strong west-east bat flight-path along the edge of Kenton Hills; the other on the edge of a smaller path running through the Fiscal Policy woodland. There were distinct differences between MS21 and MS22, and between the two locations recording to MS22.
- 3.6.69 There are known barbastelle roosts in Leiston Old Abbey (a little to the north of MS21), along the northern 'front' of Kenton Hills, and into Hilltop/Nursery Covert. There is also a known Natterer's roost in the Leiston Abbey ruins, to the west of Leiston Old Abbey Wood, and within one or more bat boxes in Kenton Hills.
- 3.6.70 MS21 did not record raised levels of barbastelle activity, nor much early activity (though the known roost or adjacent tree(s) may have been occupied in S2 2014, as consistent low-level activity was recorded in that period and activity exceeded the 75<sup>th</sup> percentile at that time). Occasional TC1 activity also recorded in S1/S3 2013.
- 3.6.71 For 'big bats', very high activity was seen in S2 and S3 2013, and high levels in S1 and S2 2014. In all sessions, activity was greater than the mean; on four occasions, more than twice the mean. This was consistent with the percentile analyses, with activity greater than the 90<sup>th</sup> percentile in all seasons/years, indicating extended periods of high activity, particularly in S1/S2 each year. Consistent early activity in all seasons of both years (more so in S1/S2 than S3, but variable) suggests occupation of a roost within the wood (or possible commuting activity from the known serotine roost at Theberton). Activity reached 149 passes in the hour after sunset in S2 2013, and across all years, exceeded 50 passes on six nights.
- 3.6.72 MS21 was also a focus of activity for *Myotis* spp., with raised activity throughout (though higher in S2/S3 each year). Activity was greater than the 75<sup>th</sup> percentile in all seasons of both years and, as for 'big bats', often exceeding the 90<sup>th</sup> percentile. Regular early activity in all seasons and both years is consistent with the occupation of a Natterer's roost in Leiston Old Abbey (though occupation of that roost was not assessed in 2013/14), and there may be others.
- 3.6.73 For MS22, activity levels for barbastelle were consistently higher along the track than in the Fiscal Policy woodland, season for season. High activity levels were seen along the track from S1 2013 to S1 2014, though much lower in S2 and S3 in 2014 (activity always exceeded the 75<sup>th</sup> percentile and usually the 90<sup>th</sup> percentile). 2014 S1 was one of the six hotspots of barbastelle activity exceeding 50 mppn.
- 3.6.74 Extensive early activity was seen along the track (more so in 2014, but earlier in 2013), and this was one of the MSs exhibiting very high passes in individual time-codes (S1, 2014, and to a lesser extent, S3). Activity in a season/year that was more than twice the mean of that season/year was recorded in four monitoring periods by MS22 (the track along the front of Kenton Hills).
- 3.6.75 In Fiscal Policy itself, barbastelle activity was higher in S1 of both years (though lower than along the track); activity also exceeded the mean for the season/year in these periods. Activity exceeded the 75<sup>th</sup> percentile in four monitoring periods of six and exceeded the 90<sup>th</sup> percentile twice. Little early activity was recorded in Fiscal Policy.

- 3.6.76 Almost no activity was recorded from 'big bats' for either mic, suggesting that they do not use the Fiscal Policy woodland, nor use the track as a flight-path.
- 3.6.77 For *Myotis* spp., activity levels were again consistently higher along the track than in the Fiscal Policy woodland (where activity was consistently low), throughout the year. Higher levels of activity were seen in all seasons of both years along the track; this was mirrored in the percentile analyses, with activity greater than the 90<sup>th</sup> percentile for extended periods, sometimes for the whole recording period.
- 3.6.78 Early activity was seen consistently along the track (all seasons, both years), but not the woodland in 2014 (in S1 and S2 2013, comprising 58% and 60% of the overall *Myotis* passes). This suggests that *Myotis* bats using the east-west commuting route are not roosting (at least, not in number) in the Fiscal Policy woodland.
- 3.6.79 Leiston Old Abbey woodland, Fiscal Policy and the west-east track described above-west track all met the criterion of an overall 'bat hotspot' on five occasions of six. Extremely high numbers of pipistrelle passes were recorded in 2014 S3 along the track (which relates in part to the way the software divides sequences of calls into passes); surprisingly, almost none of these (just 2%) were recorded in the first hour after sunset, suggesting few originated from roosts nearby. 'Big bats' and *Myotis* contributed significantly to the totals in Leiston Old Abbey woodland (MS21); whilst for MS22 along the track, it was barbastelle and *Myotis* spp.

*Nursery covert, peripheral ride [MS18, MS19]*

- 3.6.80 MS18 and MS19 are located on the southern peripheral ride of Kenton Hills, with MS18 further to the west. There are a number of known barbastelle roosts in this plantation, with two located close to the peripheral ride between the MSs, and two closer to MS19 to the east. MS18 recorded no data in 2013 S2.
- 3.6.81 Activity levels were much lower at MS18 than MS19, and very little early activity was ever recorded at MS18. Higher levels of barbastelle activity were recorded by MS19 in S1 and S2 in 2014, and to a much lesser extent in 2013; less so in S3 in either year. Activity in S1 and S2 in 2014 exceeded twice the mean for these seasons/years. Activity at MS19 regularly exceeded the 75<sup>th</sup> percentile in S1 and S2 (particularly in 2013 where activity also exceeded the 90<sup>th</sup> percentile), but not in S3. There was high levels of early activity in S1 2013 (63% of total activity); 2014 S1 (27%) and S2 (62%); 2014 S1 (27%) and S2 (8%), suggestive of roost occupation. MS19 was one of the three MSs in S2 exhibiting high numbers of passes in one or more individual time-codes, but the highest rates of passes were much reduced compared to the pass rates seen in S1. These higher rates of activity were reflected in MS18, but only in S1 (both years), indicating that barbastelle were not travelling regularly west from MS19 later in the year, at least not along the peripheral ride.
- 3.6.82 'Big bats' were not very active at MS18 or MS19, corroborating the findings from the northern edge of Kenton Hills and associated track. *Myotis* spp were also not very active at MS18; in contrast, MS19 recorded *Myotis* activity throughout, with regular early activity, consistent with a roost and/or commuting (Natterer's bats are known to roost in bat boxes in Kenton Hills). *Myotis* activity at MS19 exceeded the 75<sup>th</sup> percentile in all seasons/years monitored for the majority of each recording period, and often exceed the 90<sup>th</sup> percentile.
- 3.6.83 MS18 met the criterion for an overall bat hotspot in 2014 (S1), but numbers were low at other times (there was no data from S2 2013 (machine failure). MS19 also met the

criterion for an overall bat hotspot in 2014 (S1, S2); in S2, barbastelle and *Myotis* species contributed to the higher levels of activity.

- 3.6.84 Overall, these areas are important for roosting and commuting barbastelle and *Myotis* spp. as well as common/soprano pipistrelle. Although pipistrelle pass numbers were not as high here as in some other locations, the proportion of calls in the first hour of the night in S3 in both years was particularly high at MS18 (approaching 70%).

*Fields adjacent to Kenton Hills [MS08, MS15]*

- 3.6.85 MS08 was located in a patchy hedgeline leading north from Kenton Hills and located to the east of M22. MS15 was a stereo microphone monitoring both the track (east of MS22) and a tree-line perpendicular to the track.
- 3.6.86 Very little activity was recorded by MS08 for any species / species group, at any point, with the exception of S3 2014, where barbastelle activity was not high but did exceed the mean for that season/year. At that location, passes here exceeded the 75 percentile for just over a week.
- 3.6.87 The track and tree-line monitored by MS15 generated high levels of pipistrelle activity, including raised levels of Nathusius' pipistrelle activity that often exceeded the mean (on 8 occasions of 12 for the stereo mics combined). These passes were not close to sunset or sunrise, and therefore did not suggest the presence of a roost. Barbastelle activity never exceeded 3mppn (and thus never exceeded the 75% percentile); *Myotis* spp. and 'big bat' activity was generally even lower, and often zero.

*Fields to the south [MS25, MS26, MS28, MS31, MS33]*

- 3.6.88 These areas were selected for survey because they had been less-intensively surveyed previously and/or because they are adjacent to habitat that is intended to provide improved foraging opportunities for bats in the short- to medium-term. (For example, they are allied to habitat creation for reptile mitigation). MS25 is adjacent to Aldhurst Farm habitat creation scheme; MS26 and MS31 are close to Broom Covert (south of Sandy Lane); MS28 (2013 only) is further south, on Lover's Lane; and MS33 is on the edge of Reckham Pitts Wood.
- 3.6.89 MS25 recorded low levels of bat activity for all species except the *Myotis* group, where activity greater than the mean was seen in 2014 S1 only (12mppn – activity here exceeded the 90<sup>th</sup> percentile for the majority of the monitoring period). MS26 recorded barbastelle activity greater than the mean in S3 (and greater than the 75<sup>th</sup> percentile) in both years; all other species' activity was very low. MS28 (deployed in 2013 only) recorded low activity for most species/seasons, with the exception of *Myotis* spp., where activity was greater than the mean in S2 only (and briefly above the 75<sup>th</sup> percentile).
- 3.6.90 MS31 recorded a peak of activity in S3, 2013 for barbastelle (56mppn; for a few days greater than the 90<sup>th</sup> percentile), but not at other times (these calls were subsequently manually verified as barbastelle). In that season (S3, 2013), as well as in 2014 (S2 and S3), activity greater than the mean was also seen for 'big bats' and, for S3 2013 only, for *Myotis* spp. The percentile analyses briefly recorded 'big bat' activity greater than the 75<sup>th</sup> percentile in S3 2013 and throughout 2014 (*Myotis* similarly). MS31 used a stereo set-up; the mic recording the greater level of activity varied between recording periods. MS33 (2014 only) recorded activity levels greater than twice the mean for 'big bats' in 2014 S2 (above the 90<sup>th</sup> percentile for a few days, and with early activity comprising 40% of passes), but otherwise low levels of activity for all

species. MS31 was also identified as a 'hot spot', with barbastelle comprising 14% of the passes.

3.6.91 None of these MSs recorded significant early activity.

#### *Coronation Wood [MS27]*

3.6.92 This station was monitored in 2013 only (and previously by Amec in 2012). MS27 was positioned at the point of greatest barbastelle activity in previous surveys. Although two seasons were identified as 'hot spots', this mainly related to pipistrelle activity (over 90%). Only very low levels of barbastelle and 'big bats' were recorded; activity for *Myotis* spp. was higher than the mean in both S2 and S3, and briefly exceeded the 75<sup>th</sup> percentile at these times. Very little early activity recorded.

### 3.7 Summary and interpretation

3.7.1 This document reports only on the results of the SM2 surveys in 2013 and 2014 and, during the impact assessment, these data will be interpreted in the context of the existing findings from previous studies, and not used in isolation. However, the following points are noted from the 2013/2014 work:

- Barbastelle activity over the six seasons monitored varied between 5.2 mppn and 11.9 mppn, with activity in both years highest in June (maternity, largely pre-lactation), and lowest in July/August, which covers lactation and the start of colonies dispersing.
- In contrast, 'big bat' activity was very high in one season (22.2 mppn, July/August 2013), and otherwise varied from 2.2 to 8.6 mppn. In both years, activity was lowest in September/October (mating and pre-hibernation).
- For *Myotis* spp., activity over the six seasons monitored varied between 3.6 mppn and 8.8 mppn. Activity was lowest in June, and the later two seasons were similar within each year (all seasons lower, by season, in 2014 than 2013).
- The activity of Nathusius' pipistrelle varied from 1.8 to 3.5 mppn and accounted for less than 1% of overall activity recorded. Earlier work (Amec, 2011) suggested that numbers peaked in Spring and late Summer/early Autumn), and that this may have been related to migration. The SM2 monitoring programme started after any potential Spring peak, but the higher levels of activity recorded in S1 than S3 do not support the migration theory. Relative activity in June was higher than in the other two seasons.
- Common/soprano pipistrelle activity varied between 294 and 378 mppn, with no obvious pattern between season/years in the raw data.

3.7.2 These patterns were drawn from examination of the 'raw means', and need to be interpreted with caution because of the highly-skewed nature of the data.

3.7.3 Analysis of the data using techniques that took this characteristic of the data into account showed overall:

- Seasonal differences in the number of total nightly bat passes observed were highly statistically significant for all species groups, indicating seasonal activity patterns. Bat activity was highest in S1 for barbastelle, Nathusius' pipistrelle

and the combined pipistrelle group, and highest in S2 for the *Myotis* spp. and 'Big bat' species groups.

- There were strongly significant differences in the observed bat pass rate, as measured as bat passes per hour. This indicates that seasonal differences in the number of bat passes recorded are not simply a result of differences in night length, and hence nightly sampling period.
- In some species or species groups, seasonal patterns in total nightly bat passes differed from seasonal patterns in nightly bat pass rate. This was likely due to interactions between activity levels and the longer observation period (night length) in S3, which allows opportunity for increased total bat passes but tends to reduce the bat pass rate value.
- Variations in nightly temperature explained some of the variation in bat activity recorded. Minimum nightly temperature was positively related to the number of bat passes and the bat pass rate, such that on warmer nights, higher levels of bat activity was recorded. This effect was recorded in all of the species or species groups, except the *Myotis* spp. group.

#### 3.7.4 By species:

- Barbastelle were widely distributed, being recorded at every MS (in each of the two years, where deployed in both years), though less active south of Kenton Hills and the marshes to the south. However, with the exception of a few key areas (and even in apparently key areas), activity varied between years and between seasons. This suggests that, to some extent, their behaviour adapts to roost location and prey availability. **Nonetheless, the indication from the raw data that relative activity was higher in S1 was borne out by the more detailed analyses that took the skewed nature of the data into account.** For both the total number of passes, and the bat pass rate, bat activity was significantly higher in S1. There was no significant effect of year on the number of bat passes.
- Little attempt was made to separate the 'big bat' species into noctule, Leisler's bat and serotine. However, it is possible to say with confidence that noctule are more common than serotine, and to be reasonably certain that no serotine roosts are present within the Estate. Leisler's bat is rarely present (if at all). For 'big bat' species, the subsequent analyses (taking the skewed distribution of the data into account) demonstrated a significant increase from S1 to S2, with a steep decline from S2 to S3. There was no significant effect of year on the number of bat passes.
- Other than for MS36 data, no attempt was made to separate the *Myotis* spp recorded into Natterer's bat and Daubenton's bat, though the former is likely to be much more common. For *Myotis* spp., the subsequent analyses similarly confirmed strong seasonal differences, with activity lowest in S1, highest in S2, and considerably lower in S3 (the bat pass rate did not differ significantly between S1 and S3). Numbers of passes were significantly lower in 2014 than in 2013.
- For Nathusius's pipistrelle, the pattern was similar to that of barbastelle, with the number of bat passes highest in S1, lower in S3 and lowest in S2 (though similar in S2/S3). There was no significant effect of year on the number of bat passes.

- While no obvious pattern of activity was discernible from the raw means, the subsequent analysis for 'all pipistrelle species' revealed a significant seasonal difference in the number of pipistrelle passes recorded. The number of bat passes was highest in S1, decreased in S2 and further declined in S3. Numbers of bat passes were significantly higher in 2014 than 2013; the opposite trend to that seen for *Myotis* spp.

3.7.5 A number of potential roosts were indicated by the data (some of this activity may relate to commuting behaviour from which it may be possible to locate roosts):

- Activity which suggested the presence of a barbastelle roost (in addition to the previously identified roosts), was recorded in Goose Hill (though the previously identified roosts are relatively close), and possibly in the vicinity of Broom Covert (MS31).
- Activity which suggested the presence of a 'big bat' (likely noctule) roost nearby was identified near MS05 and/or MS06 and MS07 (The Grove); MS12 (the eastern part of Goose Hill) and MS21 (Leiston Old Abbey Woods). Grimsey's (which is known to support barbastelle) may also support roosts.
- Activity which suggested the presence of a *Myotis* roost nearby was consistent with the known Natterer's bat roosts in The Grove, Leiston Abbey ruins, and the bat boxes in Kenton Hills; early activity also suggested a possible roost in Ash Wood.
- The Grove may also support a roost of brown long-eared bats. The area around Plantation Cottages may support a common or soprano pipistrelle roost.

3.7.6 In relation to specific areas, the following patterns of behaviour were indicated from the data (see Figures 1-4 for locations):

- Barbastelle more frequently commuted north-south than east-west from Ash Wood, though it is also possible that they did not use linear features to fly away from the wood. Very little activity was recorded on the south-west of Ash Wood, suggesting that the linear feature here is of low importance.
- Barbastelle activity at Black Walks and the northern end of The Grove was high, suggesting links to the north beyond the Estate (including to the area of Plantation Cottages, where there are known roosts). The Grove itself was one of the more important areas for barbastelle, particularly in the first season of monitoring (though note that the MS here covered only a small area of this feature). It also appears to be important for 'big bats' and *Myotis* sp(p), with suspected/known roosts.
- The 'flightpaths' heading north, monitored at three points: along the Eastbridge Road, at the north end of Black Walks, and to the north of the Grove, were all well-used by barbastelle, particularly that located within Black Walks (which lies between Plantation Cottages and Ash Wood). The two more eastern routes were also used by 'big bats', much less so for *Myotis* spp.
- Goose Hill was identified as important for barbastelle, 'big bats' and *Myotis*, with activity varying with season and inconsistencies between locations, even when only a few hundred metres apart. The highest single peak for any species group was recorded at the MS located to the east of (i.e. outside) the proposed red-line boundary.

- At the south-eastern corner of Goose Hill, where the rides were adjacent to wet grassland foraging habitat, the rides appeared to be of greater importance for barbastelle, 'big bats' and pipistrelle (including Nathusius' pipistrelle), while the foraging habitat appeared to be used more by *Myotis* spp. (note that only a small proportion of the foraging habitat would have been sampled). Having said that, the field was probably used more consistently by 'big bats' than the rides. There was much less bat activity at the location of the proposed crossing from Goose Hill across the SSSI to the C Platform.
- Habitat within Goodrum's Fen generated higher levels of barbastelle activity in almost all monitoring seasons than other habitat of this type (or similar) located in and around the SSSI. In the first year here, foraging was focussed in the early part of the evening, as has been noted in other surveys (detector and radio-tracking). It is important to note, however, that foraging activity in the more open areas covered by these MSs may be under-recorded, partly because activity may be at a distance from the recorder, and partly because barbastelle reduce the amplitude of their calls when catching prey, which makes them harder to detect. These areas also had some importance for 'big bats' and *Myotis* spp.
- Although the corridor linking Ash Wood to Hilltop Covert via Stonewall Belt was used by barbastelle, 'big bats' and *Myotis* spp., the data did not suggest that this belt of vegetation is a strong commuting route for barbastelle, at least not early in the evening when this species is more likely to use linear features, nor did this seem to be the case for other species.
- There were high levels of barbastelle activity along the Upper Abbey bridleway at the level of Upper Abbey Farm; these were much reduced at the MS only a short distance to the north. The sheltered part of the track appears to have greater importance as a foraging area than as a flight path to the north. This was also the case for *Myotis* spp., though 'big bats' did not use this corridor to any great extent.
- A potential western commuting route was explored, running between Leiston Old Abbey Woodland and Eastbridge, along the Eastbridge Road. This area did not record significant numbers of bats, but was used by all species, including Nathusius' pipistrelle. Higher numbers of *Myotis* were recorded here. The route is connected to both Upper Abbey track and Leiston Old Abbey Woodland, where high levels of activity were recorded.
- Leiston Old Abbey woodland, Fiscal Policy and the east-west track all met the criterion of an overall 'bat hotspot' on five occasions out of six (though for Fiscal Policy, this was almost entirely pipistrelle activity). There were distinct differences in the species' use of these areas, with 'big bats' and *Myotis* spp. very active in Leiston Old Abbey woodland, and barbastelle and *Myotis* spp. more active along the Kenton Hills track. For species other than for pipistrelle, activity was always lower in Fiscal Policy than along the track.
- The peripheral ride through the southern part of Kenton Hills was well-used at its eastern end by barbastelle (less so to the west); a similar pattern was seen for *Myotis*. This woodland track was not frequently used by 'big bats', despite occasional use of bat boxes in Kenton Hills by noctule.
- The arable fields were monitored along tree-lines which extended into them. Very little activity was recorded along the western feature, whilst the easternmost tree-line generated high levels of pipistrelle activity, including Nathusius' pipistrelle. Of interest is that the high levels of barbastelle and

*Myotis* spp. activity recorded at the western part of the track were not reflected in higher levels of activity in the eastern monitoring point.

- The fields to the south, which are adjacent to habitat that is intended to provide improved foraging opportunities for bats in the short- to medium-term, largely generated low levels of bat activity, with the exception of Broom Covert.
- Only very low levels of barbastelle and 'big bats', and slightly higher levels of *Myotis* spp., were recorded in Coronation Wood.

3.7.7 'Bat hotspots' were determined based on relative activity (as noted above, relative bat activity is defined in terms of the numbers of bat passes recorded in this study, and does not correlate to the numbers of bats or to published criteria):

- Three-quarters of the MSs were classified as a 'bat hotspot' in one or more season (i.e. mean passes per night for a single recording season from all species combined exceeded 300). Much of this activity related to common/soprano pipistrelle, both of which are widespread and common.
- Fourteen MSs met the criterion for a 'bat hotspot' where pipistrelle activity comprised less than 90% of the total on at least one occasion: MS02, MS03, MS07, MS10, MS12, MS14, MS16, MS17, MS19, MS21, MS22, MS29, MS31 and MS36. Of these, only two (MS10 and MS14) are within the proposed red-line boundary. Four are close to the proposed red-line boundary (MS17, MS21, MS22 and MS29); the remainder are beyond it.

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# FIGURES

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Figure 1-4: Mean-pass maps by species, year and season	
Figure 1(a-f)	Barbastelle (2013 S1-S2-S3; 2014 S1-S2-S3)
Figure 2 (a-f)	'Big bats' (2013 S1-S2-S3; 2014 S1-S2-S3)
Figure 3 (a-f)	<i>Myotis</i> (2013 S1-S2-S3; 2014 S1-S2-S3)
Figure 4 (a-f)	Nathusius' pipistrelle (2013 S1-S2-S3; 2014 S1-S2-S3)
Figure 5: A summary of the spatial and temporal distribution across all six sessions (all seasons; both years)	
Figure 5a	Barbastelle
Figure 5b	'Big bats'
Figure 5c	<i>Myotis</i>
Figure 5d	Nathusius' pipistrelle
Figure 6	HOTSPOT FIGURE TO FOLLOW
Figure 7	Boxplot and percentile analyses – see Section A3



## DETAILED RESULTS

# A1. 2013 AND 2014 AUTOMATED BAT DETECTOR SURVEY RESULTS

### A1.1. Notes on species groups

A1.1.1. Table A1- 2 to Table A1- 13 set out the mean passes per night (mppn) across all sessions and seasons for both years, for each of six species/species groups as follows:

- Barbastelle
- *Myotis* spp.
- 'Big bat' spp.
- Nathusius' Pipistrelle
- Pipistrelle spp.
- Long-eared bats

A1.1.2. The following information should be considered before reviewing the tables:

- Files not given an identification are considered to have been noise files (rather than bat calls) and are not included here.
- Files identified by the software as "Parasi" (i.e. SonoChiro has not identified the presence of a bat call but cannot entirely rule out the potential for one to be present) are not included here.
- Files identified as "Chiro sp." (i.e. SonoChiro has identified that a bat call is present, but there is insufficient information present to be able to provide a group or species level identification) are not included here.
- Constant high frequency background noise can mimic the call parameters of horseshoe bats. Files identified as greater or lesser horseshoe (or to the horseshoe bat group) are considered to be mis-identified noise files, and are not included here. However, owing to the presence of a single lesser horseshoe bat within Suffolk, many miles outside of the species' current range, a proportion of the 'lesser horseshoe bat' calls were verified, and all were found to be constant high-frequency background noise calls.
- The '*Myotis* spp.' column [\*] includes those calls identified by SonoChiro specifically as Natterer's bat and Bechstein's bat in addition to those identified to a group level as *Myotis* sp. Suffolk is outside of the known range of Bechstein's bat.
- The 'big bat spp.' column [\*\*] includes those calls identified by SonoChiro specifically as noctule, Leisler's bat and serotine in addition to those identified to a group level as *Eptesicus/Nyctalus*. It excludes calls assigned to the Northern bat. The UK is outside of the known range of the Northern bat, though vagrants are occasionally recorded in south-east England. This bat uses a call with a long constant-frequency element, and constant low-frequency background noise (26-29kHz) can be mistaken for this species.
- 'Nathusius' Pipistrelle' [\*\*\*] includes those calls identified by SonoChiro specifically as Nathusius' pipistrelle in addition to those identified as 'Nathusius'/Kuhl/Savi' pipistrelle and those identified as Kuhl's pipistrelle. These

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were all considered to be *Nathusius'* pipistrelle: although the calls are very similar and difficult to distinguish, on the basis of geographical distribution. Savi's pipistrelle is a southern European species, and Kuhl's pipistrelle only as an occasional vagrant to the south-east.

- 'Pipistrelle spp.' [\*\*\*\*] includes those calls identified by SonoChiro specifically as common, soprano, *Nathusius'* or Kuhl's pipistrelles in addition to those identified to a group level as common/soprano pipistrelle or Kuhl/*Nathusius'*/Savi pipistrelle. SonoChiro does not assign calls to a *Nathusius'*/common pipistrelle grouping, even though there is known to be some overlap.
- 'Long-eared bats' [\*\*\*\*\*] includes those calls identified by SonoChiro specifically as brown or grey long-eared bats in addition to those identified to a group level as long-eared bats (this is because Suffolk is outside of the known range of grey long-eared bat).
- Cells highlighted in green in the final column indicate where total mppn exceeded 300 for a particular MS (these were classified as 'bat hotspots'). In addition, for these hotspots, the pipistrelle column is highlighted in blue where pipistrelle activity accounted for less than 90% of that total.

A1.1.3. In addition, the 'detectability' of different species differs. Table 2.4 in Amec, 2009 (reproduced below as Table A1- 1) indicates the likely detectability of UK bat species or species groups, based on preliminary and unpublished research undertaken by BSG in collaboration with Bristol University. This work was not undertaken on the model of bat detector used in the present study, and has not been peer-reviewed; nonetheless, it provides an illustration of the scale of difference in detectability of different species/groups.

Table A1- 1. Maximum detection distance (m) by species or species group.

Species or group	Maximum detection distance (m)
<i>Pipistrellus</i> species	30
Brown long-eared bat	<5 for typical foraging calls; 5-10m for louder commuting calls
<i>Myotis</i> spp	15
Noctule	>100m (CF call)
Leisler's bat	50 (CF call)
Serotine	30?
Barbastelle*	5

\* For barbastelle, the study did not distinguish between commuting calls and typical foraging calls. When foraging, barbastelle are now known to emit calls that are 10 to 100 times lower in amplitude than those of other aerial hawking bats (Goerlitz *et al.*, 2012).

A1.1.4. A further consideration is the directionality of calls which varies, partly as a consequence of call frequency, partly as a result of nostril vs mouth emission of calls (some species do both). While SM2 microphones (described as 'omnidirectional') have a wider 'field of view' than those of Anabats, directionality of calls is also likely to affect the detectability of bats in a species-specific way.

A1.1.5. These factors affecting detectability highlight why species percentages listed in the tables should not be directly compared.

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### A1.2. Results tables

- A1.2.1. Table A1- 2 to Table A1- 13 present the activity data for all sessions, seasons and years for all monitoring stations. (MS).
- A1.2.2. Table A1- 14 to Table A1- 17 compare, for each of four species/species groups, activity (mppn) with the overall mean activity for that season/year.
- A1.2.3. Table A1- 18 present barbastelle activity data for the Upper Abbey track.
- A1.2.4. Table A1- 19 present barbastelle activity data for the potential commuting route to the west of Upper Abbey Track.
- A1.2.5. Table A1- 20 presents barbastelle activity data for Stonewall Belt.
- A1.2.6. Table A1- 21 provides an illustration of Time-Code (TC) data.

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Table A1- 2. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 1, 2013.

2013 SEASON 1					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location <sup>9</sup>	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	Nathusius' Pipistrelle ***	Pipistrelle spp.****	Long-eared bats*****	Total
1	2	11	Mono	13	0.92	8.54	30.38	6.77	355.15	0.38	402.15
	3	7	Mono	13	6.00	3.85	13.23	1.92	100.54	1.00	126.54
	4	14	Mono	13	8.92	0.62	0.31	0.62	88.77	0.08	99.31
	5ab	2	SS	13	0.08	0.23	0.85	0.23	30.08	0.00	31.46
			WS	13	1.85	0.69	1.15	0.46	89.08	0.08	93.31
	6ab	1	ES	13	1.46	1.69	1.08	1.08	28.69	0.08	34.08
			NS	13	0.00	0.85	3.08	0.77	132.15	0.38	137.23
	7	13	Mono	12	89.83	34.42	32.33	6.67	1293.33	2.33	1458.92
	8	12	Mono	14	1.00	0.79	1.07	0.64	113.86	0.57	117.93
	9	4	Mono	13	0.46	0.31	0.00	0.08	20.62	0.08	21.54
	10	15	Mono	14	8.64	7.64	4.50	3.21	336.93	5.21	366.14
	11	5	Mono	15	7.73	6.13	7.80	4.07	178.20	0.80	204.73
	14	6	Mono	13	33.31	2.15	2.08	0.85	801.23	1.54	841.15
	15ab	3	TL	5	0.00	0.00	0.00	1.20	61.60	0.00	62.80
			TR	5	0.00	0.00	0.00	0.20	306.80	0.00	307.00
	18	8	Mono	14	11.00	2.86	2.50	1.36	250.93	0.07	268.71
	19	9	Mono	14	7.57	9.50	4.36	1.79	174.86	0.14	198.21
Session 1 Total				210							

<sup>9</sup> Location codes are detailed in Table A4 - 1.

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Table A1- 3. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 1, 2013.

2013 SEASON 1					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat spp.**	Nathusius' Pipistrelle ***	Pipistrelle spp.****	Long-eared bats*****	Total
2	12	9	Mono	13	7.54	2.23	18.69	4.92	153.46	0.85	187.69
	16ab	3	FD	14	0.79	17.71	4.86	14.93	482.93	1.57	522.79
			XR	14	12.50	6.00	2.57	8.50	453.29	0.64	483.50
	17	14	Mono	14	18.29	11.00	16.71	0.93	331.07	2.50	380.50
	20	13	Mono	13	70.15	4.77	4.23	6.15	758.00	1.38	844.69
	21	8	Mono	13	3.38	7.69	18.77	1.08	388.08	3.77	422.77
	22ab	1	FP	14	16.64	1.64	0.29	0.00	321.21	0.36	340.14
			TA	14	24.93	22.64	0.00	0.00	937.64	0.07	985.29
	23	6	Mono	14	14.29	7.93	3.07	1.71	375.79	1.07	403.86
	24	5	Mono	13	4.46	8.46	9.54	4.85	514.69	0.85	542.85
	25	12	Mono	12	3.83	0.83	2.00	1.08	649.75	1.00	658.50
	26	4	Mono	14	3.50	4.71	1.64	0.86	287.79	0.29	298.79
	27	11	Mono	14	1.86	2.07	0.71	8.57	395.79	1.14	410.14
	28	7	Mono	0	No Data						
	29	15	Mono	13	4.00	3.15	8.62	9.38	133.38	1.38	159.92
Session 2 Total				189							

## DETAILED RESULTS

Table A1- 4. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 2, 2013.

2013 SEASON 2					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
1	2	9	Mono	14	0.71	6.71	7.43	6.86	155.71	0.57	178.00
	3	5	Mono	14	1.21	1.71	3.14	0.29	99.79	0.57	106.71
	4	6	Mono	14	6.57	2.07	6.21	0.64	486.21	0.29	502.00
	5ab	1	SS	13	0.31	0.31	9.38	4.23	111.69	0.00	125.92
			WS	13	0.08	0.46	10.54	5.08	77.08	0.08	93.31
	6ab	3	ES	13	0.54	1.23	31.08	1.38	74.08	0.46	108.77
			NS	13	0.08	4.23	19.85	1.69	88.62	0.54	115.00
	7	12	Mono	14	2.57	20.93	63.07	1.00	247.43	3.07	338.07
	8	15	Mono	14	4.57	1.36	3.86	0.50	193.21	1.07	204.57
	9	11	Mono	14	3.14	0.79	3.64	0.43	169.79	0.14	177.93
	10	4	Mono	14	10.29	5.50	57.36	1.50	320.64	6.57	401.86
	11	7	Mono	14	13.29	6.93	38.36	3.21	177.07	4.79	243.64
	14	13	Mono	14	39.71	2.57	0.50	0.29	307.36	2.14	352.57
	15ab	2	TL	7	1.00	0.43	0.00	0.14	601.57	0.00	603.14
			TR	7	0.86	0.57	0.43	21.86	372.57	0.00	396.29
	18	8	Mono	0	No Data						
	19	14	Mono	14	3.93	15.21	2.14	0.64	123.14	0.29	145.36
Session 1 Total				206							

## DETAILED RESULTS

Table A1- 5. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 2, 2013.

2013 SEASON 2					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
2	12	11	Mono	11	6.82	9.09	326.00	1.27	412.91	2.27	758.36
	16ab	2	FD	14	12.86	14.36	11.71	1.43	178.00	4.36	222.71
			XR		16.29	4.14	4.29	1.00	429.86	1.71	457.29
	17	14	Mono	14	7.21	28.43	16.29	1.00	149.36	3.57	205.86
	20	12	Mono	11	11.64	14.64	2.18	1.18	173.64	1.45	204.73
	21	4	Mono	14	2.57	18.93	80.21	0.50	329.21	6.71	438.14
	22ab	2	FP	14	1.50	3.21	0.14	1.36	228.86	0.93	236.00
			TA		30.57	39.00	0.43	4.57	472.50	2.29	549.36
	23	13	Mono	12	5.33	17.00	1.58	0.42	362.08	5.50	391.92
	24	7	Mono	14	1.36	15.00	3.21	1.36	134.29	0.93	156.14
	25	15	Mono	12	0.58	2.00	5.33	0.00	83.50	1.33	92.75
	26	5	Mono	12	0.50	0.83	3.83	0.58	113.25	1.42	120.42
	27	10	Mono	12	0.75	10.00	3.83	4.58	1064.33	3.83	1087.33
	28	8	Mono	12	1.67	10.17	6.42	1.17	235.92	1.25	256.58
	29	6	Mono	14	0.79	21.21	6.43	2.43	113.86	4.14	148.86
Session 2 Total				194							

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Table A1- 6. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 3, 2013.

2013 SEASON 3					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	‘Big Bat spp.**	Nathusius’ Pipistrelle ***	Pipistrelle spp.****	Long-eared bats*****	Total
1	2	12	Mono	9	2.00	5.67	4.67	4.33	644.33	3.33	664.33
	3	15	Mono	7	136.43	11.86	7.29	2.00	156.29	14.00	327.86
	4	11	Mono	4	0.75	0.00	0.00	0.50	19.00	0.00	20.25
	5ab	2	SS	6	0.33	0.50	2.17	0.00	17.17	0.00	20.17
			WS	6	0.33	0.50	0.33	0.50	266.50	0.50	268.67
	6ab	16	ES	8	11.38	8.13	0.88	2.25	221.50	0.00	244.13
			NS	8	0.63	4.00	1.75	1.50	501.50	0.13	509.50
	7	4	Mono	4	0.25	5.00	2.25	1.50	82.00	1.75	92.75
	8	14	Mono	5	0.20	2.00	0.20	0.00	9.40	0.00	11.80
	9	9	Mono	7	39.86	1.71	0.86	2.14	1069.71	1.29	1115.57
	10	8	Mono	4	6.25	0.75	0.50	0.00	55.00	2.50	65.00
	11	5	Mono	7	4.43	13.43	2.43	1.29	108.43	4.29	134.29
	14	13	Mono	4	29.25	17.50	0.50	1.25	177.75	1.25	227.50
	15ab	1	TL	13	0.00	0.08	0.31	2.46	66.92	0.00	69.77
			TR	13	1.77	1.00	0.15	2.15	537.31	0.15	542.54
	18	6	Mono	7	0.43	1.43	0.71	0.14	126.00	2.14	130.86
	19	7	Mono	14	0.07	31.14	2.57	1.07	51.93	0.50	87.29
	30ab	3	ER	11	5.73	0.09	2.00	1.18	59.09	0.18	68.27
			TC	11	3.73	0.27	2.18	6.00	70.91	0.18	83.27
Session 1 Total				148							

## DETAILED RESULTS

Table A1- 7. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 3, 2013

2013 SEASON 3					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
2	12	5	Mono	14	4.71	9.36	0.93	3.29	416.93	2.00	437.21
	16ab	1	FD	14	0.86	0.50	0.64	1.21	67.50	1.07	71.79
			XR	14	15.14	1.21	0.36	1.21	231.71	0.00	249.64
	17	13	Mono	13	7.85	9.92	9.62	0.69	277.46	3.15	308.69
	20	6	Mono	4	1.50	1.50	4.50	0.00	18.50	0.25	26.25
	21	9	Mono	13	3.77	23.46	4.77	0.46	296.00	10.15	338.62
	22ab	16	FP	11	3.73	1.64	1.64	0.18	1112.55	1.18	1120.91
			TA		23.00	19.45	0.64	0.91	1941.73	0.45	1986.18
	23	15	Mono	14	4.93	12.36	3.86	0.64	219.00	2.36	243.14
	24	4	Mono	14	9.57	24.64	0.21	4.86	461.36	3.14	503.79
	25	14	Mono	3	0.33	1.33	0.00	0.00	30.33	0.33	32.33
	26	8	Mono	4	12.75	1.25	2.50	2.50	99.00	0.00	118.00
	27	12	Mono	6	0.17	11.00	1.67	1.50	102.00	5.00	121.33
	28	11	Mono	10	1.80	8.60	0.70	0.60	14.20	2.20	28.10
	29	7	Mono	14	13.50	18.86	2.57	5.36	230.29	5.36	275.93
	31ab	3	EP	5	0.00	0.00	0.60	0.40	2.20	0.20	3.40
			WP		56.20	13.80	12.40	3.60	294.20	17.00	397.20
Session 2 Total				169							

## DETAILED RESULTS

Table A1- 8. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 1, 2014.

2014 SEASON 1					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	Myotis spp.*	'Big Bat spp.**	Nathusius' Pipistrelle ***	Pipistrelle spp.****	Long-eared bats*****	Total
1	2	14	Mono	14	37.00	5.21	9.93	7.14	593.79	1.36	654.43
	3	4	Mono	14	10.29	7.36	29.14	2.43	300.00	3.64	352.86
	4	6	Mono	12	24.50	1.75	4.92	2.42	440.33	2.25	476.17
	5ab	16	SS	14	0.14	0.86	12.50	2.64	54.36	0.07	70.57
			WS		0.29	0.21	6.36	5.93	188.00	0.00	200.79
	6ab	1	ES	14	1.21	1.43	4.50	2.07	38.29	0.21	47.71
			NS		0.07	0.93	1.21	6.43	68.36	0.00	77.00
	7	11	Mono	13	38.69	11.54	18.00	4.92	1289.08	8.92	1371.15
	8	12	Mono	13	2.00	1.31	0.54	0.85	70.15	0.77	75.62
	9	8	Mono	13	16.00	2.46	5.38	1.77	364.31	0.31	390.23
	10	15	Mono	14	14.14	4.29	5.79	2.21	79.29	9.71	115.43
	11	5	Mono	13	39.23	3.38	9.38	4.15	164.77	3.77	224.69
	14	7	Mono	13	31.46	9.62	0.62	2.31	948.69	0.92	993.62
	15ab	2	TL	13	0.00	0.46	0.31	6.31	254.54	0.08	261.69
			TR		2.31	0.38	0.00	7.54	128.15	0.00	138.38
	18	13	Mono	13	14.85	4.92	4.00	0.69	345.85	2.31	372.62
	19	9	Mono	13	32.62	3.85	1.31	2.00	503.08	0.08	542.92
	30ab	3	ER	13	7.15	0.77	0.54	0.31	174.31	0.15	183.23
			TC		0.00	0.00	0.23	0.23	106.23	0.00	106.69
	32	10	E	13	4.38	1.54	2.92	1.85	81.38	1.92	94.00
			W	13	3.62	2.15	4.46	1.15	52.08	0.54	64.00
Session 1 Total				279							

## DETAILED RESULTS

Table A1- 9. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 1, 2014.

2014 SEASON 1					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
2	12	11	Mono	7	9.00	1.43	137.71	7.29	497.57	0.71	653.71
	16ab	2	FD	15	6.53	2.20	23.27	23.53	137.93	3.67	197.13
			XR		32.53	1.80	4.27	15.73	249.67	0.07	304.07
	17	8	Mono	15	3.67	3.27	7.73	0.40	109.07	0.20	124.33
	20	14	Mono	14	15.43	2.93	8.50	6.36	178.43	0.86	212.50
	21	7	Mono	15	7.40	5.80	21.47	1.53	207.33	3.87	247.40
	22ab	3	FP	15	13.27	2.07	0.07	0.87	460.80	0.00	477.07
			TA		77.20	23.87	0.07	0.53	483.67	0.40	585.73
	23	13	Mono	14	1.07	5.00	1.86	0.71	312.64	0.21	321.50
	24	15	Mono	14	0.36	4.93	5.14	2.29	247.14	0.29	260.14
	25	5	Mono	14	0.93	12.00	3.79	1.50	962.14	1.14	981.50
	26	6	Mono	13	0.38	0.62	2.23	0.31	102.46	0.08	106.08
	29	9	Mono	14	0.14	3.86	8.57	4.14	63.93	1.00	81.64
	31ab	10	EP	13	0.00	2.54	2.62	2.46	48.15	0.69	56.46
			WP		0.69	3.08	11.69	1.92	66.92	1.00	85.31
	33	21	Mono	14	0.50	0.86	1.50	0.14	695.29	0.07	698.36
	34	16	Stereo Left	14	4.93	0.79	2.57	0.43	701.00	0.07	709.79
			Stereo Right	14	3.50	1.00	5.71	0.64	269.79	0.86	281.50
	35	4	Mono	14	4.57	0.71	16.79	4.93	94.86	0.36	122.21
	36	12	Mono	14	0.00	2.71	26.14	3.43	282.07	2.36	316.71
Session 2 Total				276							

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Table A1- 10. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 2, 2014.

2014 SEASON 2					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
1	2	15	Mono	14	1.93	6.14	7.64	2.50	508.93	1.00	528.14
	3	8	Mono	14	4.14	4.50	9.86	0.64	279.21	0.50	298.86
	4	12	Mono	13	5.92	6.21	15.46	0.64	673.14	2.21	703.60
	5ab	16	SS	14	0.29	1.29	3.93	0.64	95.71	0.00	101.86
			WS		0.36	0.71	2.14	10.86	273.50	0.00	287.57
	6ab	10	ES	14	1.00	1.07	18.43	0.36	28.00	0.29	49.14
			NS		0.36	1.79	4.00	27.29	112.50	0.50	146.43
	7	21	Mono	15	5.13	44.86	35.87	0.21	754.79	6.07	846.93
	8	5	Mono	15	0.60	2.00	0.57	0.29	60.21	0.43	64.10
	9	7	Mono	13	3.69	4.64	3.29	0.50	417.50	1.14	430.76
	10	6	Mono	13	8.85	4.79	21.69	0.36	239.43	3.36	278.47
	11	11	Mono	15	20.33	7.21	16.13	0.93	417.79	2.43	464.82
	14	9	Mono	13	2.00	11.93	0.14	0.36	136.86	0.14	151.43
	15ab	2	TL	15	0.67	0.86	1.73	11.43	824.64	0.14	839.47
			TR		0.93	0.79	0.07	12.43	905.00	0.00	919.21
	18	4	Mono	15	1.67	8.00	2.50	0.00	62.86	3.36	78.38
	19	13	Mono	15	36.07	23.14	1.71	0.50	483.36	0.36	545.14
	30ab	3	ER	13	1.85	4.00	2.77	0.79	96.50	0.07	105.97
			TC		0.23	1.07	1.23	0.43	86.07	0.00	89.03
	32	1	Stereo Left	12	0.25	1.14	2.64	0.36	24.57	0.36	29.32
			Stereo Right		4.08	6.36	3.14	0.14	29.36	1.71	44.80
	Session 1 Total				223						

## DETAILED RESULTS

Table A1- 11. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 2, 2014.

2014 SEASON 2					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
2	12	21	Mono	14	6.21	4.36	48.29	0.57	605.07	1.50	666.00
	16ab	2	FD	13	14.00	5.00	5.00	0.77	126.62	1.08	152.46
			XR		11.00	0.85	0.23	0.31	234.85	1.00	248.23
	17	7	Mono	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20	13	Mono	14	20.86	9.50	7.50	0.43	205.21	3.86	247.36
	21	12	Mono	15	7.27	11.00	43.40	0.07	548.40	4.20	614.33
	22	10	FP	13	0.62	1.15	0.15	0.15	303.85	0.15	306.08
			TA	13	4.85	21.46	2.62	3.31	319.31	2.62	354.15
	23	15	Mono	15	7.27	5.40	1.60	0.27	244.47	5.07	264.07
	24	11	Mono	14	2.64	7.29	2.14	1.00	226.93	0.93	240.93
	25	9	Mono	11	0.09	0.00	0.18	0.00	30.91	0.18	31.36
	26	6	Mono	15	0.47	0.13	0.40	0.20	142.47	0.67	144.33
	29	4	Mono	13	10.23	21.77	6.08	2.46	291.69	7.00	339.23
	31	1	EP	9	1.11	3.89	9.11	1.33	70.11	0.67	86.22
			WP	9	0.33	2.78	1.78	2.00	31.67	0.78	39.33
	33	8	Mono	15	1.47	6.00	20.27	1.20	934.13	0.00	963.07
	34	3	LN	10	2.90	2.30	0.40	1.10	404.70	0.60	412.00
			TL	10	0.10	0.00	0.30	0.00	13.10	0.00	13.50
	35	5	Mono	13	0.54	0.31	0.00	0.08	7.69	0.00	8.62
	36	16	Mono	2	0.50	2.50	11.00	0.00	42.00	0.00	56.00
	Session 2 Total			246							

## DETAILED RESULTS

Table A1- 12. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 1 of Season 3, 2014.

2014 SEASON 3					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius'</i> <i>Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
1	2	9	Mono	13	5.62	7.08	15.62	5.62	209.62	3.38	246.92
	3	28	Mono	13	72.38	6.38	23.85	14.15	698.77	3.38	818.92
	4	15	Mono	12	17.00	0.67	0.50	0.17	170.17	0.42	188.92
	5ab	3	SS	12	0.10	0.90	2.30	0.40	115.10	0.00	118.80
			WS	10	1.08	0.50	1.00	1.58	270.75	1.00	275.92
	6ab	2	ES	8	34.88	2.50	4.88	4.75	131.13	1.00	179.13
			NS		4.50	2.13	3.13	2.88	437.25	1.25	451.13
	7	13	Mono	13	3.62	16.92	17.85	4.38	1082.69	59.46	1184.92
	8	12	Mono	12	12.58	5.92	1.50	0.67	38.67	2.25	61.58
	9	4	Mono	12							
	10	6	Mono	12	6.42	1.33	4.25	5.92	313.17	12.83	343.92
	11	7	Mono	12	6.67	16.58	5.08	1.58	102.17	2.42	134.50
	14	11	Mono	12	74.08	72.67	3.17	5.33	626.25	4.67	786.17
	15ab	16	TL	12	2.90	0.60	0.90	2.10	105.00	0.00	111.50
			TR	10	0.00	0.00	0.00	12.00	533.67	0.00	545.67
	18	5	Mono	12	0.17	0.17	1.75	0.00	207.42	0.08	209.58
	19	21	Mono	12	0.58	11.00	2.33	0.33	228.50	0.17	242.92
	30ab	10	ER	12	3.50	0.25	0.58	16.92	105.33	0.08	126.67
			TC		0.33	0.33	0.58	0.75	125.67	0.08	127.75
	32	1	E	12	1.17	0.33	1.25	0.92	16.00	0.67	20.33
			W	12	5.33	2.50	9.92	2.50	71.50	2.75	94.50
Session 1 Total				243							

## DETAILED RESULTS

Table A1- 13. Mean number of passes per night, by species or species group, recorded by automated detectors in Session 2 of Season 3, 2014.

2014 SEASON 3					Mean Passes Per Night						
Session	Monitoring Station	SM2	Microphone Location	Number of Functional Nights	Barbastelle	<i>Myotis</i> spp.*	'Big Bat' spp.**	<i>Nathusius' Pipistrelle</i> ***	<i>Pipistrelle</i> spp.****	Long-eared bats*****	Total
2	12	8	Mono	13	5.15	9.69	6.46	1.62	217.77	1.15	241.85
	16ab	1	FD	13	1.92	2.92	3.62	3.69	230.92	5.38	248.46
			XR		3.23	2.00	2.00	2.15	362.54	1.00	372.92
	17	5	Mono	12	0.08	2.00	0.00	0.33	53.92	0.00	56.33
	20	13	Mono	14	8.71	14.64	4.00	3.79	816.79	7.79	855.71
	21	7	Mono	13	1.85	13.38	6.85	0.62	248.92	16.62	288.23
	22	10	FP	14	0.00	1.86	0.00	0.00	241.36	0.00	243.21
			TA	14	6.79	12.79	0.93	0.29	2344.29	2.14	2367.21
	23	11	Mono	14	1.07	8.50	4.71	1.07	462.21	6.21	483.79
	24	3	Mono	4	0.25	3.75	1.25	0.50	269.00	2.75	277.50
	25	15	Mono	10	0.10	1.40	0.00	0.10	14.60	0.50	16.70
	26	12	Mono	14	14.29	2.57	1.07	0.50	94.50	10.93	123.86
	29	6	Mono	13	0.54	3.92	2.85	0.92	99.62	0.69	108.54
	31	16	EP	7	3.14	6.43	5.29	2.00	162.57	0.29	179.71
			WP	7	1.71	2.00	3.00	0.43	37.57	0.57	45.29
	33	4	Mono	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	34	2	LN	10	18.10	7.00	0.50	1.60	384.60	1.00	412.80
			TL	10	1.30	1.90	0.10	0.40	91.80	0.70	96.20
	35	9	Mono	13	1.31	1.46	3.08	2.15	52.62	0.46	61.08
	36	21	Mono	14	0.93	8.36	6.29	2.50	185.07	0.00	203.14
	Session 2 Total			236							

## DETAILED RESULTS

Table A1- 14. Comparison of barbastelle activity (mean passes per night), by species or species group, with overall mean activity for that season/year.

		S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
MS	Channel	2013			2013			2014			2014		
MEAN OVERALL	mppn				11.91	6.04	9.94				11.30	5.19	8.53
M02	L	0.92	0.71	2.00	<1	<1	< mean	37.00	1.93	5.62	**	< mean	< mean
M03	L	6.00	1.21	136.43	< mean	< mean	**	10.29	4.14	72.38	< mean	< mean	**
M04	L	8.92	6.57	0.75	< mean	*	<1	24.50	5.92	17.00	**	*	**
M05	SS	0.08	0.31	0.33	<1	<1	<1	0.14	0.29	0.10	<1	<1	<1
M05	WS	1.85	0.08	0.33	< mean	<1	<1	0.29	0.36	1.08	<1	<1	< mean
M06	ES	1.46	0.54	11.38	< mean	<1	*	1.21	1.00	34.88	< mean	< mean	**
M06	NS	0.00	0.08	0.63	<1	<1	<1	0.07	0.36	4.50	<1	<1	< mean
M07	L	89.83	2.57	0.25	**	< mean	<1	38.69	5.13	3.92	**	< mean	< mean
M08	L	1.00	4.57	0.20	< mean	< mean	<1	2.00	0.60	12.58	< mean	<1	*
M09	L	0.46	3.14	39.86	<1	< mean	**	16.00	3.69	No data	*	< mean	
M10	L	8.64	10.29	6.25	< mean	*	< mean	14.14	8.85	6.42	*	*	< mean
M11	L	7.73	13.29	4.43	< mean	**	< mean	36.43	20.33	6.67	**	**	< mean
M12	L	7.54	6.82	4.71	< mean	*	< mean	9.00	6.21	5.15	< mean	*	< mean
M14	L	33.31	39.71	29.25	**	**	**	31.46	2.00	74.08	**	< mean	**
M15	TL	0.00	1.00	0.00	<1	< mean	<1	0.00	0.67	2.90	<1	<1	< mean
M15	TR	0.00	0.86	1.77	<1	<1	< mean	2.31	0.93	0.00	< mean	<1	<1
M16	FD	0.79	12.86	0.86	<1	**	<1	6.53	14.00	1.92	< mean	**	< mean
M16	XR	12.50	16.29	15.14	*	**	*	32.53	11.00	3.23	**	**	< mean
M17	L	18.29	7.21	7.85	*	*	< mean	3.67	No data	0.10	< mean		<1
M18	L	11.00	No data	0.43	< mean		<1	13.79	1.67	0.17	*	< mean	<1
M19	L	7.57	3.93	0.07	< mean	< mean	<1	30.29	36.07	0.58	**	**	<1
M20	L	70.15	11.64	1.50	**	*	< mean	15.43	20.86	8.71	*	**	*
M21	L	3.38	2.57	3.77	< mean	< mean	< mean	7.40	7.27	1.85	< mean	*	< mean
M22	FP	16.64	1.50	3.73	*	< mean	< mean	13.27	0.62	0.00	*	<1	<1
M22	TA	24.93	30.57	23.00	**	**	**	77.20	4.85	6.79	**	< mean	< mean
M23	L	14.29	5.33	4.93	*	< mean	< mean	1.07	7.27	1.07	< mean	*	< mean
M24	L	4.46	1.36	9.57	< mean	< mean	< mean	0.36	2.64	0.33	<1	< mean	<1
M25	L	3.83	0.58	0.33	< mean	<1	<1	0.93	0.09	0.09	<1	<1	<1
M26	L	3.50	0.50	12.75	< mean	<1	*	0.38	0.47	14.29	<1	<1	*
M27	L	1.86	0.75	0.17	< mean	<1	<1	No data	No data	No data			
M28	L	No data	1.67	1.80		< mean	< mean	No data	No data	No data			
M29	L	4.00	0.79	13.50	< mean	<1	*	0.14	10.23	0.54	<1	*	<1
M30	ER	No data	No data	5.73			< mean	7.15	1.85	3.50	< mean	< mean	< mean
M30	TC	No data	No data	3.73			< mean	0.00	0.23	0.33	<1	<1	<1
M31	EP	No data	No data	0.00			<1	0.00	1.11	3.14	<1	< mean	< mean
M31	WP	No data	No data	56.20			**	0.69	0.33	1.71	<1	<1	< mean
M32	E	No data	No data	No data				4.38	0.25	1.17	< mean	<1	< mean
M32	W	No data	No data	No data				3.62	4.45	5.33	< mean	< mean	< mean
M33	L	No data	No data	No data				0.50	1.47	No data	<1	< mean	
M34	LN	No data	No data	No data				4.93	2.90	18.10	< mean	< mean	**
M34	TL	No data	No data	No data				3.50	0.11	1.30	< mean	<1	< mean
M35	L	No data	No data	No data				4.57	0.64	1.31	< mean	<1	< mean
M36	L	No data	No data	No data				0.00	1.00	0.93	<1	< mean	<1

## DETAILED RESULTS

Table A1- 15. Comparison of 'big bat' activity (mean passes per night), by species or species group, with overall mean activity for that season/year.

MS	Channel	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
MEAN OVERALL	mppn	2013			2013			2014			2014		
					6.31	22.23	2.15				8.62	8.30	4.15
M02	L	30.38	7.43	4.67	**	< mean	*	9.93	7.64	15.62	*	< mean	**
M03	L	13.23	3.14	7.29	**	< mean	*	29.14	9.86	23.85	**	*	**
M04	L	0.31	6.21	0.00	< 1	< mean	< 1	4.92	15.46	0.50	< mean	*	< 1
M05	SS	0.85	9.38	2.17	< 1	< mean	< mean	6.36	3.93	2.30	*	< mean	< mean
M05	WS	1.15	10.54	0.33	< mean	< mean	< 1	12.50	2.14	1.00	< mean	< mean	< mean
M06	ES	1.08	31.08	0.88	< mean	*	< 1	1.21	18.43	4.88	< mean	**	*
M06	NS	3.08	19.85	1.75	< mean	< mean	< mean	4.50	4.00	3.13	< mean	< mean	< mean
M07	L	32.33	63.07	2.25	**	**	*	18.00	35.87	19.33	**	**	**
M08	L	1.07	3.86	0.20	< mean	< mean	< 1	0.54	0.53	1.50	< 1	< 1	< mean
M09	L	0.00	3.64	0.86	< 1	< mean	< 1	5.38	3.54	No data	< mean	< mean	
M10	L	4.50	56.93	0.50	< mean	**	< 1	5.79	21.69	4.25	< mean	**	*
M11	L	7.80	38.14	2.43	*	*	< mean	8.71	16.13	5.08	*	*	*
M12	L	18.69	350.55	0.93	**	**	< 1	137.71	48.29	6.46	**	**	*
M14	L	2.08	1.00	0.50	< mean	< mean	< 1	0.62	0.15	3.17	< 1	< 1	< mean
M15	TL	0.00	0.00	0.00	< 1	< 1	< 1	0.00	1.73	0.90	< 1	< mean	< 1
M15	TR	0.00	0.43	0.00	< 1	< 1	< 1	0.31	0.07	0.00	< 1	< 1	< 1
M16	FD	4.86	11.71	0.64	< mean	< mean	< 1	4.27	5.00	3.62	**	< mean	< mean
M16	XR	2.50	4.07	0.36	< mean	< mean	< 1	23.27	0.23	2.00	< mean	< 1	< mean
M17	L	17.00	16.21	9.62	**	< mean	*	7.73	No data	0.00	< mean		< 1
M18	L	2.50	No data	0.71	< mean		< 1	3.71	2.33	1.75	< mean	< mean	< mean
M19	L	4.36	2.14	2.57	< mean	< mean	< mean	1.21	1.60	2.33	< mean	< mean	< mean
M20	L	4.15	2.18	4.50	< mean	< mean	*	8.50	7.50	4.00	< mean	< mean	< mean
M21	L	18.54	80.21	4.77	**	**	*	21.47	43.40	6.85	**	**	*
M22	FP	0.29	0.07	1.64	< 1	< 1	< mean	0.07	0.15	0.00	< 1	< 1	< 1
M22	TA	0.00	0.36	0.64	< 1	< 1	< 1	0.07	2.62	0.93	< 1	< mean	< 1
M23	L	3.07	1.58	3.86	< mean	< mean	< mean	1.86	1.60	4.71	< mean	< mean	*
M24	L	9.54	3.21	0.14	*	< mean	< 1	5.14	2.14	1.67	< mean	< mean	< mean
M25	L	2.00	5.33	0.00	< mean	< mean	< 1	3.79	0.18	0.00	< mean	< 1	< 1
M26	L	1.64	3.50	2.50	< mean	< mean	< mean	2.00	0.40	1.07	< mean	< 1	< mean
M27	L	0.71	3.75	1.67	< 1	< mean	< mean	No data	No data	No data			
M28	L	No data	6.42	0.70		< mean	< 1	No data	No data	No data			
M29	L	8.62	6.43	2.57	*	< mean	< mean	8.57	6.08	2.85	< mean	< mean	< mean
M30	ER	No data	No data	2.36			< mean	0.23	2.77	0.58	< 1	< mean	< 1
M30	TC	No data	No data	1.82			< mean	0.54	1.23	0.58	< 1	< mean	< 1
M31	WP	No data	No data	0.60			< 1	2.62	9.11	5.29	< mean	*	*
M31	EP	No data	No data	12.40			**	11.69	1.78	3.00	*	< mean	< mean
M32	E	No data	No data	No data				2.92	3.08	1.25	< mean	< mean	< mean
M32	W	No data	No data	No data				4.46	4.00	9.92	< mean	< mean	**
M33	L	No data	No data	No data				1.50	20.27	No data	< mean	**	
M34	LN	No data	No data	No data				2.57	0.40	0.50	< mean	< 1	< 1
M34	TL	No data	No data	No data				5.71	0.33	0.10	< mean	< 1	< 1
M35	L	No data	No data	No data				16.79	0.00	3.08	*	< 1	< mean
M36	L	No data	No data	No data				26.14	22.00	6.29	**	**	*

## DETAILED RESULTS

Table A1- 16. Comparison of *Myotis* activity (mean passes per night), by species or species group, with overall mean activity for that season/year.

		S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
MS	Channel	2013			2013			2014			2014		
MEAN OVERALL	mppn				5.71	8.83	8.65				3.62	6.65	6.96
M02	L	8.54	6.71	5.67	*	< mean	< mean	5.21	6.14	6.38	*	< mean	< mean
M03	L	3.85	1.71	11.86	< mean	< mean	*	7.36	4.50	7.08	**	< mean	*
M04	L	0.62	2.07	0.00	< 1	< mean	< 1	1.75	6.69	0.67	< mean	*	< 1
M05	SS	0.23	0.31	0.50	< 1	< 1	< 1	0.86	1.29	0.90	< 1	< mean	< 1
M05	WS	0.69	0.46	0.50	< 1	< 1	< 1	0.21	0.71	0.50	< 1	< 1	< 1
M06	ES	1.69	1.23	8.13	< mean	< mean	< mean	1.43	5.71	2.50	< mean	< mean	< mean
M06	NS	0.85	4.23	4.00	< 1	< mean	< mean	0.93	1.79	2.13	< 1	< mean	< mean
M07	L	34.42	20.93	5.00	**	**	< mean	11.54	41.87	18.33	**	**	**
M08	L	0.79	1.36	2.00	< 1	< mean	< mean	1.31	1.87	5.92	< mean	< mean	< mean
M09	L	0.31	0.79	1.71	< 1	< 1	< mean	2.46	5.00	No Data	< mean	< mean	
M10	L	7.64	5.50	0.75	*	< mean	< 1	4.29	5.15	1.33	*	< mean	< mean
M11	L	6.13	6.93	13.43	*	< mean	*	3.14	6.73	16.58	< mean	*	**
M12	L	2.23	9.09	9.36	< mean	*	*	1.43	4.36	9.69	< mean	< mean	*
M14	L	2.15	2.57	17.50	< mean	< mean	*	9.62	12.85	72.67	**	*	**
M15	TL	0.00	0.43	0.08	< 1	< 1	< 1	0.46	0.80	0.60	< 1	< 1	< 1
M15	TR	0.00	0.57	1.00	< 1	< 1	< 1	0.38	0.73	0.00	< 1	< 1	< 1
M16	FD	17.71	14.36	0.50	**	*	< 1	2.20	5.00	2.92	< mean	< mean	< mean
M16	XR	6.00	4.14	1.21	*	< mean	< mean	1.80	0.85	2.00	< mean	< 1	< mean
M17	L	11.00	28.43	9.92	*	**	*	3.27	No Data	2.40	< mean		< mean
M18	L	2.86	No data	1.43	< mean		< mean	4.57	7.47	0.17	*	*	< 1
M19	L	9.50	15.21	31.14	*	*	**	3.57	21.60	11.00	< mean	**	*
M20	L	4.77	14.64	1.50	< mean	*	< mean	2.93	9.50	14.64	< mean	*	**
M21	L	7.69	18.93	23.46	*	**	**	5.80	11.00	13.38	*	*	*
M22	FP	1.64	3.21	1.64	< mean	< mean	< mean	2.07	1.15	1.86	< mean	< mean	< mean
M22	TA	22.64	39.00	19.45	**	**	**	23.87	21.46	12.79	**	**	*
M23	L	7.93	17.00	12.36	*	*	*	5.00	5.40	8.50	*	< mean	*
M24	L	8.46	15.00	24.64	*	*	**	4.93	7.29	5.00	*	*	< mean
M25	L	0.83	2.00	1.33	< 1	< mean	< mean	12.00	0.00	1.27	**	< 1	< mean
M26	L	4.71	0.83	1.25	< mean	< 1	< mean	0.62	0.13	2.57	< 1	< 1	< mean
M27	L	2.07	10.00	11.00	< mean	*	*	No data	No data	No data			
M28	L	No data	10.17	8.60		*	< mean	No data	No data	No data			
M29	L	3.15	21.21	18.86	< mean	**	**	3.86	21.77	3.92	*	**	< mean
M30	ER	No data	No data	0.18			< 1	0.77	4.31	0.25	< 1	< mean	< 1
M30	TC	No data	No data	0.18			< 1	0.00	1.15	0.33	< 1	< mean	< 1
M31	EP	No data	No data	0.00			< 1	2.54	3.89	6.43	< mean	< mean	< mean
M31	WP	No data	No data	13.80			*	3.08	2.78	2.00	< mean	< mean	< mean
M32	E	No data	No data	No data				1.54	1.33	0.33	< mean	< mean	< 1
M32	W	No data	No data	No data				2.15	8.09	2.50	< mean	*	< mean
M33	L	No data	No data	No data				0.86	6.00	No Data	< 1	< mean	
M34	LN	No data	No data	No data				0.79	2.30	7.00	< 1	< mean	*
M34	TL	No data	No data	No data				1.00	0.00	1.90	< 1	< 1	< mean
M35	L	No data	No data	No data				0.71	0.36	1.46	< 1	< 1	< mean
M36	L	No data	No data	No data				2.71	5.00	8.36	< mean	< mean	*

## DETAILED RESULTS

Table A1- 17. Comparison of Nathusius' pipistrelle activity (mean passes per night), by species or species group, with overall mean activity for that season/year.

		S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
MS	Channel	2013			2013			2014			2014		
MEAN OVERALL	mppn				3.20	2.00	1.82				3.53	2.38	2.88
M02	L	6.77	6.86	4.33	**	**	**	7.14	2.50	14.15	**	*	**
M03	L	1.92	0.29	2.00	< mean	< 1	*	2.43	0.64	5.62	< mean	< 1	*
M04	L	0.62	0.64	0.50	< 1	< 1	< 1	2.42	0.69	0.17	< mean	< 1	< 1
M05	SS	0.23	4.23	0.00	< 1	**	< 1	2.64	0.64	0.40	< mean	< 1	< 1
M05	WS	0.46	5.08	0.50	< 1	**	< 1	5.93	10.86	1.58	*	**	< mean
M06	ES	1.08	1.38	2.25	< mean	< mean	*	2.07	3.43	4.75	< mean	*	*
M06	NS	0.77	1.69	1.50	< 1	< mean	< mean	6.43	27.29	2.88	*	**	*
M07	L	6.67	1.00	1.50	**	< mean	< mean	4.92	0.20	4.75	*	< 1	*
M08	L	0.64	0.50	0.00	< 1	< 1	< 1	0.85	0.27	0.67	< 1	< 1	< 1
M09	L	0.08	0.43	2.14	< 1	< 1	*	1.77	0.54	No data	< mean	< 1	
M10	L	3.21	1.50	0.00	*	< mean	< 1	2.21	0.38	5.92	< mean	< 1	**
M11	L	4.07	3.21	1.29	*	*	< mean	3.86	0.87	1.58	*	< 1	< mean
M12	L	4.92	1.27	3.29	*	< mean	*	7.29	0.57	1.62	**	< 1	< mean
M14	L	0.85	0.29	1.25	< 1	< 1	< mean	2.31	0.38	5.33	< mean	< 1	*
M15	TL	1.20	0.14	2.46	< mean	< 1	*	6.31	10.67	2.10	*	**	< mean
M15	TR	0.20	21.86	2.15	< 1	**	*	7.54	11.60	16.00	**	**	**
M16	FD	14.93	1.43	1.21	**	< mean	< mean	23.53	0.77	3.69	**	< 1	*
M16	XR	8.50	1.00	1.21	**	< mean	< mean	15.73	0.31	2.15	**	< 1	< mean
M17	L	0.93	1.00	0.69	< 1	< 1	< 1	0.40	No data	0.40	< 1		< 1
M18	L	1.36	No data	0.14	< mean		< 1	0.64	0.00	0.00	< 1	< 1	< 1
M19	L	1.79	0.64	1.07	< mean	< 1	< mean	1.86	0.47	0.33	< mean	< 1	< 1
M20	L	6.15	1.18	0.00	*	< mean	< 1	6.36	0.43	3.79	*	< 1	*
M21	L	1.08	0.50	0.46	< mean	< 1	< 1	1.53	0.07	0.62	< mean	< 1	< 1
M22	FP	0.00	1.36	0.18	< 1	< mean	< 1	0.87	0.15	0.00	< 1	< 1	< 1
M22	TA	0.00	4.57	0.91	< 1	**	< 1	0.53	3.31	0.29	< 1	*	< 1
M23	L	1.71	0.42	0.64	< mean	< 1	< 1	0.71	0.27	1.07	< 1	< 1	< mean
M24	L	4.85	1.36	4.86	*	< mean	**	2.29	1.00	0.67	< mean	< mean	< 1
M25	L	1.08	0.00	0.00	< mean	< 1	< 1	1.50	0.00	0.09	< mean	< 1	< 1
M26	L	0.86	0.58	2.50	< 1	< 1	*	0.31	0.20	0.50	< 1	< 1	< 1
M27	L	8.57	4.58	1.50	**	**	< mean	No data	No data	No data			
M28	L	No data	1.17	0.60		< mean	< 1	No data	No data	No data			
M29	L	9.38	2.43	5.36	**	*	**	4.14	2.46	0.92	*	*	< 1
M30	ER	No data	No data	2.09			*	0.31	0.85	16.92	< 1	< 1	**
M30	TC	No data	No data	5.09			**	0.23	0.46	0.75	< 1	< 1	< 1
M31	EP	No data	No data	0.40			< 1	2.46	1.33	2.00	< mean	< mean	< mean
M31	WP	No data	No data	3.60			*	1.92	2.00	0.43	< mean	< mean	< 1
M32	E	No data	No data	No data				1.85	0.42	0.92	< mean	< 1	< 1
M32	W	No data	No data	No data				1.15	0.18	2.50	< mean	< 1	< mean
M33	L	No data	No data	No data				0.14	1.20	No data	< 1	< mean	
M34	LN	No data	No data	No data				0.43	1.10	1.60	< 1	< mean	< mean
M34	TL	No data	No data	No data				0.64	0.00	0.40	< 1	< 1	< 1
M35	L	No data	No data	No data				4.93	0.09	2.15	*	< 1	< mean
M36	L	No data	No data	No data				3.43	0.00	2.50	< mean	< 1	< mean

DETAILED RESULTS

Table A1- 18. Data from monitoring stations on Upper Abbey Track 2013 and 2014.

DETAILED RESULTS

Data from Monitoring Stations on Upper Abbey Track 2013

2013	S1	S2	S3 [Please see notes on following page]																																																																										
MS04	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>29/05/2013</td><td>2</td></tr><tr><td>30/05/2013</td><td>3</td></tr><tr><td>31/05/2013</td><td>18</td></tr><tr><td>01/06/2013</td><td>6</td></tr><tr><td>02/06/2013</td><td>17</td></tr><tr><td>03/06/2013</td><td>23</td></tr><tr><td>04/06/2013</td><td>8</td></tr><tr><td>05/06/2013</td><td>23</td></tr><tr><td>06/06/2013</td><td>7</td></tr><tr><td>07/06/2013</td><td>0</td></tr><tr><td>08/06/2013</td><td>1</td></tr><tr><td>09/06/2013</td><td>4</td></tr><tr><td>10/06/2013</td><td>4</td></tr></table></div>	Date	Passes	29/05/2013	2	30/05/2013	3	31/05/2013	18	01/06/2013	6	02/06/2013	17	03/06/2013	23	04/06/2013	8	05/06/2013	23	06/06/2013	7	07/06/2013	0	08/06/2013	1	09/06/2013	4	10/06/2013	4	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>15/07/2013</td><td>1</td></tr><tr><td>16/07/2013</td><td>1</td></tr><tr><td>17/07/2013</td><td>0</td></tr><tr><td>18/07/2013</td><td>2</td></tr><tr><td>19/07/2013</td><td>0</td></tr><tr><td>20/07/2013</td><td>1</td></tr><tr><td>21/07/2013</td><td>3</td></tr><tr><td>22/07/2013</td><td>8</td></tr><tr><td>23/07/2013</td><td>21</td></tr><tr><td>24/07/2013</td><td>33</td></tr><tr><td>25/07/2013</td><td>10</td></tr><tr><td>26/07/2013</td><td>9</td></tr><tr><td>27/07/2013</td><td>0</td></tr><tr><td>28/07/2013</td><td>3</td></tr></table></div>	Date	Passes	15/07/2013	1	16/07/2013	1	17/07/2013	0	18/07/2013	2	19/07/2013	0	20/07/2013	1	21/07/2013	3	22/07/2013	8	23/07/2013	21	24/07/2013	33	25/07/2013	10	26/07/2013	9	27/07/2013	0	28/07/2013	3	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>10/09/2013</td><td>0</td></tr><tr><td>11/09/2013</td><td>0</td></tr><tr><td>12/09/2013</td><td>2</td></tr><tr><td>13/09/2013</td><td>1</td></tr></table></div>	Date	Passes	10/09/2013	0	11/09/2013	0	12/09/2013	2	13/09/2013	1						
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DETAILED RESULTS

Data from Monitoring Stations on Upper Abbey Track 2014																																																																																					
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MS14	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>29/05/2014</td><td>48</td></tr><tr><td>30/05/2014</td><td>19</td></tr><tr><td>31/05/2014</td><td>8</td></tr><tr><td>01/06/2014</td><td>30</td></tr><tr><td>02/06/2014</td><td>8</td></tr><tr><td>03/06/2014</td><td>16</td></tr><tr><td>04/06/2014</td><td>19</td></tr><tr><td>05/06/2014</td><td>29</td></tr><tr><td>06/06/2014</td><td>44</td></tr><tr><td>07/06/2014</td><td>18</td></tr><tr><td>08/06/2014</td><td>45</td></tr><tr><td>09/06/2014</td><td>39</td></tr><tr><td>10/06/2014</td><td>86</td></tr></table></div>	Date	Passes	29/05/2014	48	30/05/2014	19	31/05/2014	8	01/06/2014	30	02/06/2014	8	03/06/2014	16	04/06/2014	19	05/06/2014	29	06/06/2014	44	07/06/2014	18	08/06/2014	45	09/06/2014	39	10/06/2014	86	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>15/07/2014</td><td>4</td></tr><tr><td>16/07/2014</td><td>10</td></tr><tr><td>17/07/2014</td><td>1</td></tr><tr><td>18/07/2014</td><td>3</td></tr><tr><td>19/07/2014</td><td>0</td></tr><tr><td>20/07/2014</td><td>2</td></tr><tr><td>21/07/2014</td><td>2</td></tr><tr><td>22/07/2014</td><td>1</td></tr><tr><td>23/07/2014</td><td>0</td></tr><tr><td>24/07/2014</td><td>0</td></tr><tr><td>25/07/2014</td><td>0</td></tr><tr><td>26/07/2014</td><td>1</td></tr><tr><td>27/07/2014</td><td>2</td></tr></table></div>	Date	Passes	15/07/2014	4	16/07/2014	10	17/07/2014	1	18/07/2014	3	19/07/2014	0	20/07/2014	2	21/07/2014	2	22/07/2014	1	23/07/2014	0	24/07/2014	0	25/07/2014	0	26/07/2014	1	27/07/2014	2	<div><p>Barbastelle Passes per Night</p><table><tr><th>Date</th><th>Passes</th></tr><tr><td>03/09/2014</td><td>12</td></tr><tr><td>04/09/2014</td><td>32</td></tr><tr><td>05/09/2014</td><td>44</td></tr><tr><td>06/09/2014</td><td>69</td></tr><tr><td>07/09/2014</td><td>60</td></tr><tr><td>08/09/2014</td><td>70</td></tr><tr><td>09/09/2014</td><td>102</td></tr><tr><td>10/09/2014</td><td>77</td></tr><tr><td>11/09/2014</td><td>69</td></tr><tr><td>12/09/2014</td><td>137</td></tr><tr><td>13/09/2014</td><td>170</td></tr><tr><td>14/09/2014</td><td>47</td></tr></table></div>	Date	Passes	03/09/2014	12	04/09/2014	32	05/09/2014	44	06/09/2014	69	07/09/2014	60	08/09/2014	70	09/09/2014	102	10/09/2014	77	11/09/2014	69	12/09/2014	137	13/09/2014	170	14/09/2014	47
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Table A1- 19. Data from Monitoring Stations on potential western commuting route 2013 and 2014.

DETAILED RESULTS

Data from Monitoring Stations on potential western commuting route 2013																																																																																											
2013	S1	S2	S3 [note that M30 and M17 are monitored in different sessions]																																																																																								
MS30 [Track to Upper Abbey]	Not monitored in S1 2013	Not monitored in S2 2013	<div><div>Barbastelle Passes per Night</div><table><tr><th>Date</th><th>Passes</th></tr><tr><td>11/09/2013</td><td>3</td></tr><tr><td>12/09/2013</td><td>3</td></tr><tr><td>13/09/2013</td><td>0</td></tr><tr><td>14/09/2013</td><td>8</td></tr><tr><td>15/09/2013</td><td>0</td></tr><tr><td>16/09/2013</td><td>0</td></tr><tr><td>17/09/2013</td><td>10</td></tr><tr><td>18/09/2013</td><td>4</td></tr><tr><td>19/09/2013</td><td>4</td></tr><tr><td>20/09/2013</td><td>6</td></tr><tr><td>21/09/2013</td><td>3</td></tr></table></div>	Date	Passes	11/09/2013	3	12/09/2013	3	13/09/2013	0	14/09/2013	8	15/09/2013	0	16/09/2013	0	17/09/2013	10	18/09/2013	4	19/09/2013	4	20/09/2013	6	21/09/2013	3																																																																
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MS30 [East-bridge Rd]	Not monitored in S1 2013	Not monitored in S2 2013	<div><div>Barbastelle Passes per Night</div><table><tr><th>Date</th><th>Passes</th></tr><tr><td>11/09/2013</td><td>6</td></tr><tr><td>12/09/2013</td><td>1</td></tr><tr><td>13/09/2013</td><td>0</td></tr><tr><td>14/09/2013</td><td>20</td></tr><tr><td>15/09/2013</td><td>0</td></tr><tr><td>16/09/2013</td><td>6</td></tr><tr><td>17/09/2013</td><td>12</td></tr><tr><td>18/09/2013</td><td>4</td></tr><tr><td>19/09/2013</td><td>6</td></tr><tr><td>20/09/2013</td><td>6</td></tr><tr><td>21/09/2013</td><td>2</td></tr></table></div>	Date	Passes	11/09/2013	6	12/09/2013	1	13/09/2013	0	14/09/2013	20	15/09/2013	0	16/09/2013	6	17/09/2013	12	18/09/2013	4	19/09/2013	6	20/09/2013	6	21/09/2013	2																																																																
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DETAILED RESULTS

Data from Monitoring Stations on potential western commuting route 2014

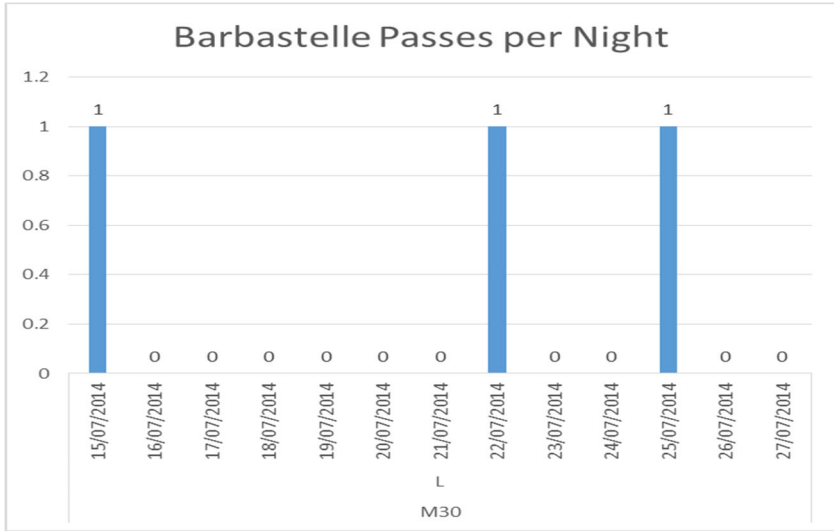
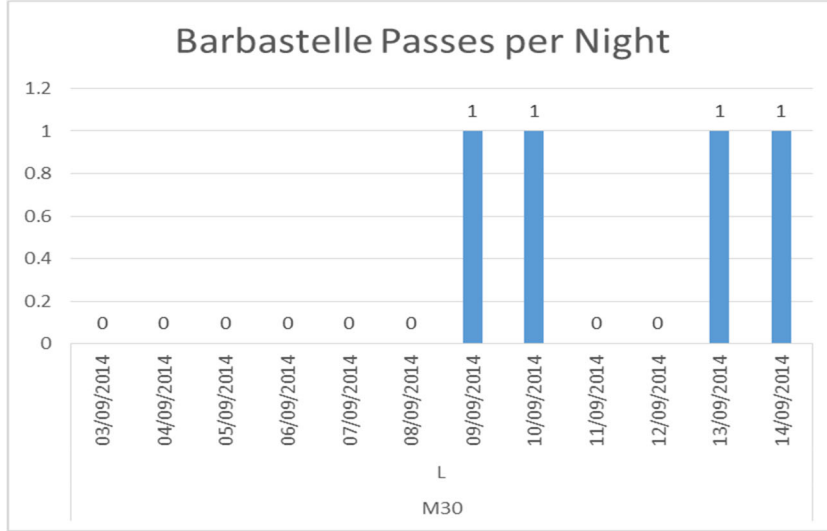
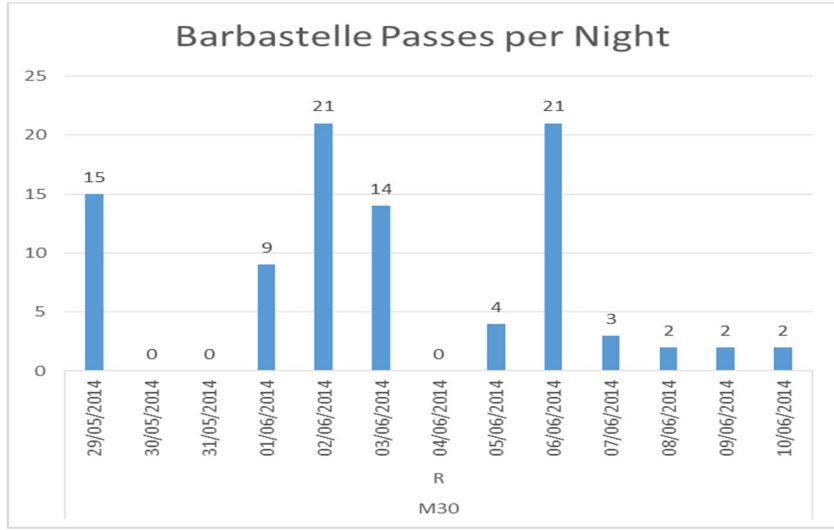
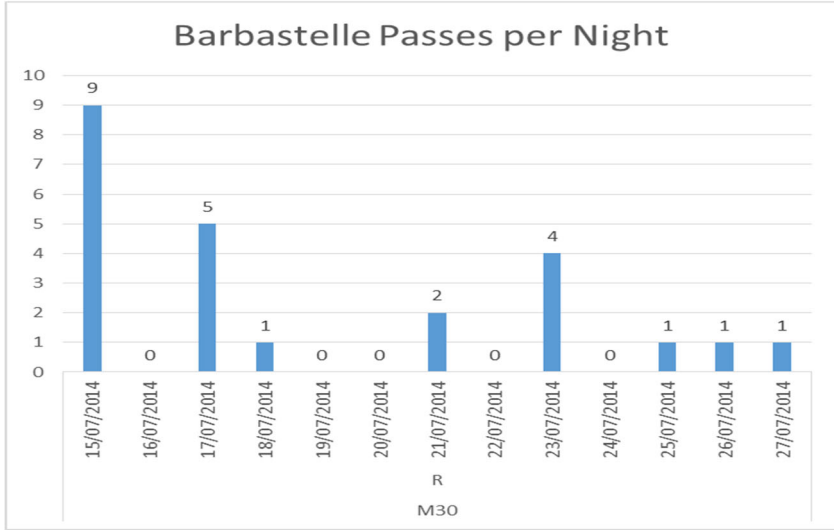
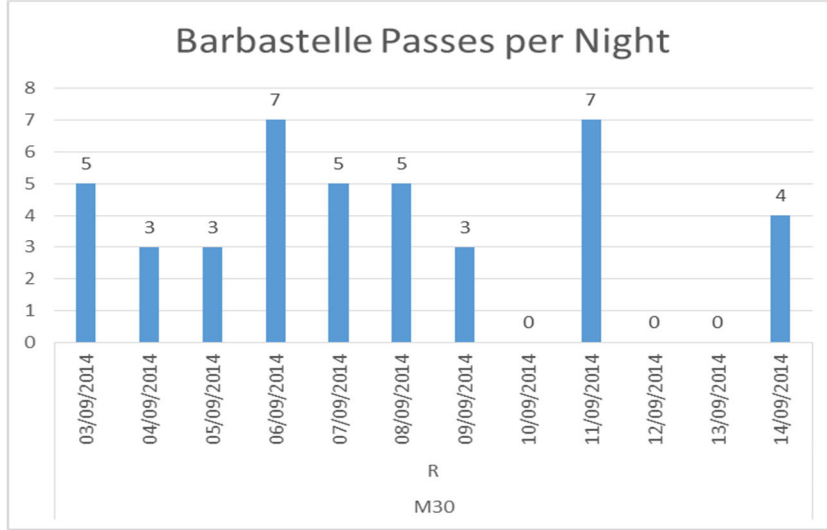
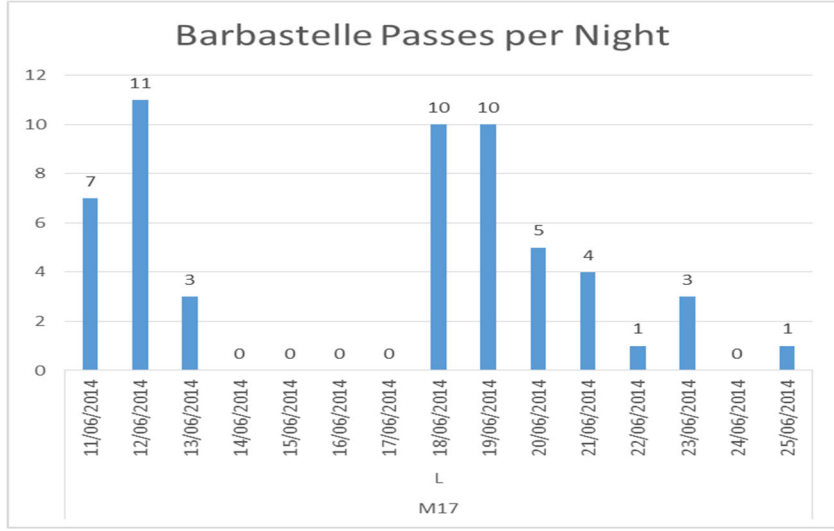
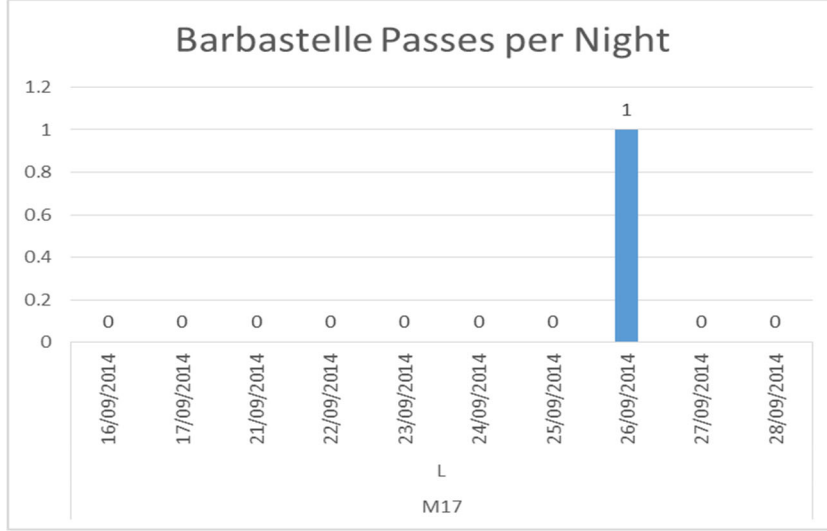
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MS30 [Track to Upper Abbey]	<div>This MS was operational throughout, but recorded no barbastelle (other species were recorded).</div>	<div>Barbastelle Passes per Night</div>  <table><tr><th>Date</th><th>Passes</th></tr><tr><td>15/07/2014</td><td>1</td></tr><tr><td>16/07/2014</td><td>0</td></tr><tr><td>17/07/2014</td><td>0</td></tr><tr><td>18/07/2014</td><td>0</td></tr><tr><td>19/07/2014</td><td>0</td></tr><tr><td>20/07/2014</td><td>0</td></tr><tr><td>21/07/2014</td><td>0</td></tr><tr><td>22/07/2014</td><td>1</td></tr><tr><td>23/07/2014</td><td>0</td></tr><tr><td>24/07/2014</td><td>0</td></tr><tr><td>25/07/2014</td><td>1</td></tr><tr><td>26/07/2014</td><td>0</td></tr><tr><td>27/07/2014</td><td>0</td></tr></table>	Date	Passes	15/07/2014	1	16/07/2014	0	17/07/2014	0	18/07/2014	0	19/07/2014	0	20/07/2014	0	21/07/2014	0	22/07/2014	1	23/07/2014	0	24/07/2014	0	25/07/2014	1	26/07/2014	0	27/07/2014	0	<div>Barbastelle Passes per Night</div>  <table><tr><th>Date</th><th>Passes</th></tr><tr><td>03/09/2014</td><td>0</td></tr><tr><td>04/09/2014</td><td>0</td></tr><tr><td>05/09/2014</td><td>0</td></tr><tr><td>06/09/2014</td><td>0</td></tr><tr><td>07/09/2014</td><td>0</td></tr><tr><td>08/09/2014</td><td>0</td></tr><tr><td>09/09/2014</td><td>1</td></tr><tr><td>10/09/2014</td><td>1</td></tr><tr><td>11/09/2014</td><td>0</td></tr><tr><td>12/09/2014</td><td>0</td></tr><tr><td>13/09/2014</td><td>1</td></tr><tr><td>14/09/2014</td><td>1</td></tr></table>	Date	Passes	03/09/2014	0	04/09/2014	0	05/09/2014	0	06/09/2014	0	07/09/2014	0	08/09/2014	0	09/09/2014	1	10/09/2014	1	11/09/2014	0	12/09/2014	0	13/09/2014	1	14/09/2014	1																												
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MS30 [East-bridge Rd]	<div>Barbastelle Passes per Night</div>  <table><tr><th>Date</th><th>Passes</th></tr><tr><td>29/05/2014</td><td>15</td></tr><tr><td>30/05/2014</td><td>0</td></tr><tr><td>31/05/2014</td><td>0</td></tr><tr><td>01/06/2014</td><td>9</td></tr><tr><td>02/06/2014</td><td>21</td></tr><tr><td>03/06/2014</td><td>14</td></tr><tr><td>04/06/2014</td><td>0</td></tr><tr><td>05/06/2014</td><td>4</td></tr><tr><td>06/06/2014</td><td>21</td></tr><tr><td>07/06/2014</td><td>3</td></tr><tr><td>08/06/2014</td><td>2</td></tr><tr><td>09/06/2014</td><td>2</td></tr><tr><td>10/06/2014</td><td>2</td></tr></table>	Date	Passes	29/05/2014	15	30/05/2014	0	31/05/2014	0	01/06/2014	9	02/06/2014	21	03/06/2014	14	04/06/2014	0	05/06/2014	4	06/06/2014	21	07/06/2014	3	08/06/2014	2	09/06/2014	2	10/06/2014	2	<div>Barbastelle Passes per Night</div>  <table><tr><th>Date</th><th>Passes</th></tr><tr><td>15/07/2014</td><td>9</td></tr><tr><td>16/07/2014</td><td>0</td></tr><tr><td>17/07/2014</td><td>5</td></tr><tr><td>18/07/2014</td><td>1</td></tr><tr><td>19/07/2014</td><td>0</td></tr><tr><td>20/07/2014</td><td>0</td></tr><tr><td>21/07/2014</td><td>2</td></tr><tr><td>22/07/2014</td><td>0</td></tr><tr><td>23/07/2014</td><td>4</td></tr><tr><td>24/07/2014</td><td>0</td></tr><tr><td>25/07/2014</td><td>1</td></tr><tr><td>26/07/2014</td><td>1</td></tr><tr><td>27/07/2014</td><td>1</td></tr></table>	Date	Passes	15/07/2014	9	16/07/2014	0	17/07/2014	5	18/07/2014	1	19/07/2014	0	20/07/2014	0	21/07/2014	2	22/07/2014	0	23/07/2014	4	24/07/2014	0	25/07/2014	1	26/07/2014	1	27/07/2014	1	<div>Barbastelle Passes per Night</div>  <table><tr><th>Date</th><th>Passes</th></tr><tr><td>03/09/2014</td><td>5</td></tr><tr><td>04/09/2014</td><td>3</td></tr><tr><td>05/09/2014</td><td>3</td></tr><tr><td>06/09/2014</td><td>7</td></tr><tr><td>07/09/2014</td><td>5</td></tr><tr><td>08/09/2014</td><td>5</td></tr><tr><td>09/09/2014</td><td>3</td></tr><tr><td>10/09/2014</td><td>0</td></tr><tr><td>11/09/2014</td><td>7</td></tr><tr><td>12/09/2014</td><td>0</td></tr><tr><td>13/09/2014</td><td>0</td></tr><tr><td>14/09/2014</td><td>4</td></tr></table>	Date	Passes	03/09/2014	5	04/09/2014	3	05/09/2014	3	06/09/2014	7	07/09/2014	5	08/09/2014	5	09/09/2014	3	10/09/2014	0	11/09/2014	7	12/09/2014	0	13/09/2014	0	14/09/2014	4
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Table A1- 20. Data from Monitoring Stations on Stonewall Belt 2014.

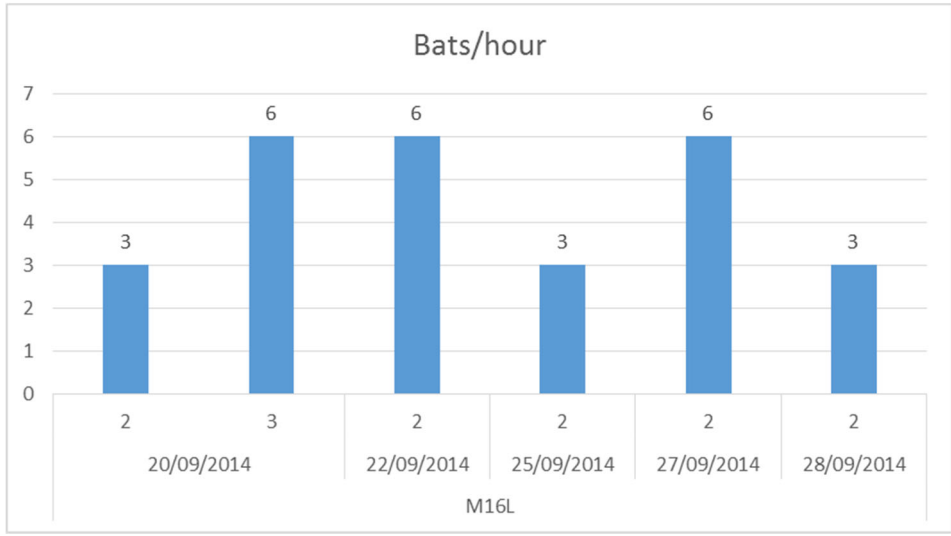
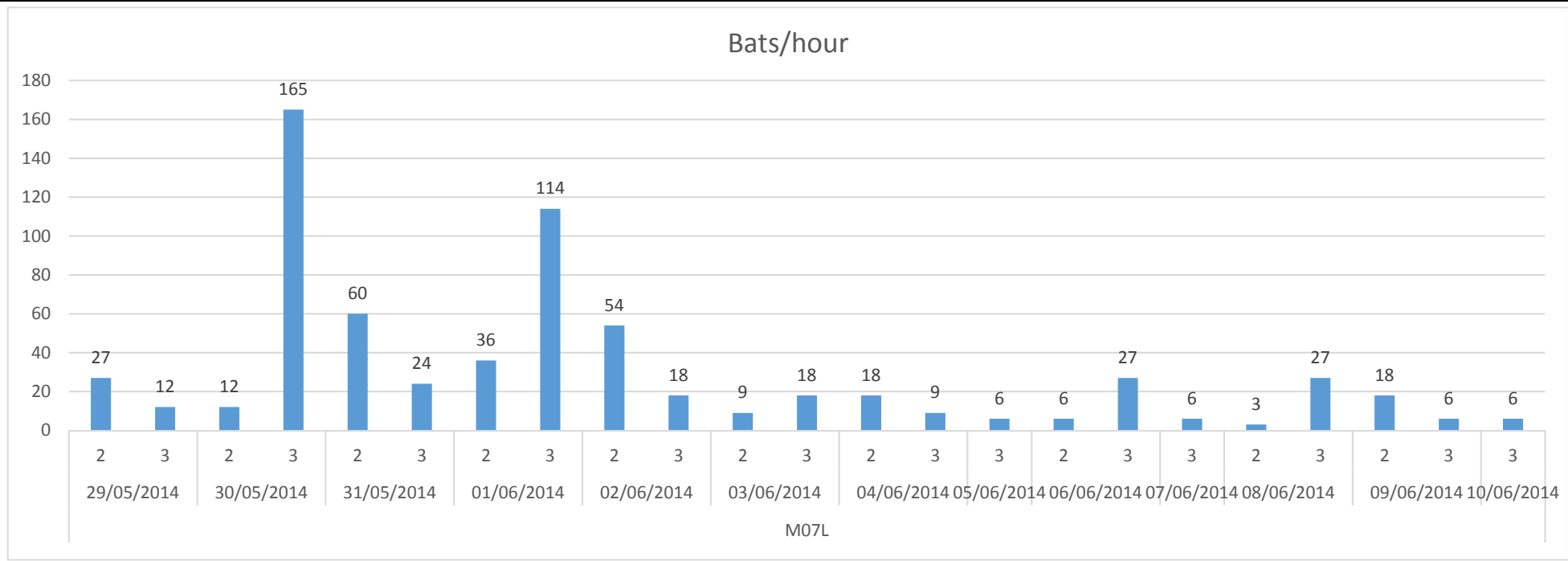
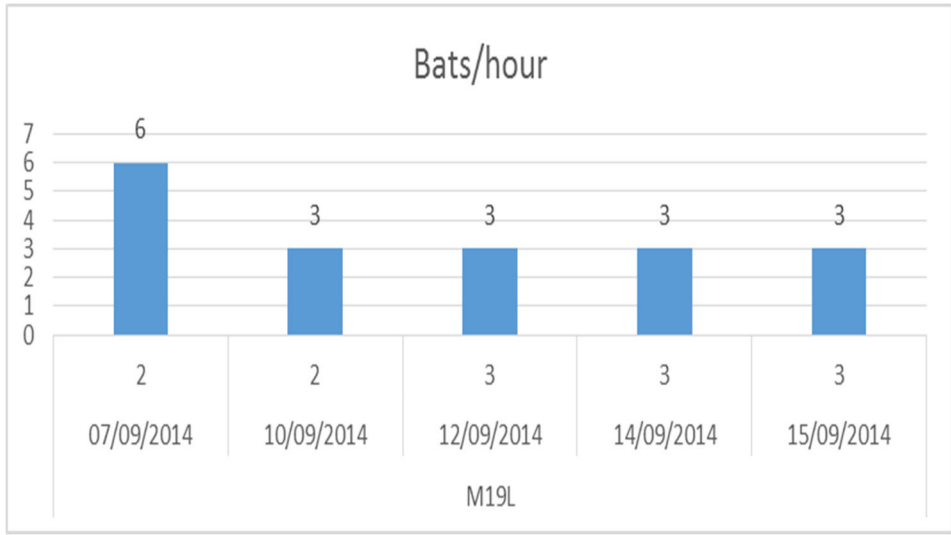
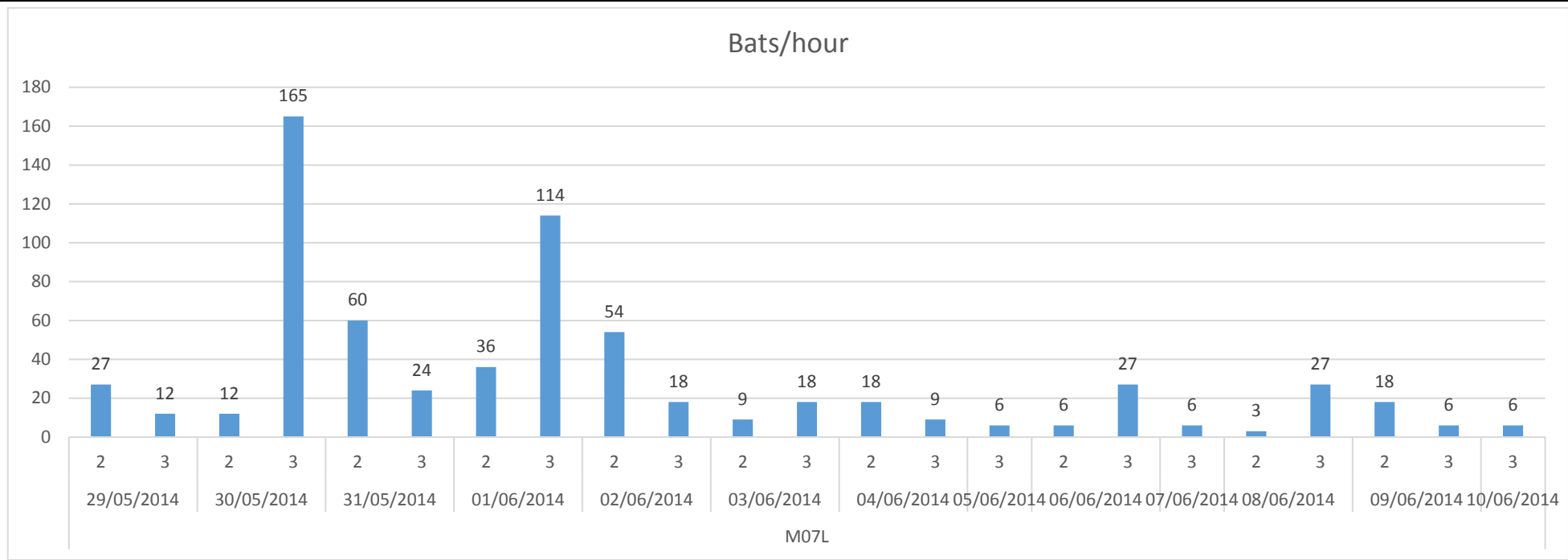
DETAILED RESULTS

Table A1.5: Data from Monitoring Stations on Stonewall Belt 2014

2014	S1	S2	S3
MS32 west of Belt	<div><div>Barbastelle Passes per Night</div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><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DETAILED RESULTS

Table A1- 21. Example time-code scenarios (for illustrative purposes only).



The two graphs in the column above show regular activity in TCs 2 and 3 (between 20 and 60 minutes after sunset) on a number of consecutive days. In all cases, bat passes/hour are shown, which are the actual calls in that TC multiplied by three. [This will be reverted back to the actual calls in the final version of this document.]

Note that the scales in the left- and right-hand graphs differ considerably.

In contrast, the two graphs in the right hand column show MSs with low levels of early activity (within the first hour after sunset) on non-consecutive days. In all cases, bat passes/hour are shown, which are the actual calls in that TC multiplied by three. [This will be reverted back to the actual calls in the final version of this document.]

## DETAILED RESULTS

Table A1- 22. Brown long-eared bat data from MSs showing >5 mppn.

Year	Season	Monitoring Station	LEB Mean passes per night (mppn)	Sunset (range for nights meeting criterion of >5ppn)	Passes in first hour [relative to sunset time each night]	Passes in TC4 [only checked if no activity in TCs1-3]
2013	1	10	5.21	21:01 - 21:15	14 (21:33 - 22:15)	-
		10	6.57	20:47 - 21:07	7 ( 21:34 - 22:02)	-
	2	21	6.71	20:23 - 20:47	1 (21:18)	-
		23	5.5	20:21 - 20:45	N	1 (21:31)
	3	3	14	19:05 - 19:19	2 (19:46 and 19:57)	-
		21	10.15	18:18 - 18:46	5 (19:24 - 19:37)	-
		27	5	18:34 - 18:46	N	2 (19:48 and 20:05)
		29	5.36	18:18 - 18:46	1 (19:10)	-
		31 (WP)	17	18:37 - 18:46	2 (19:38 and 19:41)	-
2014	1	7	8.92	21:01 - 21:13	4 (21:56 - 22:03)	-
		10	9.71	21:01 - 21:14	10 (21:45 - 22:04)	-
	2	7	6.07	20:49 - 21:07	14 (21:38 - 22:03)	-
		23	5.07	21:01 - 21:14	8 (21:16 - 21:57)	-
		29	7	21:03 - 21:12	3 (21:36 - 21:59)	-
	3	7	59.46	19:06 - 19:34	14 (19:31 - 20:24)	-
		10	12.83	19:06 - 19:34	4 (19:52 - 20:27)	-
		16 (FD)	5.38	18:33 - 19:03	3 (19:46 x2 and 19:50)	-
		20	7.79	18:37 - 19:06	2 (20:01 and 20:02)	-
		21	16.62	18:35 - 19:06	6 (19:25 - 19:50)	-
		23	6.21	18:33 - 19:06	2 (20:01 and 20:02)	-
		26	10.93	18:33 - 19:06	N	1 (19:52)



## A2. ANALYSIS OF SEASONAL DIFFERENCES IN BAT PASS METRICS

### A2.1. Aims

- A2.1.1. Preliminary analyses (Section 3.1) noted that the mean number of total bat passes differed among the three survey seasons surveyed and among species groups recorded, prompting further analyses.
- A2.1.2. Across all six species groups, the variable *total bat passes* (total passes recorded at a given location on a given night) has a highly skewed non-normal (Gaussian) distribution, with a very large number of cases with low values and small number of cases with very high values (Graph 2). These high values will have a disproportionate influence on any average values calculated, and therefore, raw averages (as presented in Section .1) need to be cautiously interpreted.
- A2.1.3. Further analyses taking into account the skewed nature of the data were therefore undertaken with the following aims:
- determine whether seasonal differences in number of bat passes recorded were significant; and
  - determine whether seasonal differences in the number of bat passes are due to differences in night length (available foraging period).
- A2.1.4. These analyses were undertaken on behalf of Arcadis by Biocensus.
- A2.1.5. Identical analyses were conducted for each of the following six species groups:
- Barbastelle
  - Nathusius' pipistrelle
  - Pipistrelle group: all pipistrelle species (including Nathusius' pipistrelle)
  - *Myotis* group
  - 'Big bat' group: noctule; Leisler's; serotine
  - 'All bats': a combination of all the groups set out above.

### A2.2. Statistical methods

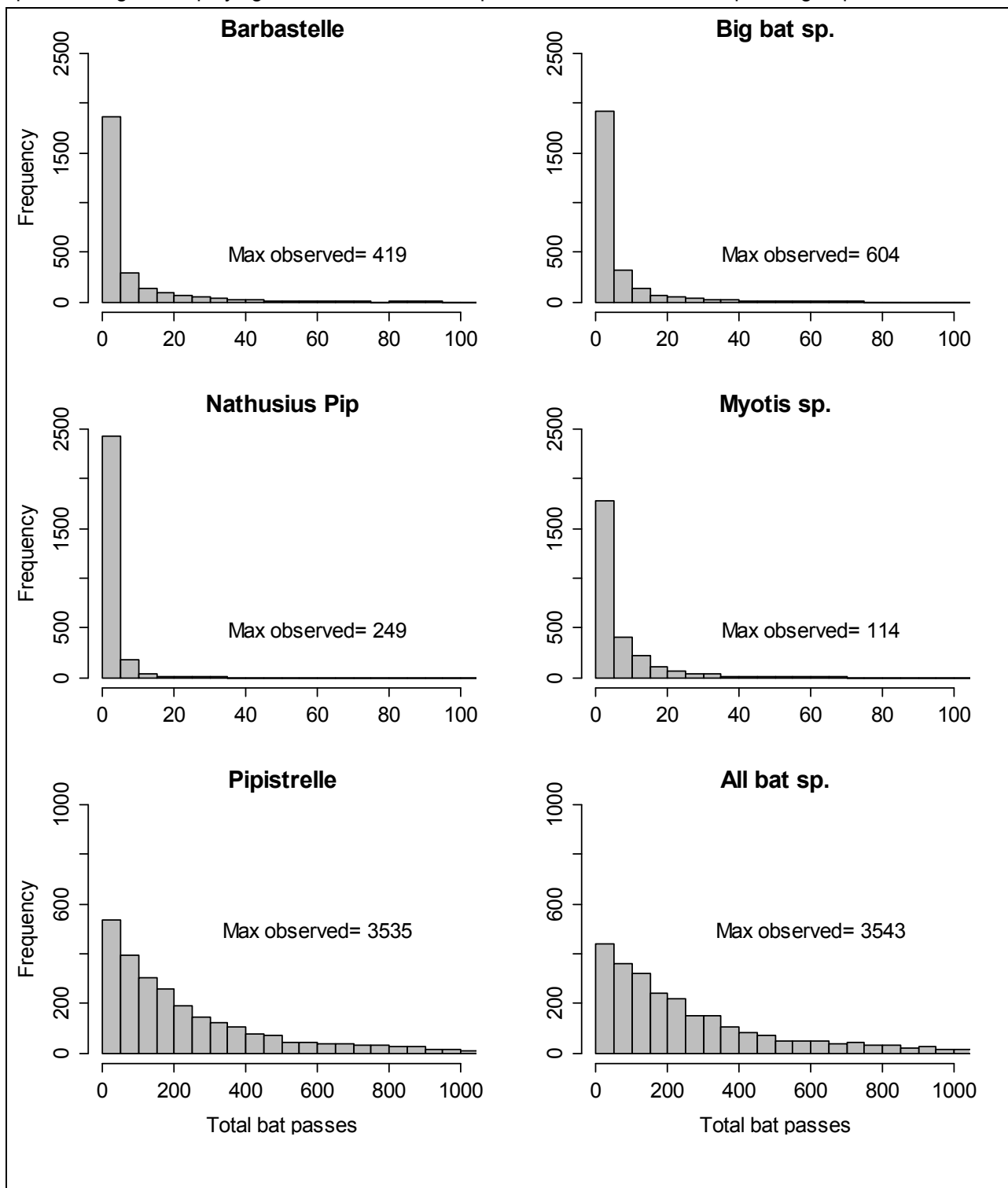
#### Total bat passes per night

- A2.2.1. In order to test whether seasonal patterns in the number of bat passes are significantly different, we carried out a series of generalised linear mixed model (GLMM) analyses. In all cases, total bat passes was the response variable (i.e. the variable of interest), with season (1 / 2 / 3) and year (2013 or 2014) included as fixed effects (predictor variables). Survey site (column 'MS' in the dataset) was included as a random effect, to account for the pseudo-replicated structure of the data. That is, each observation is not independent, but instead multiple observations are recorded for each survey location. The inclusion of the random effect also takes into account the fact that background levels of bat activity vary across the study sites independent of other

## STATISTICAL ANALYSES

variables (i.e. regardless of season, year etc., some areas will have more bat activity than others).

Graph 2. Histogram displaying distribution of total bat passes for each of the six species groups.



Shows the frequency (number of survey nights) where differing numbers of bat passes were recorded. In all cases the x axis has been shortened for illustrative purposes. The maximum number of bat passes recorded for a given night/survey location is also displayed on the figure. Note that the scale of the y and x axes differ on the bottom two species groups.

A2.2.2. Due to the heavily skewed nature of the data (many zero observations), models were carried out using a Poisson (count data) distribution and a 'log link'. In addition, we also

included observation ID (e.g. every row in the data has a unique id or row number) as an observation-level random effect. Observation-level random effects account for the fact that the data is more skewed/ variable than would be expected for a standard Poisson distribution (the data is 'over-dispersed').

- A2.2.3. To assess the significance of individual variables, statistical comparisons were made between models with and without the variable of interest (step-wise simplification), this results in a chi square  $\chi^2$  test statistic and a p value (probability that the result could occur by chance), with a p value of <0.05 indicating a significant result.

### Bat pass rate, accounting for night length

- A2.2.4. The night length (dawn to dusk) or observation period varies across the three survey seasons. S3 has the longest nights at 10.5 - 12.9 hours, compared to 7.2 - 7.8 hrs in S1 and 7.4 - 9.2 hours in S2. As a consequence, total bat passes could vary among seasons due to differences in night length, even if activity rate (bat passes per hour) were constant. In order to investigate Aim 2 and determine the extent that seasonal differences in total bat passes were influenced by night length, we repeated the above GLMM analyses while also including the night length (hours) as an 'offset' variable. The offset compensates for the additional and known variation in the response (total bat passes) resulting from differing observation period (night length). This analysis is essentially identical to that described above (for total bat passes), but instead the response variable is bat pass rate (total bat passes divided by night length)

### Effects of temperature on bat pass rate

- A2.2.5. Data on daily temperature (min /max) was also recorded for each monitoring session. It is not possible to include temperature as a variable alongside season in the above models, as the two variables are strongly related, and would confound interpretation of results. However, S1 and 3 had similar temperatures. If we subset the data to remove S2 it is therefore possible to re-run the above analysis (GLMM including season and year) while also including temperature information. This analysis was conducted for all six species groups to investigate whether nightly variation in temperature also influenced bat activity.

## A2.3. Results

### General

- A2.3.1. There were statistically significant seasonal differences in the *total bat passes* and in the *bat pass rate* in all six species groups investigated. However, the magnitude and direction of seasonal differences varied among species groups. Table A2 - 1 shows the results of GLMM analyses investigating variation in *total bat passes* and *bat pass rate*. In Table A2 - 1, S1 is the reference level (the level to which other category levels are compared), with coefficients for S2 and S3 indicating the average change in *total bat passes* and *bat pass rate* relative to season 1 on the *log scale*. Graph 3 and Graph 4 show the predicted results of the models for *total bat passes* and *bat pass rate* respectively.
- A2.3.2. Transformation of these coefficients (exponential or antilog of these numbers) produces the incident rate ratio (IRR), which indicates the relative change in the number of incidents (*total bat passes* or *bat pass rate*). Hence, if S2 had an IRR of 0.75, this would indicate that S2 had approximately 75% of the level of bat activity of S1 (a 25% decline). If S2 had an IRR of 1.5 would indicate that the number of bat

## STATISTICAL ANALYSES

passes was 150% relative to S1 (an increase of 50%). For example, in S2 the IRR for barbastelles was 0.53, indicating that on average there were 53% of the number of barbastelle passes (or a relative 47% decline) that were detected in S1 (Table A2 - 1).

- A2.3.3. Comparing IRR values for *total bat passes* and *bat pass rate* demonstrates the extent that controlling for observation period (*night length*) affects the results of the analyses. For example the S3 IRR for the *Myotis* sp. group is 1.50 (50% increase) for *total bat passes*, suggesting a marked increase in bat activity. However, the S3 IRR for *bat pass rate* is 0.94 (6% decline) indicating a slight decrease. This indicates that the number of *total bat passes* is influenced by night length, as accounting for this results in different seasonal patterns/effects.
- A2.3.4. In several species groups (*Myotis* sp., pipistrelle, and 'All bats'), there is also a significant effect of year on the *total bat passes* and *bat pass rate* recorded. In these models the reference level for year is 2013. The coefficient displayed in the table therefore indicates the difference between 2014 relative to 2013.
- A2.3.5. Significant seasonal differences in bat activity occurred for all species groups, including when controlling for differences in night length (i.e. *bat pass rate*). The general seasonal patterns for *total bat passes* and *bat pass rate* were similar for some species groups (Big bat sp., pipistrelle group, all bat sp.), but differed more markedly for other species groups (Barbastelle, *Myotis* sp., Nathusius' pipistrelle).
- A2.3.6. In all six species groups, the effects of S3 were smaller for *bat pass rate* than for *total bat passes* (Table A2 - 1). This may be because when calculating *bat pass rate*, numbers in S3 are divided by a longer night length than Seasons 1 and 2, effectively diluting the effect. Alternatively, the longer observation period per night in S3 may result in inflated *total bat passes* relative to other Seasons. Specific results relating to each species group are detailed in the following section.

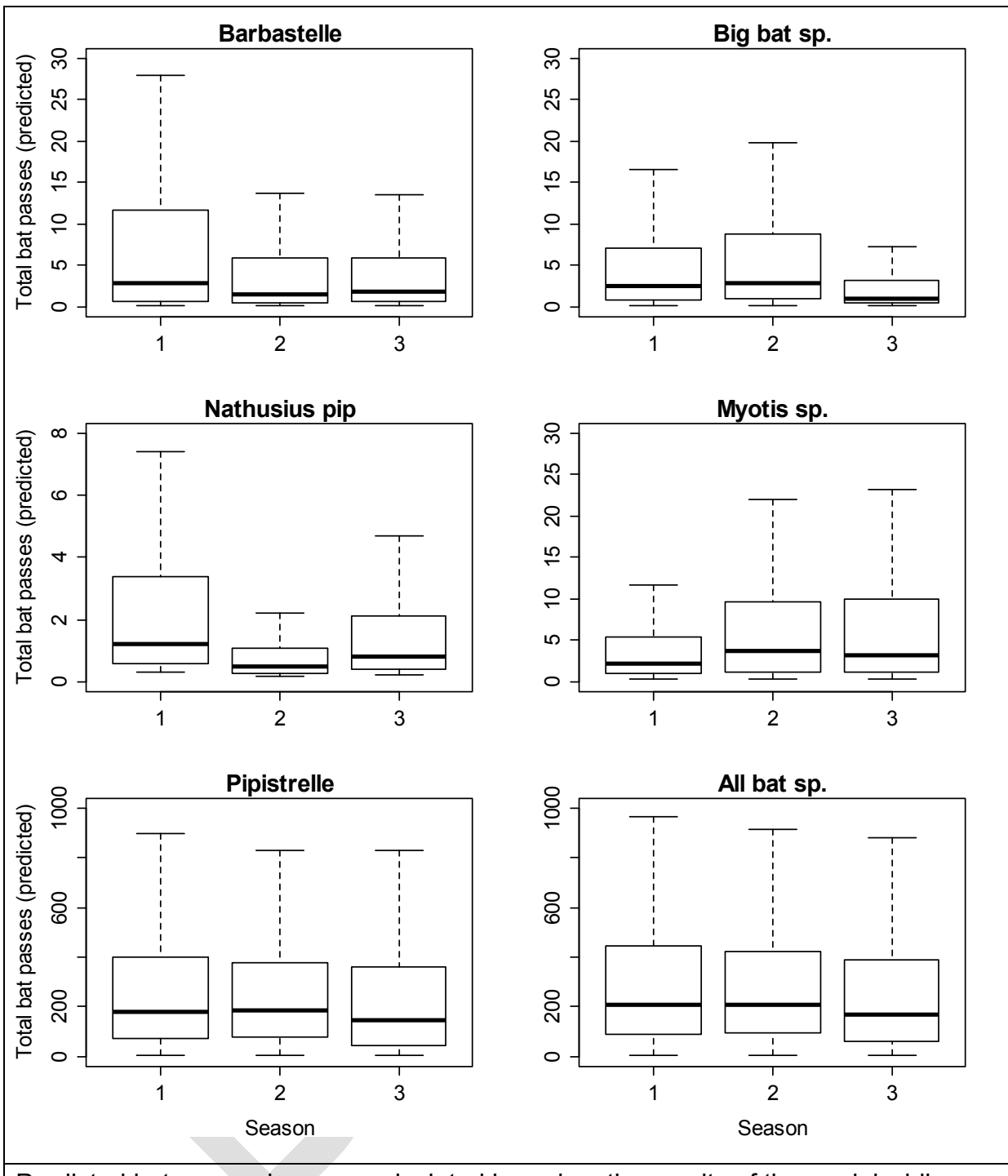
Table A2 - 1. Results of GLMM analyses investigating seasonal and annual changes in total bat passes and bat pass rate (bat passes per hour) for the six species groups analysed.

Species	effect	Total bat passes				Bat pass rate		
		coeff	se	IRR		coeff	se	IRR
<i>Barbastelle</i>	intercept	0.75	0.19	2.11		-1.25	0.19	0.29
	<b>S2</b>	<b>-0.63</b>	<b>0.08</b>	<b>0.53</b>		<b>-0.76</b>	<b>0.08</b>	<b>0.47</b>
	<b>S3</b>	<b>-0.30</b>	<b>0.08</b>	<b>0.74</b>		<b>-0.75</b>	<b>0.08</b>	<b>0.47</b>
	year (2014)	-0.02	0.07	0.98		-0.01	0.07	0.99
<i>Big bat sp.</i>	intercept	0.70	0.19	2.01		-1.30	0.19	0.27
	<b>S2</b>	<b>0.28</b>	<b>0.07</b>	<b>1.32</b>		<b>0.14</b>	<b>0.07</b>	<b>1.16</b>
	<b>S3</b>	<b>-0.74</b>	<b>0.07</b>	<b>0.48</b>		<b>-1.19</b>	<b>0.08</b>	<b>0.30</b>
	year (2014)	0.04	0.06	1.04		0.05	0.06	1.05
<i>Nathusius' Pipistrelle</i>	intercept	0.15	0.11	1.16		-1.85	0.11	0.16
	<b>S2</b>	<b>-0.99</b>	<b>0.08</b>	<b>0.37</b>		<b>-1.12</b>	<b>0.07</b>	<b>0.33</b>
	<b>S3</b>	<b>-0.50</b>	<b>0.08</b>	<b>0.60</b>		<b>-0.96</b>	<b>0.08</b>	<b>0.38</b>
	year (2014)	-0.08	0.07	0.92		-0.08	0.07	0.93
<i>Myotis sp.</i>	intercept	0.64	0.17	1.89		-1.36	0.17	0.26
	<b>S2</b>	<b>0.48</b>	<b>0.05</b>	<b>1.62</b>		<b>0.35</b>	<b>0.05</b>	<b>1.42</b>
	<b>S3</b>	<b>0.40</b>	<b>0.05</b>	<b>1.50</b>		<b>-0.06</b>	<b>0.05</b>	<b>0.94</b>
	<b>year (2014)</b>	<b>-0.13</b>	<b>0.05</b>	<b>0.88</b>		<b>-0.12</b>	<b>0.05</b>	<b>0.88</b>
<i>Pipistrelle</i>	intercept	4.90	0.15	134.56		2.91	0.14	18.27
	<b>S2</b>	<b>-0.11</b>	<b>0.05</b>	<b>0.90</b>		<b>-0.24</b>	<b>0.05</b>	<b>0.79</b>
	<b>S3</b>	<b>-0.24</b>	<b>0.05</b>	<b>0.79</b>		<b>-0.69</b>	<b>0.05</b>	<b>0.50</b>
	<b>year (2014)</b>	<b>0.24</b>	<b>0.05</b>	<b>1.27</b>		<b>0.24</b>	<b>0.05</b>	<b>1.27</b>
<i>All bat sp.</i>	intercept	5.06	0.14	158.28		3.07	0.13	21.49
	<b>S2</b>	<b>-0.10</b>	<b>0.05</b>	<b>0.91</b>		<b>-0.22</b>	<b>0.05</b>	<b>0.80</b>
	<b>S3</b>	<b>-0.22</b>	<b>0.05</b>	<b>0.80</b>		<b>-0.68</b>	<b>0.05</b>	<b>0.51</b>
	<b>year (2014)</b>	<b>0.20</b>	<b>0.04</b>	<b>1.22</b>		<b>0.20</b>	<b>0.05</b>	<b>1.23</b>

For each variable the coefficient (coeff) is the change in the log of the response (total bat passes or bat pass rate) due to that variable. The se is the standard error (measure of variation) for the coefficient. The IRR, or incident rate ratio, is the relative change in the response variable relative to the reference level (S1 for the season variable and 2013 for the year variable). Bold variables are those with statistically significant effects ( $p < 0.05$ ).

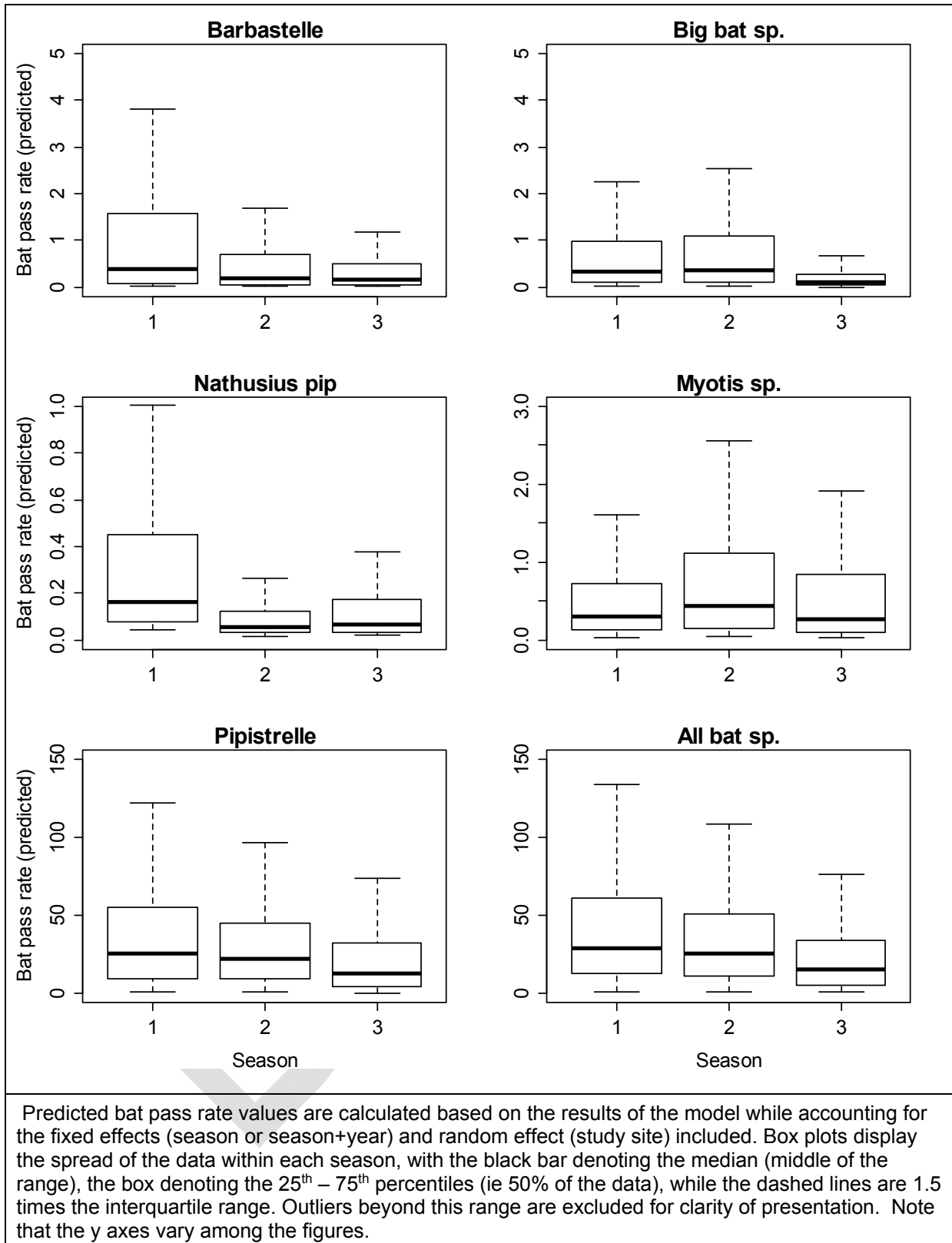
## STATISTICAL ANALYSES

Graph 3. Boxplots displaying predicted (or 'fitted') values from the GLMMs investigating seasonal differences in total bat passes.



Predicted bat pass values are calculated based on the results of the model while accounting for the fixed effects (season or season+year) and random effect (study site) included. Box plots display the spread of the data within each season, with the black bar denoting the median (middle of the range), the box denoting the 25<sup>th</sup> – 75<sup>th</sup> percentiles (i.e. 50% of the data), while the dashed lines are 1.5 times the interquartile range. Outliers beyond this range are excluded for clarity of presentation. Note that the y axes vary among the figures

Graph 4. Boxplots displaying predicted (or 'fitted') values from the GLMMs investigating seasonal differences in bat pass rate (passes per hour).



## Species and species group results

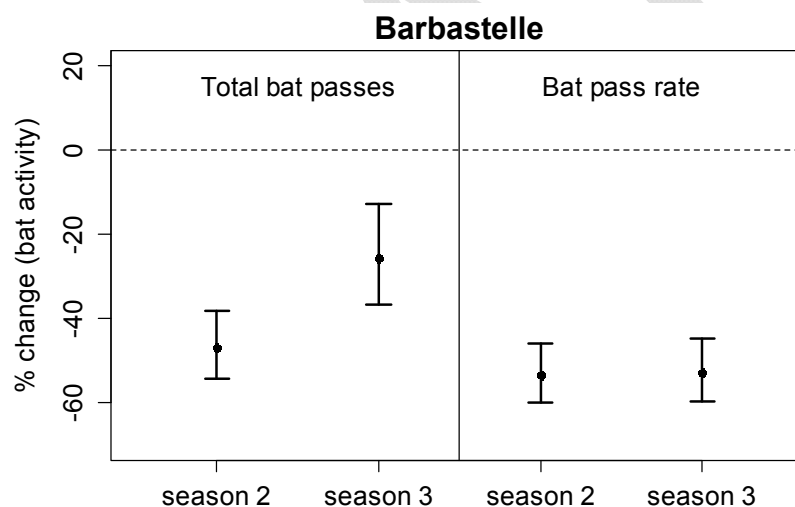
A2.3.7. The effect of season on measures of bat passes are summarised in Graph 1, and detailed below by species and species group.

## STATISTICAL ANALYSES

### Barbastelle

- A2.3.8. There was a significant seasonal difference in the number of barbastelle total bat passes recorded ( $\chi^2_2=64.55$ ,  $p<0.001$ ). The number of bat passes was highest in S1, with a significantly lower number in S3 and the lowest number in S2 (Graph 3). The incident rate ratio (IRR) value of 0.53 for S2 indicates the number of bat passes were 53% relative to S1 (47% decline, Graph 5). The IRR value of 0.74 for S3 indicates levels of bat activity were 74% on average, relative to S1 (26% decline, Graph 5). *Total bat passes* were significantly higher in S3 than S2 ( $\chi^2_1=12.62$ ,  $p<0.001$ ). There was no significant effect of year on the number of bat passes ( $\chi^2_1=0.09$ ,  $p=0.77$ ). The Barbastelle *bat pass rate* also varied significantly with season ( $\chi^2_2=119.55$ ,  $p<0.001$ , Table A2 - 1), indicating that strong seasonal effects persist even when night length is considered. As with *total bat passes*, the highest *bat pass rate* was observed in S1, with lower values in Seasons 2 and 3 (Graph 5). However, in contrast to *total bat passes*, the analyses indicated that *bat pass rate* in Seasons 2 and 3 were very similar (Table A2 - 1) with an IRR of 0.47 (53% decrease relative to S1) in both seasons. *Bat pass rate* did not significantly differ between Seasons 2 and 3 ( $\chi^2_1=0.06$ ,  $p=0.82$ ). This suggests that the higher *total bat passes* values observed in S3 (relative to S2) are partly the result of night length. A similar *bat pass rate* in S3 stretched over a longer night results in an inflated number of *total bat passes* in S3 compared to S2.

Graph 5. Average seasonal changes in Barbastelle activity (total bat passes and bat pass rate) estimated from GLMM analyses.



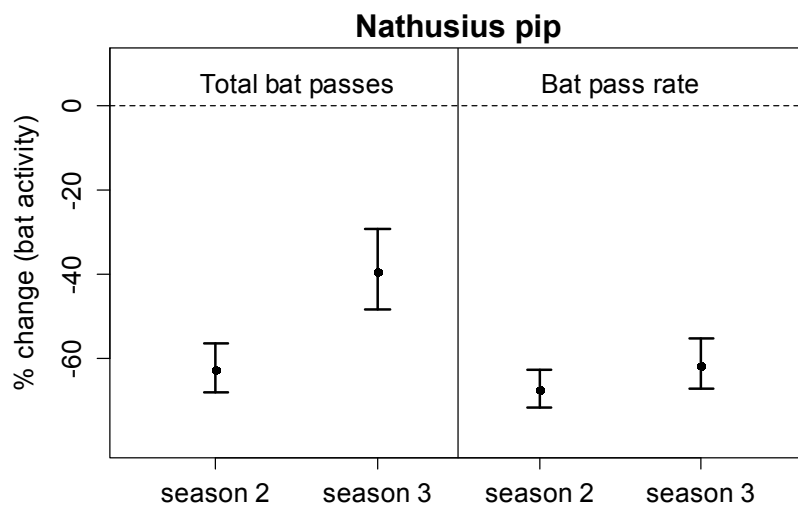
The y axis is the change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values presented in Table A2 - 1 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals for the effects).

### Nathusius' pipistrelle

- A2.3.9. There was a significant seasonal difference in the number of Nathusius' pipistrelle passes recorded ( $\chi^2_2=152.58$ ,  $p<0.001$ ). The overall pattern was similar to that of barbastelle, with the number of bat passes highest in S1, lower in S3 and the lowest in S2 (Table A2 - 1, Graph 3). The IRR value of 0.37 for S2 indicates levels of bat activity were 37% relative to S1 (63% decline, Table A2 - 1, Graph 6). The IRR value of 0.60 for S3 indicates levels of bat activity were 60% relative to S1 (40% decline). *Total bat passes* were significantly higher in S3 than S2 ( $\chi^2_1=31.23$ ,  $p<0.001$ ). There was no significant effect of year on the number of bat passes ( $\chi^2_1=1.31$ ,  $p=0.25$ , Table A2 - 1).

The Nathusius' pipistrelle *bat pass rate* also varied significantly with season ( $\chi^2_2=230.31$ ,  $p<0.001$ , Table A2 - 1) indicating that strong seasonal effects persist even when night length is considered. As with *total bat passes*, the highest *bat pass rate* was observed in S1, with lower values in Seasons 2 and 3. However, in contrast to *total bat passes*, the analyses indicated that *bat pass rate* was only slightly higher in S3 than S2 (Table A2 - 1, Graph 6 with an IRR of 0.33 for S2 (67% decrease) and 0.38 (62% decrease) in S3. *Bat pass rate* was still significantly higher in S3 than S2 ( $\chi^2_1=4.88$ ,  $p=0.027$ ). Again this suggests that the higher *total bat passes* values observed in S3 (relative to S2) are partly the result of night length. A similar *bat pass rate* in S3 stretched over a longer night results in an inflated number of *total bat passes* in S3 compared to S2.

Graph 6. Average seasonal changes in Nathusius' pipistrelle activity (total bat passes and bat pass rate) estimated from GLMM analyses.



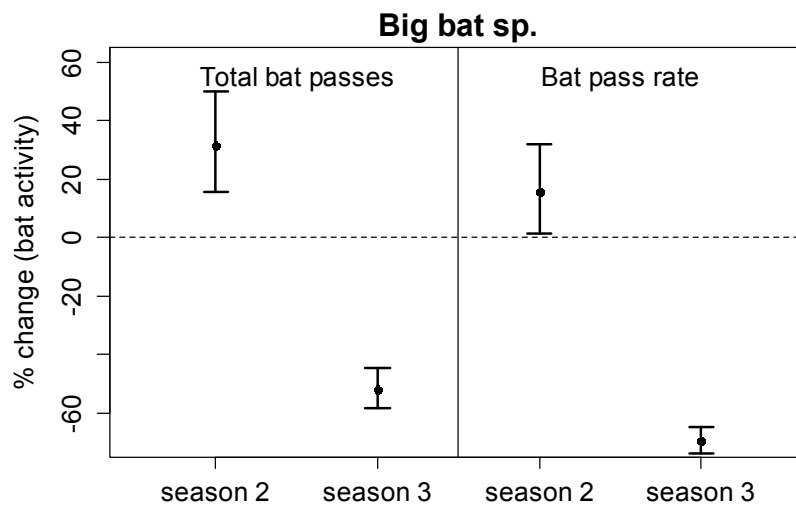
The y axis is the change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table A2 - 1 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals for the effects).

### **'Big bat' spp. group.**

A2.3.10. The results of the GLMM analyses indicate a significant seasonal difference in the number of 'Big bat' spp. passes recorded ( $\chi^2_2=178.63$ ,  $p<0.001$ ). The number of bat passes increased from S1 to S2 and then declined steeply in S3 (Table A2 - 1, Graph 7). The incident rate ratio (IRR) value of 1.32 for S2 indicates the number of bat passes were 132% relative to S1 (32% increase). The IRR value of 0.48 for S3 indicates levels of bat activity were 48% relative to S1 (52% decline). The number of *total bat passes* was significantly higher in S2 than S3 ( $\chi^2_2=146.43$ ,  $p<0.001$ ). There was no significant effect of year on the number of bat passes ( $\chi^2_1=0.49$ ,  $p=0.49$ ). The 'Big bat' spp. *bat pass rate* also varied significantly with season ( $\chi^2_2=330.82$ ,  $p<0.001$ , Table A2 - 1), indicating that strong seasonal effects persist even when night length is considered. Seasonal patterns in *bat pass rate* observed were generally similar to that of *total bat passes* (Graph 7), with higher values in S2 (relative to S1), and the lowest values in S3 (Table A2 - 1, Graph 4). The IRR value of 1.16 for S2 indicates the number of bat passes were 116% relative to S1 (16% increase). The IRR value of 0.30 for S3 indicates levels of bat activity were 30% relative to S1 (70% decline).

## STATISTICAL ANALYSES

Graph 7. Average seasonal changes in Big bat sp. activity (total bat passes and bat pass rate) estimated from GLMM analyses.



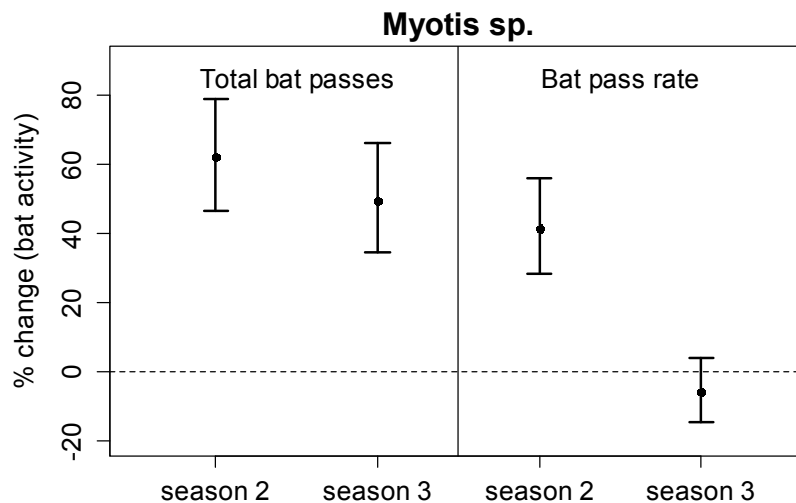
The y axis is the average change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table 2 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals) for the effects.

- A2.3.11. The number of 'Big bat' spp. *total bat passes* recorded were particularly high for the location MS12. However, excluding this location from the analyses had marginal effects on the results. Seasonal differences were still significant for total bat passes ( $\chi^2_2=138.08$ ,  $p<0.001$ ) and bat pass rate ( $\chi^2_2=280.92$ ,  $p<0.001$ ). Coefficients for total bat passes were 0.23 and -0.64 for Seasons 2 and 3 respectively (S2 IRR = 1.25; S3 IRR = 0.52). Coefficients for bat pass rate were 0.10 and -1.09 for Seasons 2 and 3 respectively (S2 IRR = 1.05; S3 IRR = 0.34). These results are very similar to those obtained when this location was included in the analyses (Table A2 - 1).

### Myotis sp. group

- A2.3.12. There was a significant seasonal difference in the number of *Myotis* spp. passes recorded ( $\chi^2_2=97.476$ ,  $p<0.001$ , Table A2 - 1). The number of bat passes was lowest in S1, and increased in Seasons 2 and 3, with the highest values in S2 (Graph 8). The IRR value of 1.62 for S2 indicates levels of bat activity were 162% relative to S1 (62% increase). The IRR value of 1.50 for S3 indicates levels of bat activity were 150% relative to S1 (50% increase). S2 had a significantly higher number of *total bat passes* than S3 ( $\chi^2_2=97.476$ ,  $p<0.001$ ). Numbers of bat passes were also significantly lower in 2014 than 2013 ( $\chi^2_2=8.20$ ,  $p=0.004$ , Table A2 - 1), with an IRR of 0.92 indicating an 8% decline. The *Myotis* sp. *bat pass rate* also varied significantly with season ( $\chi^2_2=70.05$ ,  $p<0.001$ , Table A2 - 1), again indicating that strong seasonal effects persist even when night length is considered. In contrast with the results for *total bat passes*, the lowest *bat pass rate* was observed in S3 (rather than S1), with slightly higher values in S1 and the highest values in S2 (Table A2 - 1, Graph 8). The IRR of S3 was 0.94 indicating a slight (8%) decrease relative to S1. In a direct comparison S1 and S3 did not differ in their *bat pass rate* ( $\chi^2_2=0.91$ ,  $p=0.33$ ). The IRR of S2 was 1.42 (42% increase relative to S1), which was similar to the result for *total bat passes* (Graph 8). As with other species this suggests that the higher *total bat passes* values observed in S3 relative to S1 are partly the result of night length.

Graph 8. Average seasonal changes in *Myotis* sp. activity (total bat passes and bat pass rate) estimated from GLMM analyses.

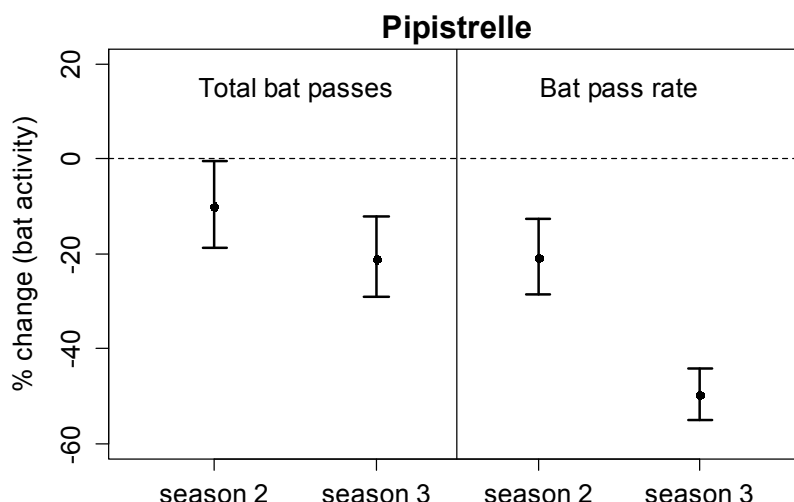


The y axis is the average change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table A2 - 1 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals) for the effects.

### Pipistrelle group:

A2.3.13. There was a significant seasonal difference in the number of pipistrelle passes recorded ( $\chi^2_2=18.748$ ,  $p<0.001$ , Table A2 - 1). The number of bat passes was highest in S1, and decreased in S2 and further declined in S3 (Graph 9). The IRR value of 0.90 for S2 indicates levels of bat activity were 90% relative to S1 (10% decline). The IRR value of 0.79 for S3 indicates levels of bat activity were 79% relative to S1 (21% decline). Despite the different average effects of S2 and 3, they did not differ significantly in the number of *total bat passes* ( $\chi^2_2=3.25$ ,  $p=0.07$ ). Numbers of bat passes were significantly higher in 2014 than 2013 ( $\chi^2_1=25.04$ ,  $p<0.001$ ), with an IRR of 1.27 indicating a 27% increase. The pipistrelle *bat pass rate* also varied significantly with season ( $\chi^2_2=157.28$ ,  $p<0.001$ , Table A2 - 1), again indicating that strong seasonal effects persist even when night length is considered. Seasonal patterns in *bat pass rate* observed were generally similar to that of *total bat passes* (Graph 9), with higher values in S2 (relative to S1), and the lowest values in S3 (Table A2 - 1, Graph 4). The IRR value 0.79 for S2 indicates the number of bat passes were 79% relative to S1 (21% decline). The IRR value of 0.50 for S3 indicates levels of bat activity were 50% relative to S1 (50% decline). In contrast to *total bat passes*, the *bat pass rate* was significantly lower in S3 than S2 ( $\chi^2_2=55.81$ ,  $p<0.001$ ). Again the difference observed for S3 is greater than the difference in *total bat passes*, most likely due to the longer nights in S3 (which act to lower *bat pass rate*).

Graph 9. Average seasonal changes in pipistrelle activity (total bat passes and bat pass rate) estimated from GLMM analyses.

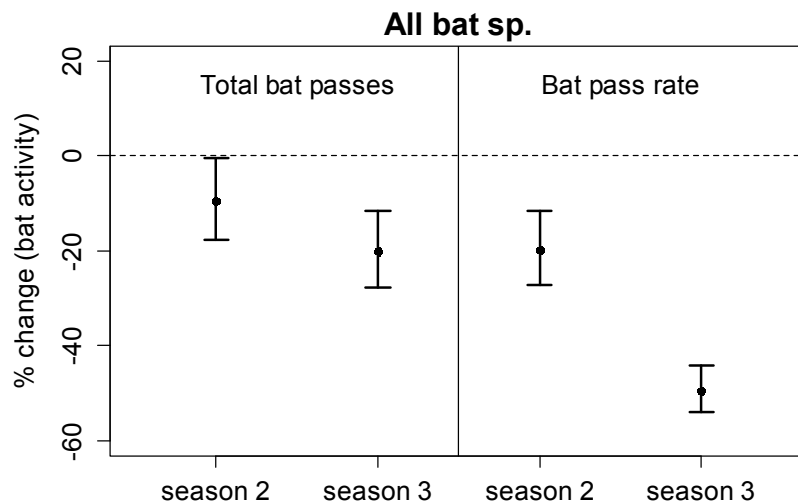


The y axis is the average change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table 2 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals) for the effects.

### All bat species:

- A2.3.14. There was a significant seasonal difference in the number of all bat passes recorded ( $\chi^2_2=18.45$ ,  $p<0.001$ ). Unsurprisingly, the pattern observed for all bat species was very similar to that for the pipistrelle group, as the large majority of bat passes recorded overall were pipistrelles). The number of bat passes was highest in S1, and decreased in S2 and further declined in S3 (Table A2 - 1, Graph 1). The IRR value of 0.91 for S2 indicates levels of bat activity were 91% relative to S1 (9% decline). The IRR value of 0.80 for S3 indicates levels of bat activity were 80% relative to S1 (20% decline). The number of *total bat passes* did not significantly differ from S2 to S3 ( $\chi^2_2=2.84$ ,  $p=0.09$ ). Numbers of bat passes were significantly higher in 2014 than 2013 ( $\chi^2_1=29.65$ ,  $p<0.001$ ), with an IRR of 1.22 indicating a 22% increase. Seasonal differences in *bat pass rate* were again similar to those observed in pipistrelles. *Bat pass rate* differed significantly among seasons ( $\chi^2_2=166.12$ ,  $p<0.001$ ), with lower values in Seasons 2 and 3 than S1 (Graph 4, Table A2 - 1, Graph 1). The IRR value was 0.80 for S2 (20% decline). The IRR value of 0.51 for S3 indicates levels of bat activity were 51% relative to S1 (49% decline). In contrast to *total bat passes*, the *bat pass rate* was significantly lower in S3 than S2 ( $\chi^2_2=57.51$ ,  $p<0.001$ ). Again the difference in *bat pass rate* observed for S3 is greater than the difference in *total bat passes*, most likely due to the longer nights in S3 which provide a longer window to detect bat passes, even if pass rate is lower.

Graph 10. Average seasonal changes in All bat sp. activity (total bat passes and bat pass rate) estimated from GLMM analyses.



The y axis is the average change in activity relative to S1 (the reference level in the model, indicated by the dotted line). Percentage change is calculated from the IRR values in Table A2 - 1 (e.g. IRR of 0.5 = 50% decline). The error bars are the 95% CI (confidence intervals) for the effects.

### Effects of temperature on the number of bat passes

A2.3.15. By including minimum temperature (°C) in the model, using data from Seasons 1 and 3 only, we find that minimum temperature has a significant positive effect on the total bat passes recorded for all species groups (Table A2 - 2), with the exception of *Myotis* spp. Temperature had a positive effect, in that a higher number of bat passes were recorded on nights with a higher minimum recorded temperature. The IRR values in Table A2 - 2 describe the change in *total bat passes* and *bat pass rate observed* with each 1 °C rise in the minimum nightly temperature. The effect of season was still strongly significant in these models for all species groups, further indicating that significant seasonal patterns of activity persist, even when accounting for daily variations in temperature.

Table A2 - 2. Results of GLMM analyses investigating variation in total bat passes due to temperature, (minimum nightly temperature) and season, for the six species groups analysed.

Species	effect	coeff	se	IRR	$\chi^2$	df	p
Barbastelle	Temp	0.06	0.01	1.06	14.80	1	0.0002
	S3	-0.31	0.08	0.73	13.19	1	0.0003
Big bat sp.	Temp	0.13	0.01	1.14	89.48	1	<0.0001
	S3	-0.85	0.07	0.43	142.32	1	<0.0001
Nathusius' Pip	Temp	0.09	0.01	1.09	49.07	1	<0.0001
	S3	-0.52	0.07	0.60	35.59	1	<0.0001
Myotis sp.	Temp	0.02	0.01	1.02	2.41	1	0.1207

## STATISTICAL ANALYSES

Species	effect	coeff	se	IRR	$\chi^2$	df	p
	<b>S3</b>	<b>0.41</b>	<b>0.20</b>	<b>1.50</b>	<b>53.814</b>	<b>1</b>	<b>&lt;0.0001</b>
Pipistrelle	<b>Temp</b>	<b>0.06</b>	<b>0.01</b>	<b>1.06</b>	<b>28.127</b>	<b>1</b>	<b>&lt;0.001</b>
	<b>S3</b>	<b>-0.26</b>	<b>0.05</b>	<b>0.77</b>	<b>22.399</b>	<b>1</b>	<b>&lt;0.001</b>

For each variable the (coeff) coefficient is the change in the *log* of the response (*total bat passes* or *bat pass rate*) due to that variable. The se is the standard error (measure of variation) for the coefficient. The IRR incident rate ratio, is the relative change in the response relative to the reference level. Bold variables are those with statistically significant effects ( $p < 0.05$ ).

### A2.4. Conclusions

- A2.4.1. These analyses indicate strong seasonal changes in bat activity within all of the bat species and species groups recorded in this project at Sizewell C. Seasonal patterns varied across the species groups investigated. Bat activity was highest in season one for Barbastelle, Nathusius' pipistrelle, pipistrelle group, and highest in S2 for Myotis sp. group and Big bat species group. Seasonal patterns for all bat species together, were heavily influenced by the fact that the overwhelming majority of bat detections was pipistrelle species, such that all bat activity results primarily reflect pipistrelle species activity.
- A2.4.2. Comparisons between analyses on total bat passes and bat pass rate (bats per hour), indicated that significant seasonal differences in bat activity are apparent even when variation in potential observation time (night length) related to time of year are accounted for. However, the exact differences between seasons differed for some species when comparing total bat passes to bat pass rate. Specifically, the biggest disparities in the seasonal changes in total bat passes and bat pass rate were related to S3. This is likely to be a result of the interaction between nightly bat activity levels and the longer night length in this season.
- A2.4.3. Minimum nightly temperature was found to be positively related to bat activity in five out of the six species groups, such that bats were more active on warmer nights. Within seasons, nightly variations in weather will therefore further influence bat activity recorded.

## A3. DESCRIPTIVE STATISTICS BY MS

### A3.1. Box plots and histograms

- A3.1.1. Boxplots and histograms, as described in Section 3.3, follow overleaf for each of the species/species groups analysed in more detail. Note that the boxplots each use different scales, reflecting the levels of activity recorded. They are presented in the following order:
- Barbastelle: 2013 – Boxplot; 75<sup>th</sup> percentile analysis; 90<sup>th</sup> percentile analysis; replicated for 2014
  - 'Big bats': as barbastelle, but the boxplots are displayed at two scales
  - *Myotis* species: as barbastelle.

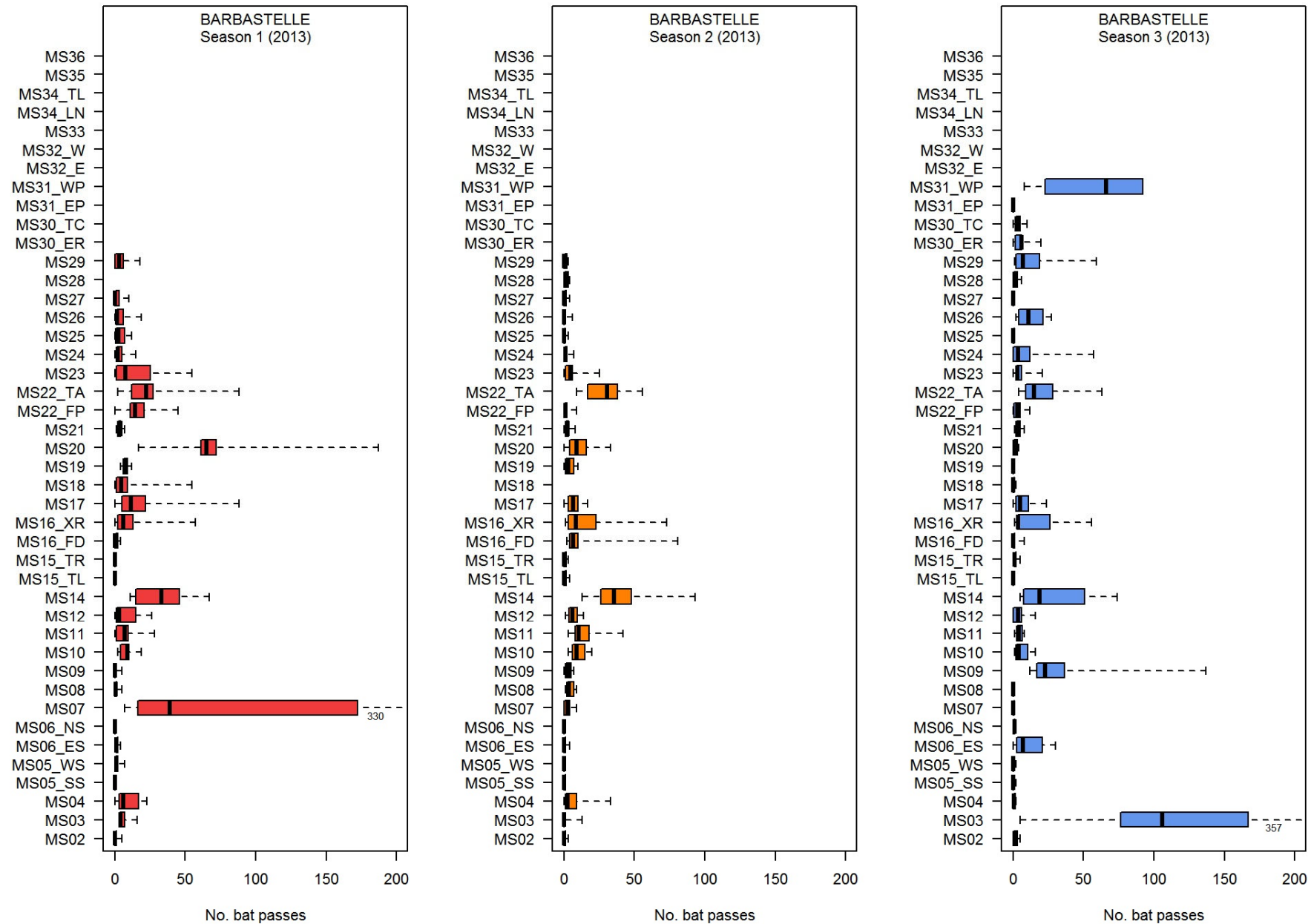
A3.1.2. Note that the boxplots and percentile analyses do not take into account nights where monitoring was unsuccessful or terminated early. Thus: all MSs are displayed on all graphs whether operational or not in any year/season, and the maximum number of nights on which activity exceeded the 75<sup>th</sup> or 90<sup>th</sup> percentiles is limited to the number of nights on which each machine was functioning correctly. The number of functional nights for each MS in each year/season is set out in Annex A1.1.

**Figure 7 follows (in 20 parts)**

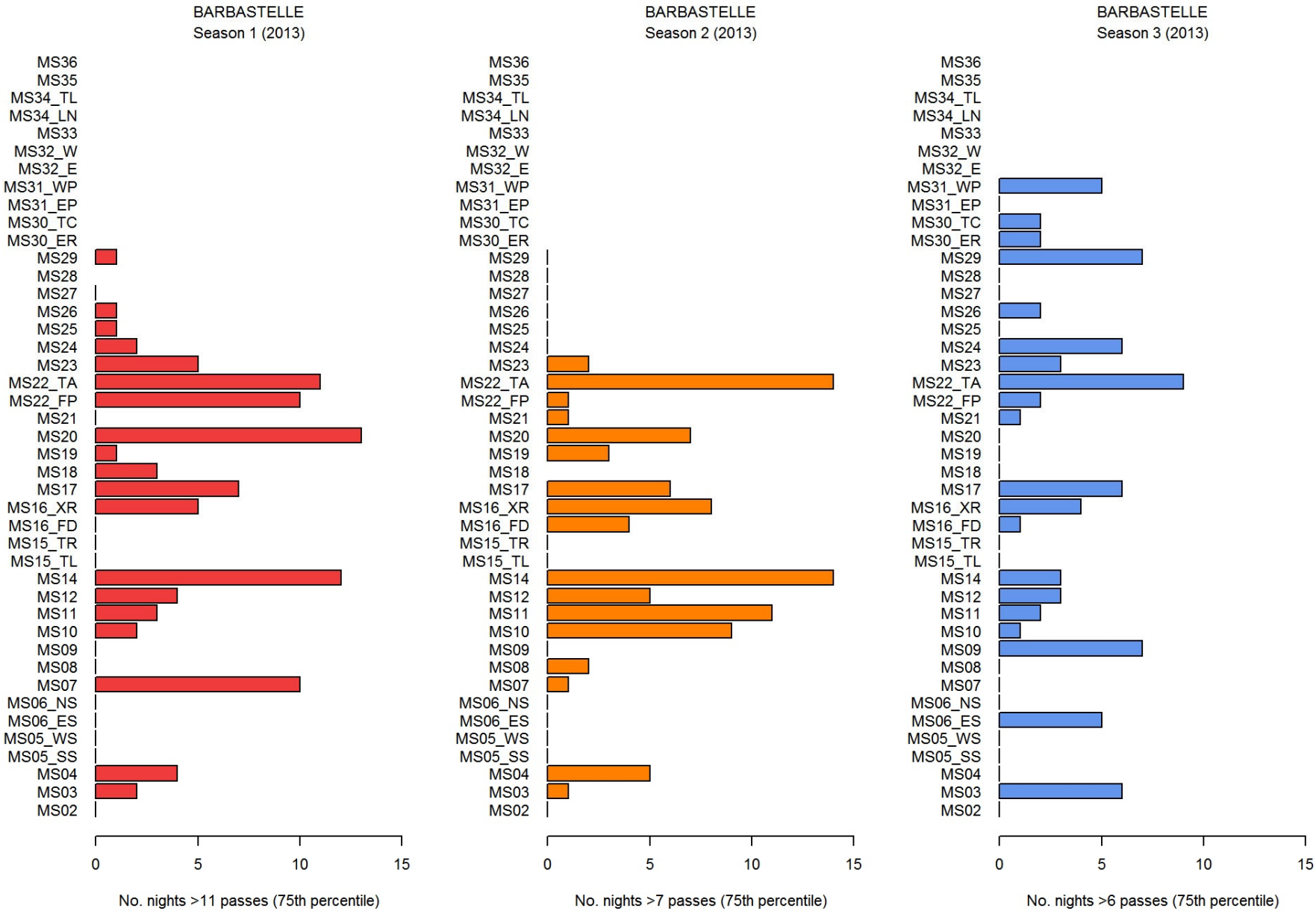
DRAFT



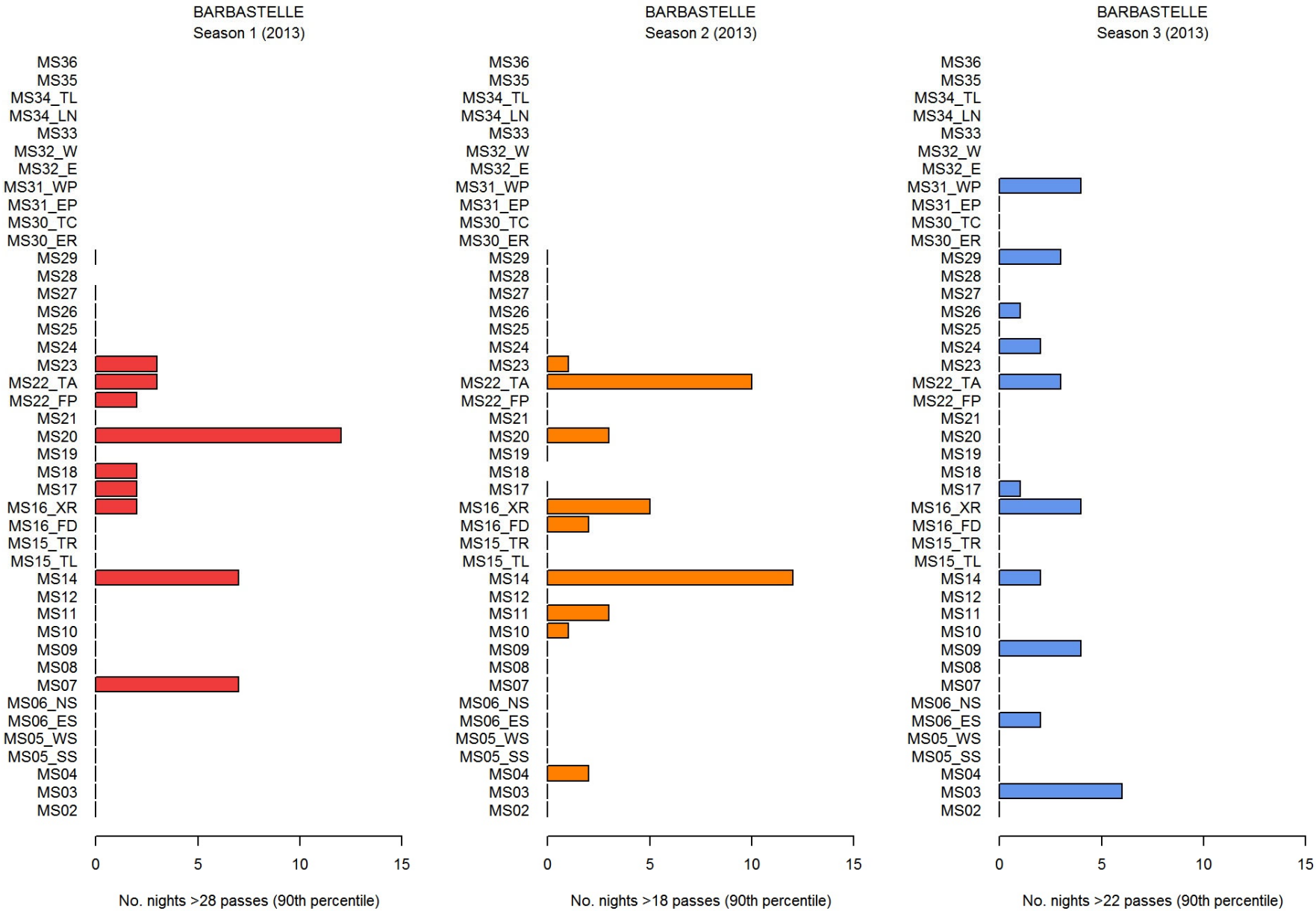
A3: DESCRIPTIVE STATISTICS BY MS



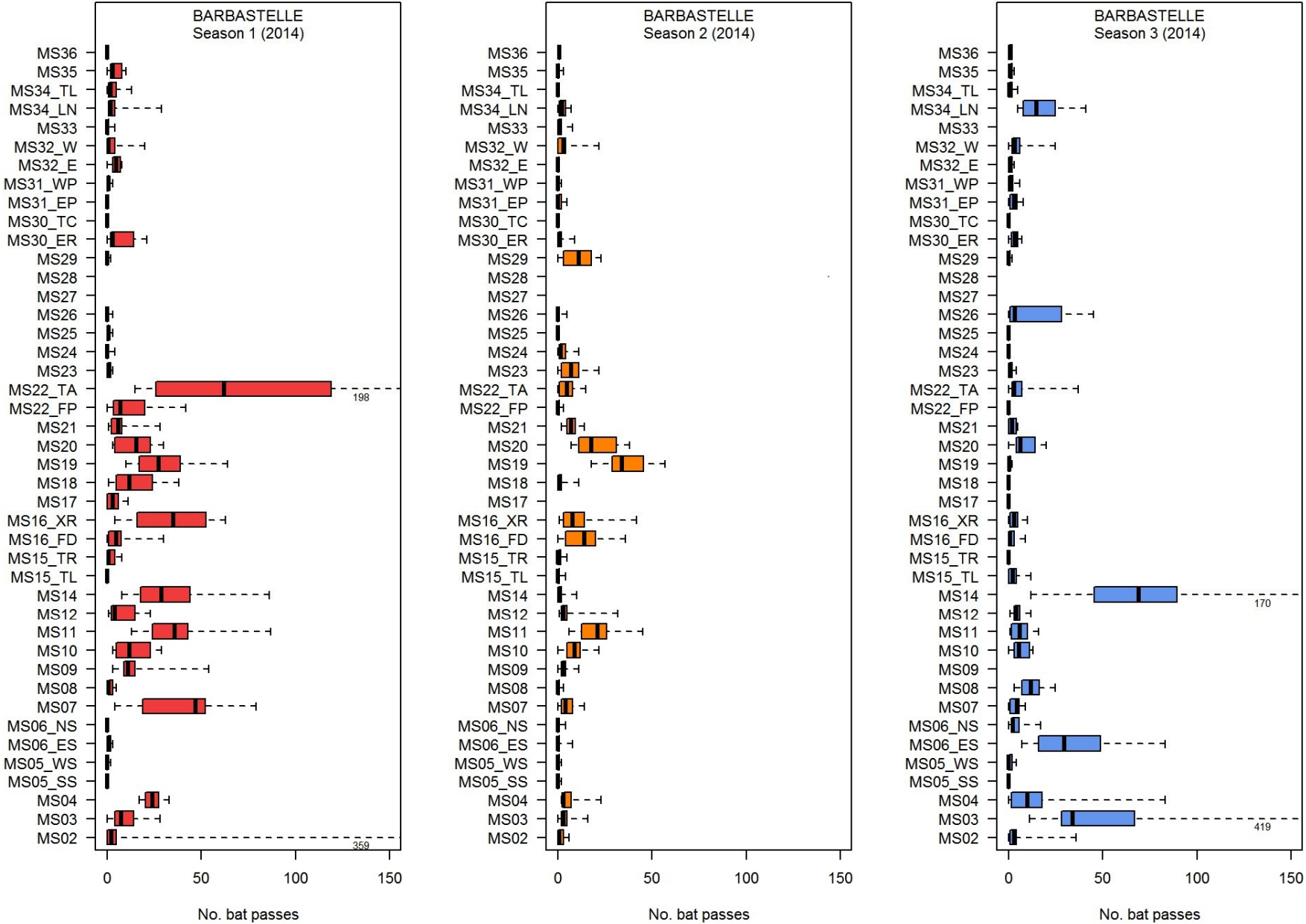
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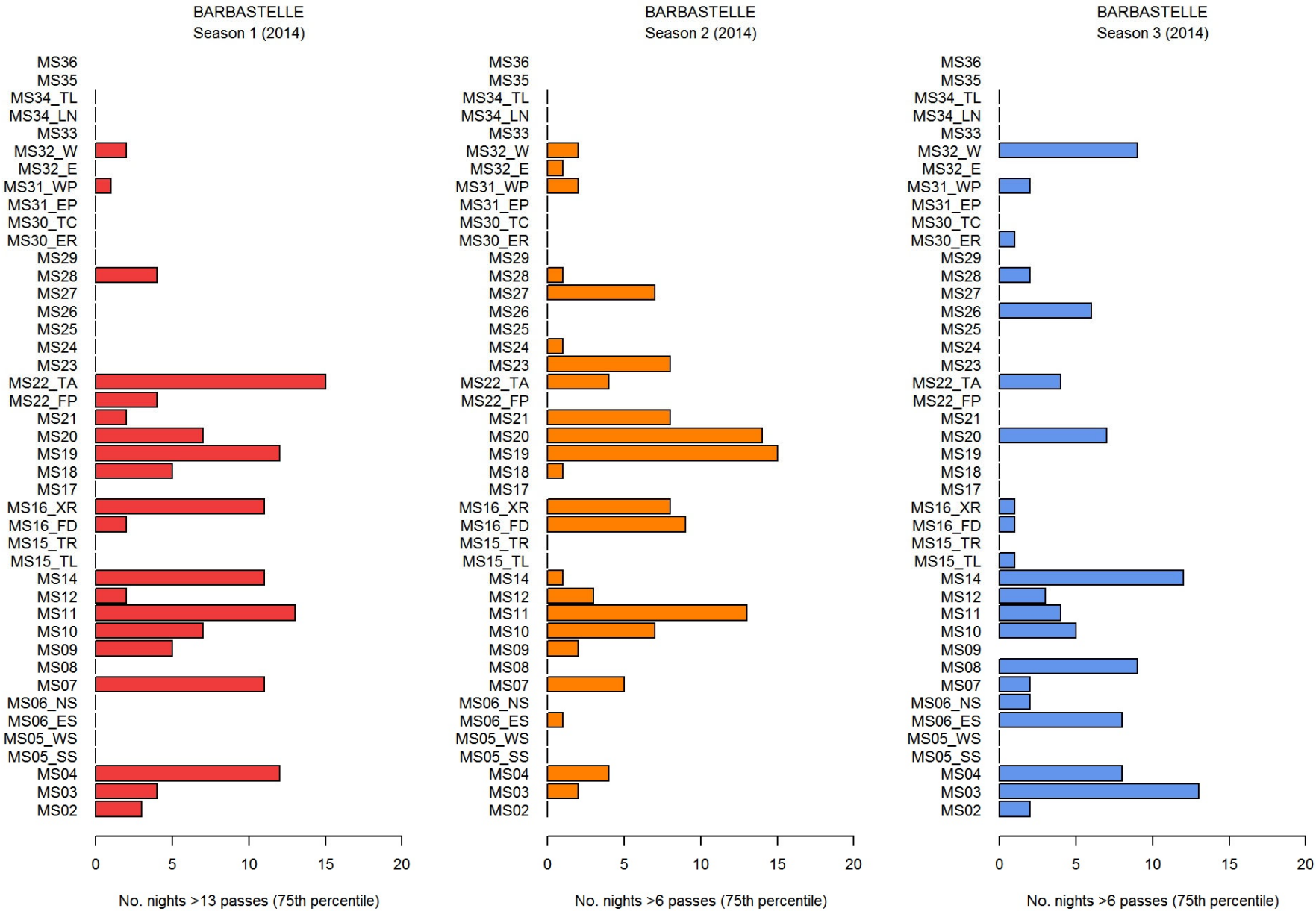
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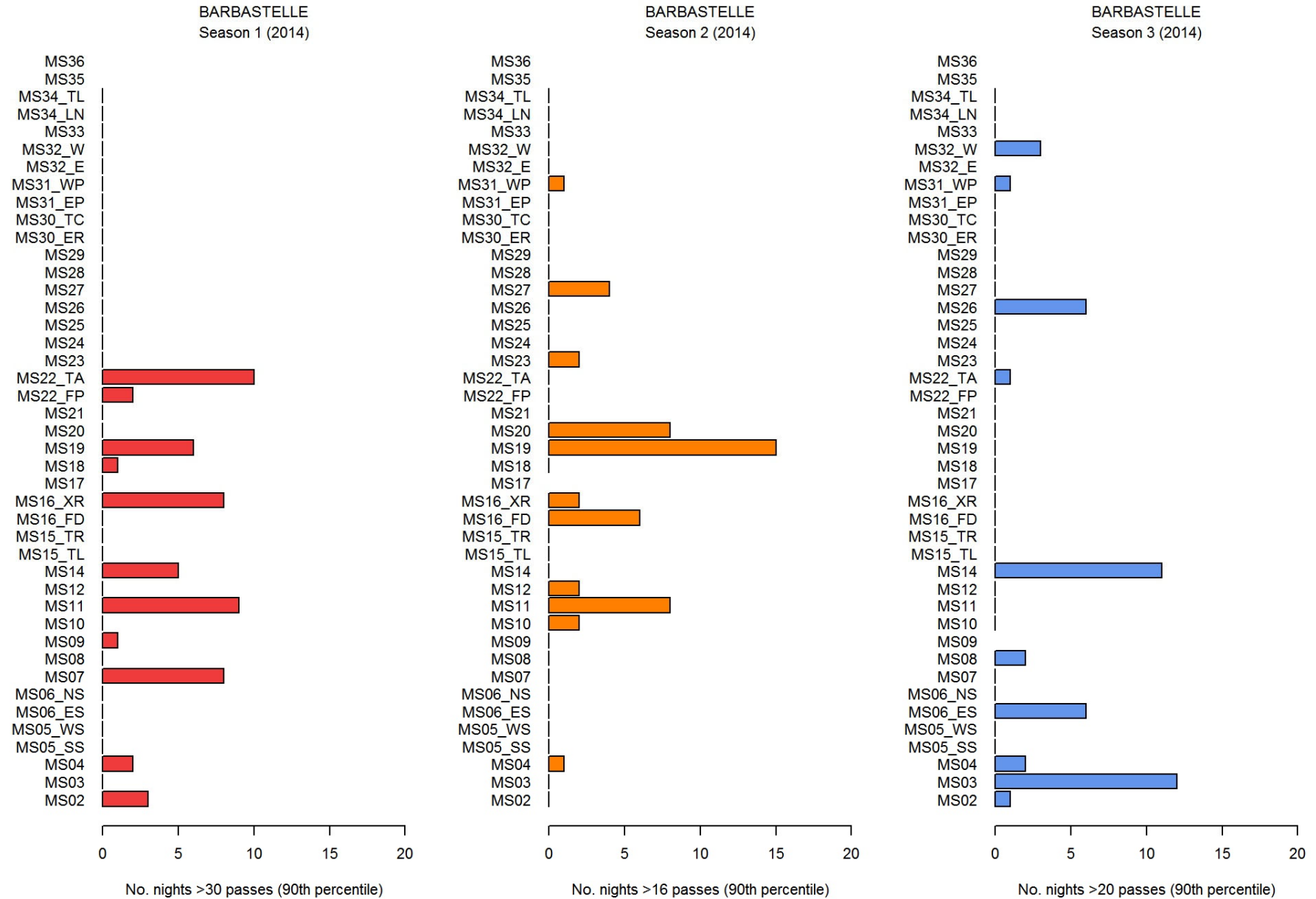
A3: DESCRIPTIVE STATISTICS BY MS



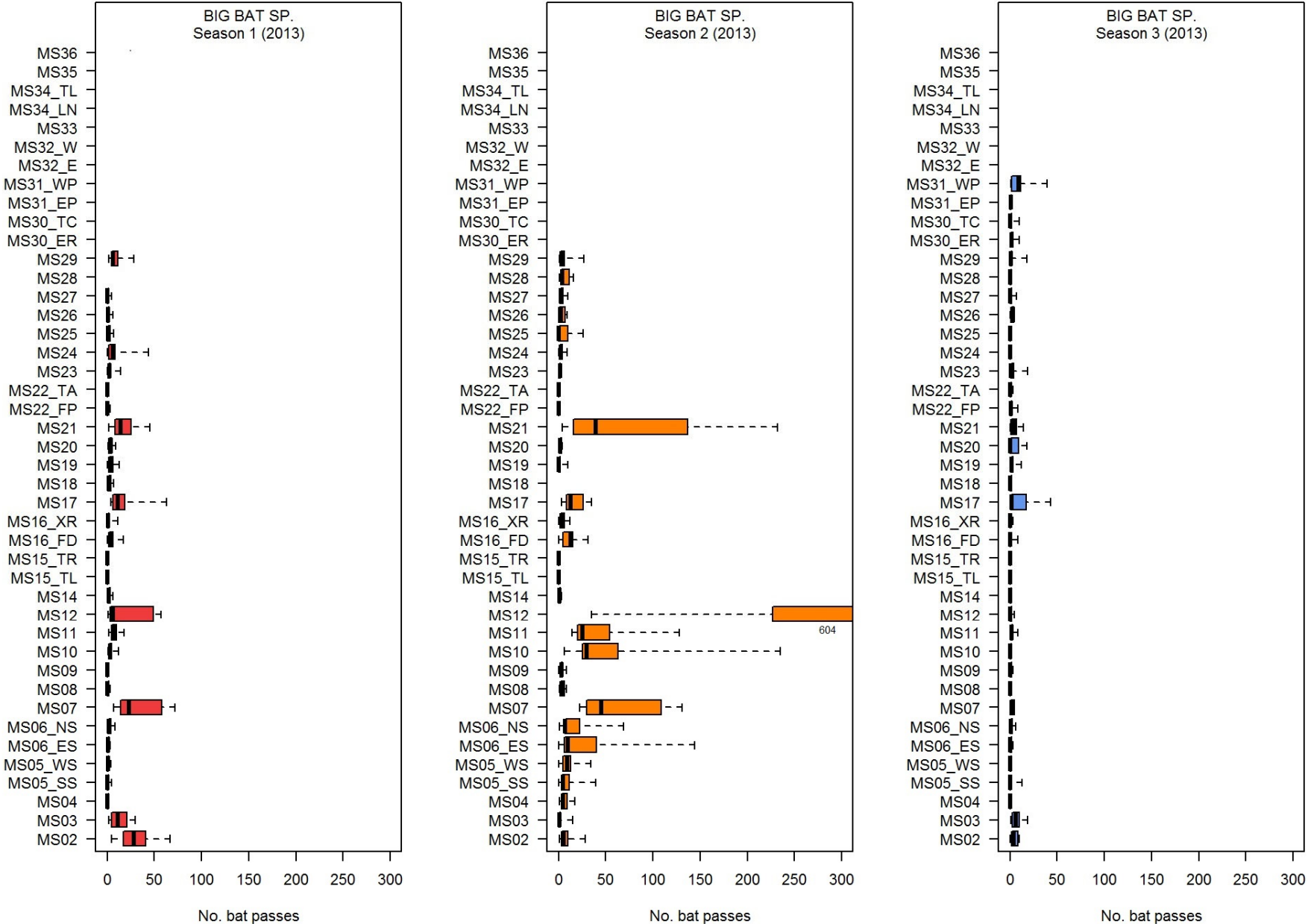
A3: DESCRIPTIVE STATISTICS BY MS



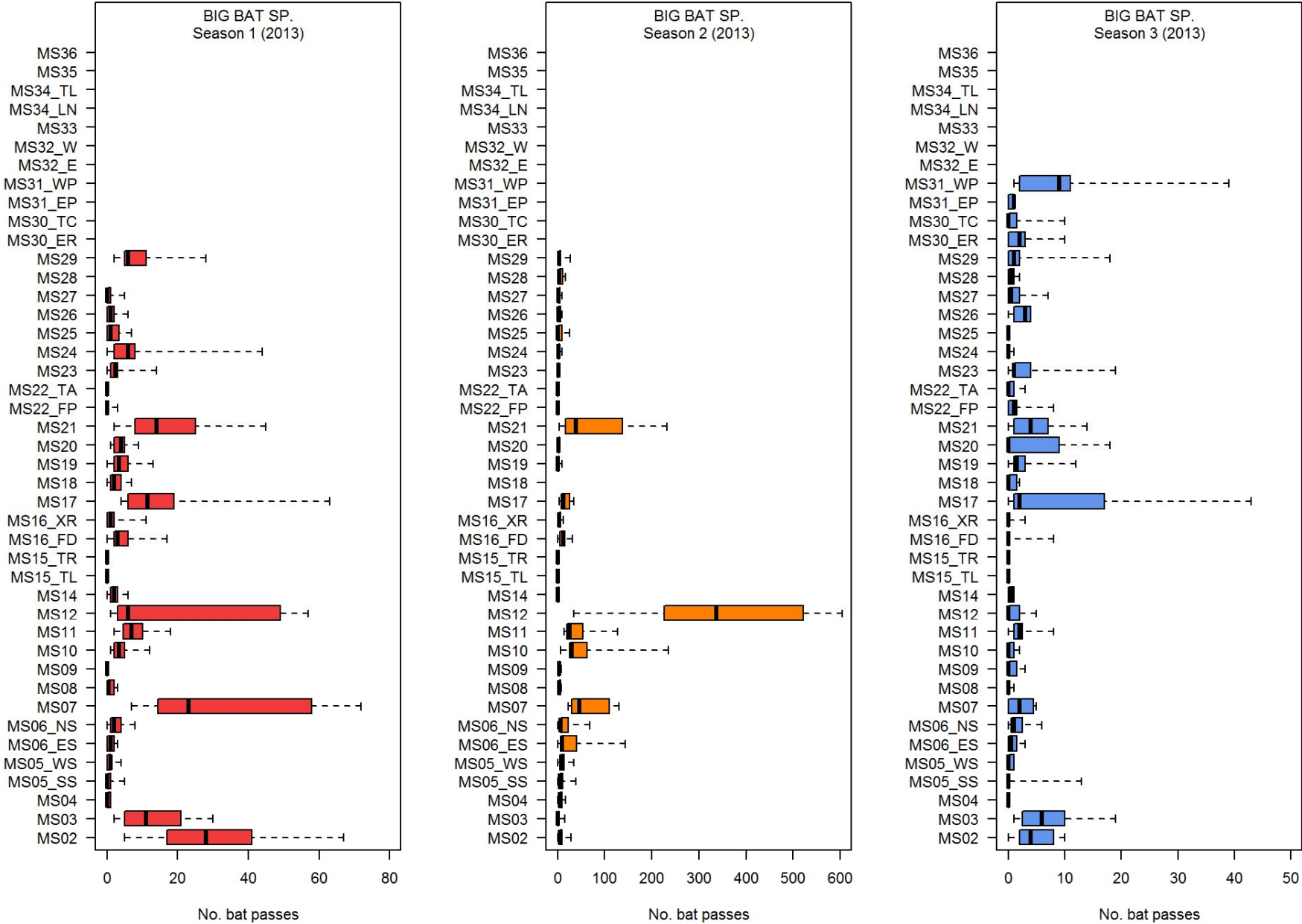
A3: DESCRIPTIVE STATISTICS BY MS



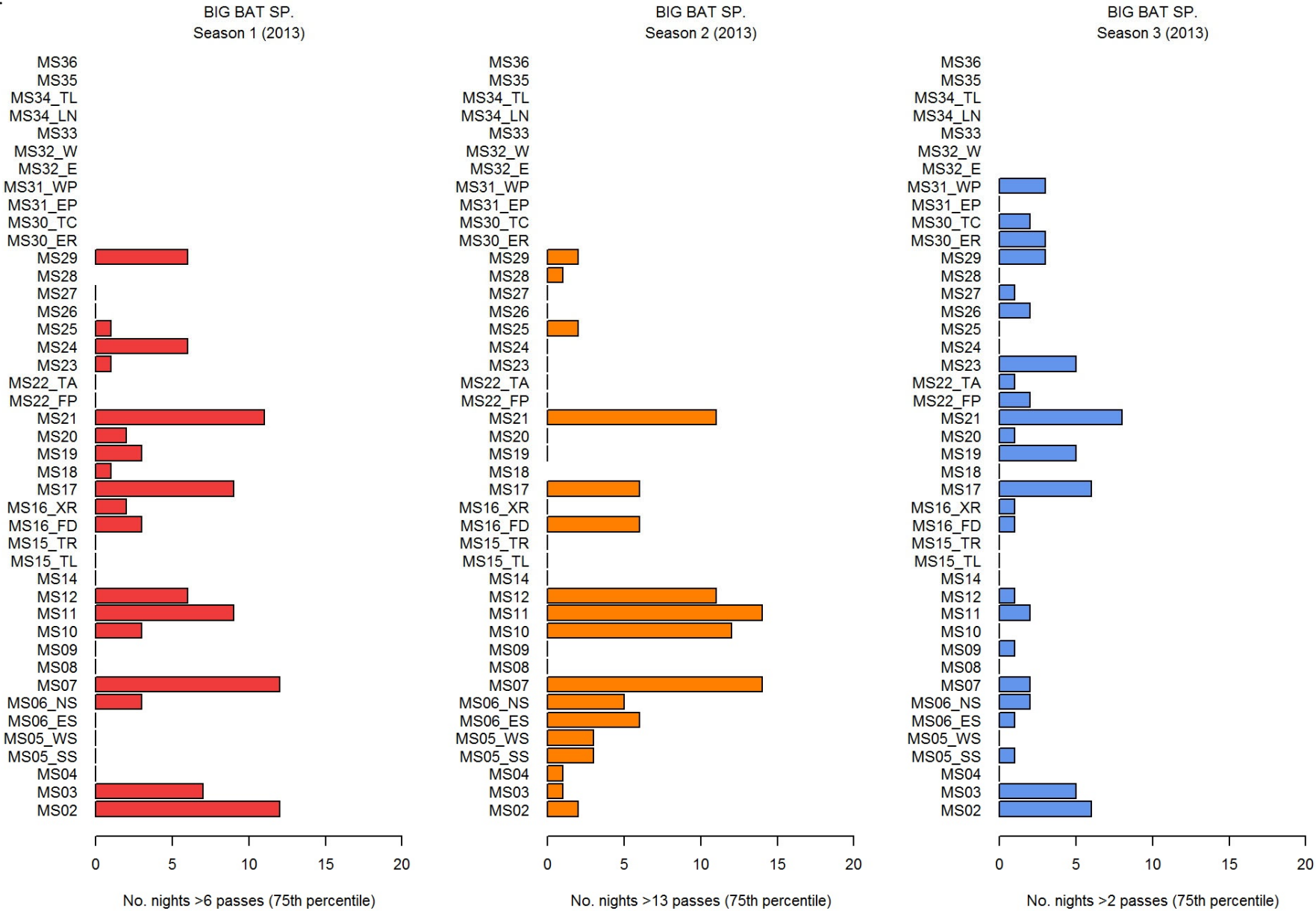
A3: DESCRIPTIVE STATISTICS BY MS



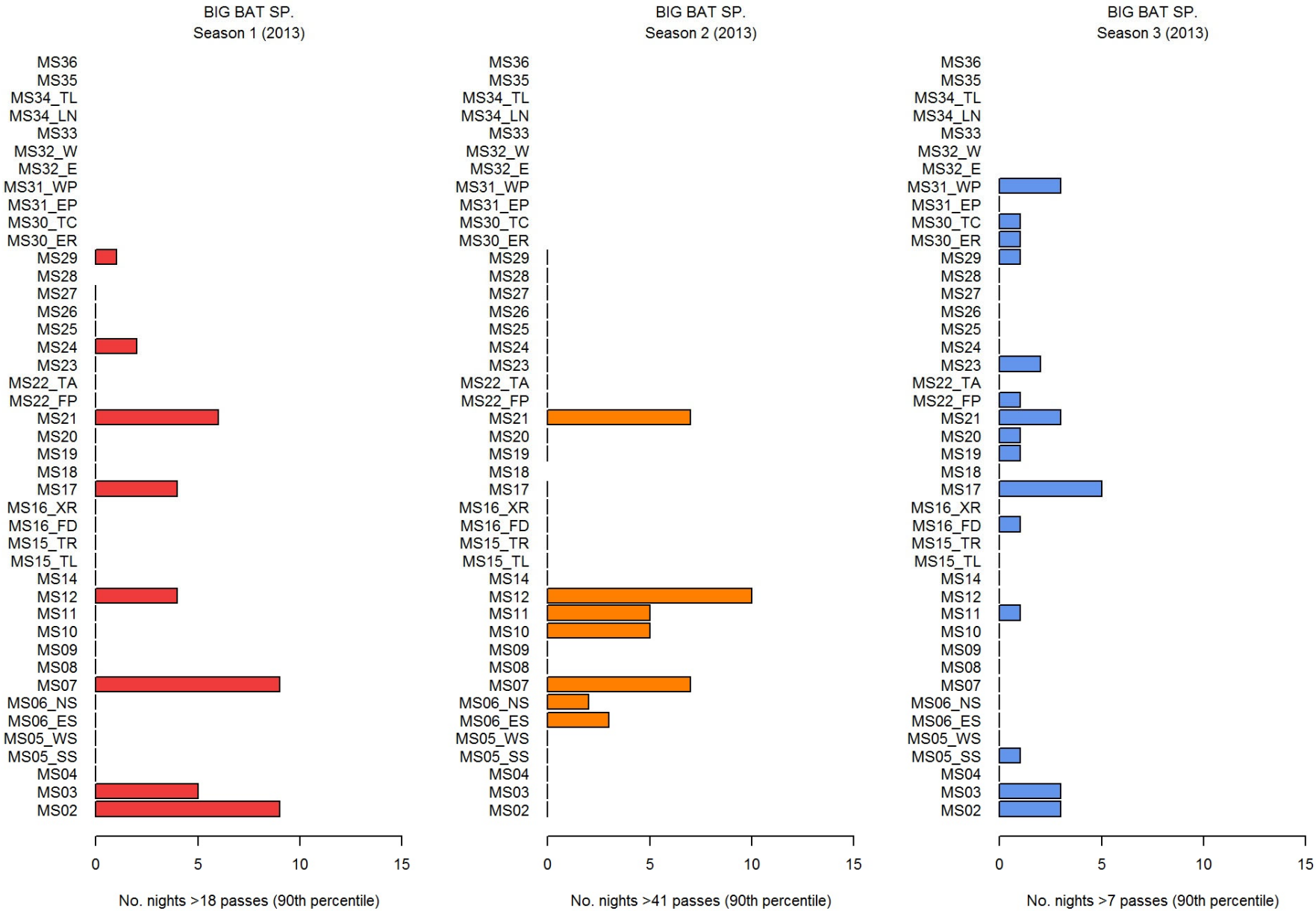
A3: DESCRIPTIVE STATISTICS BY MS



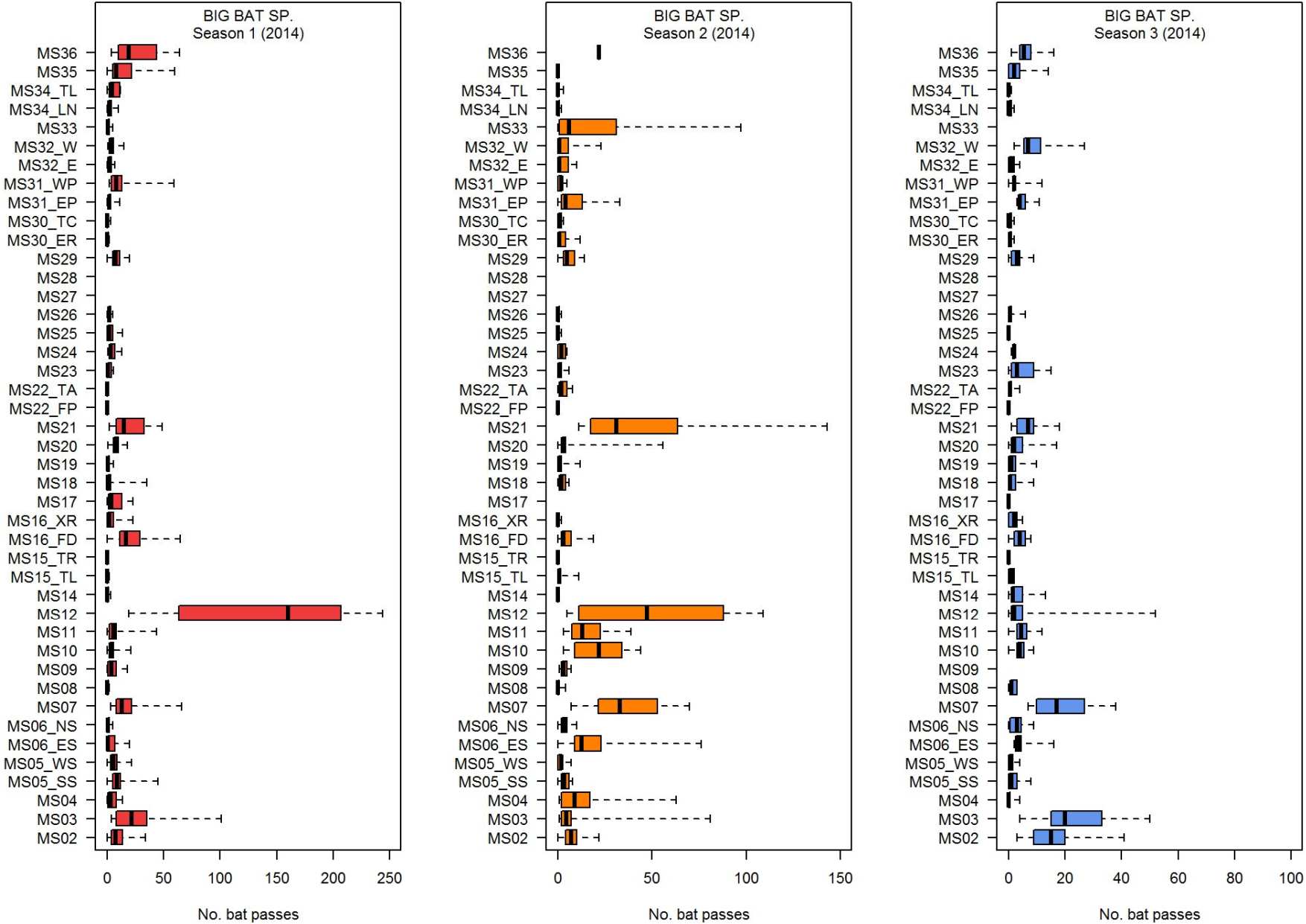
A3: DESCRIPTIVE STATISTICS BY MS



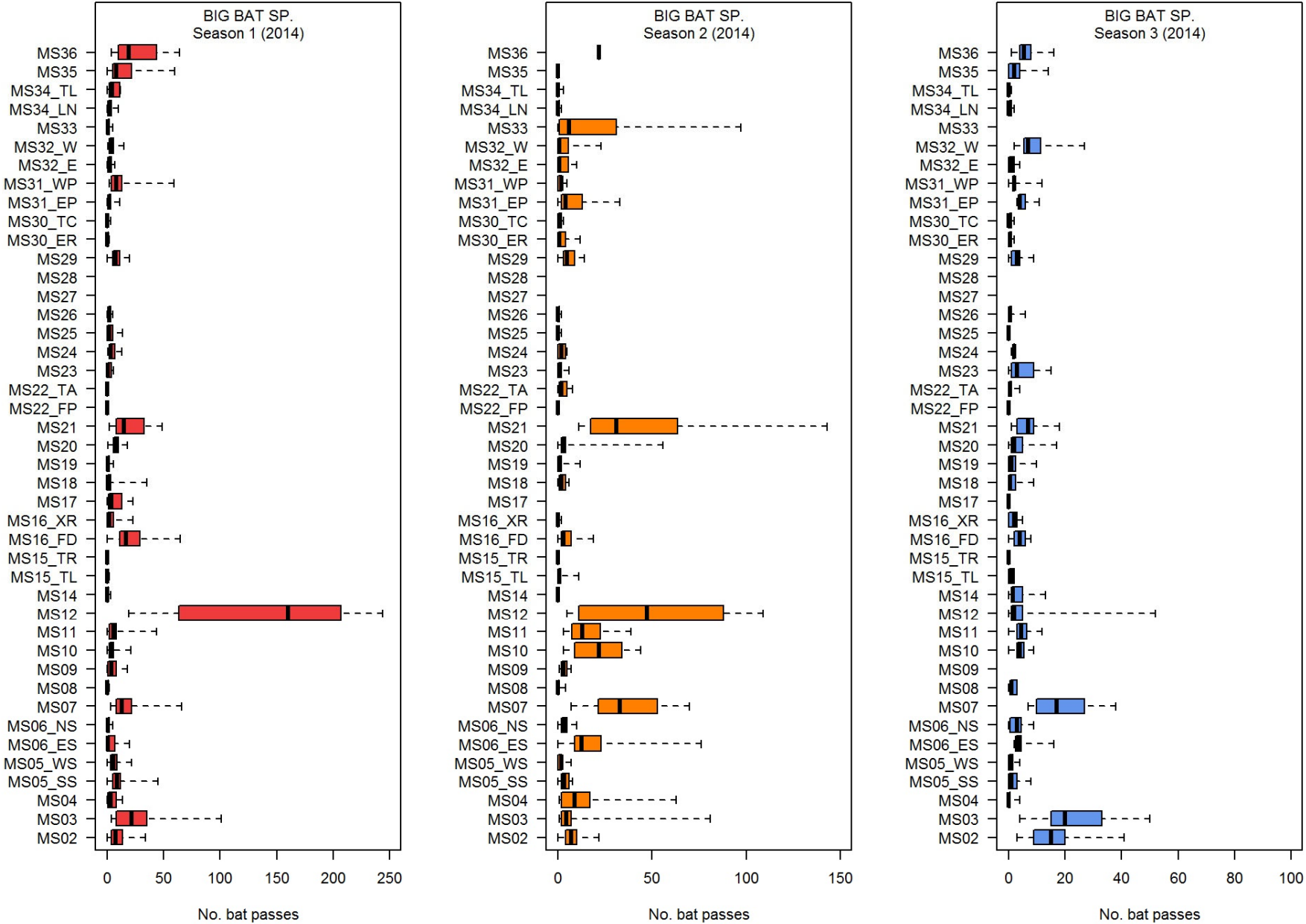
A3: DESCRIPTIVE STATISTICS BY MS



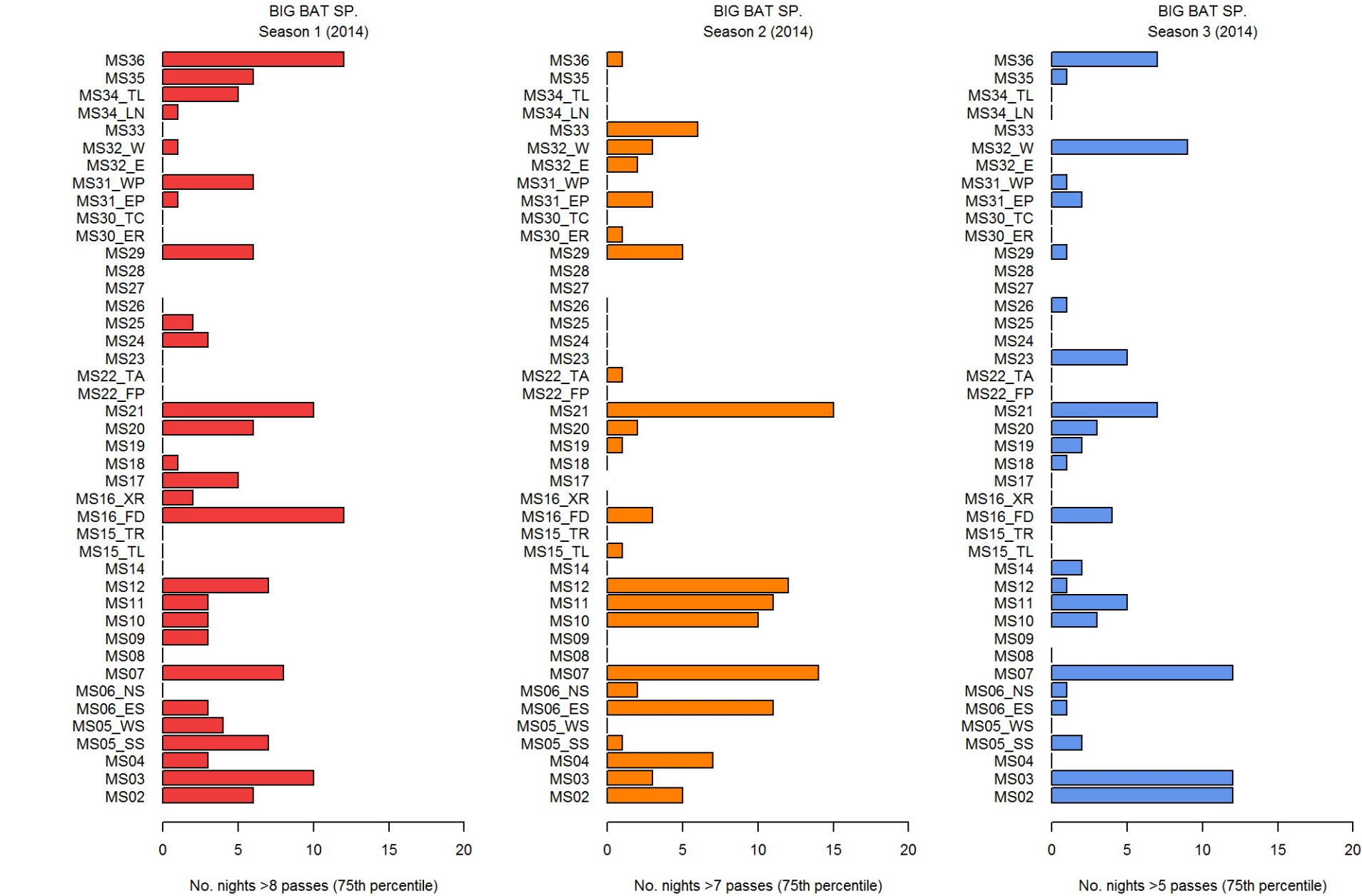
A3: DESCRIPTIVE STATISTICS BY MS



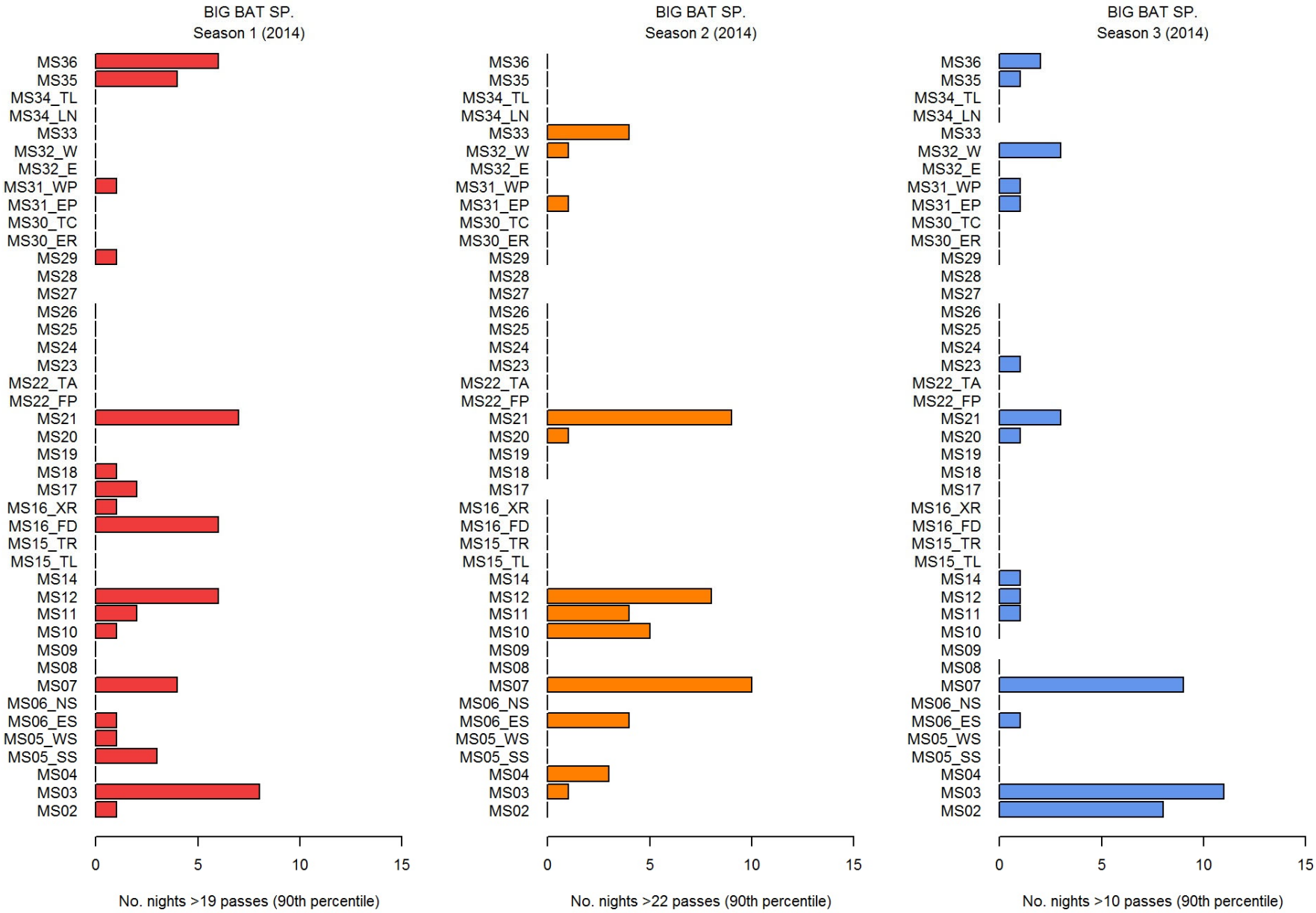
A3: DESCRIPTIVE STATISTICS BY MS



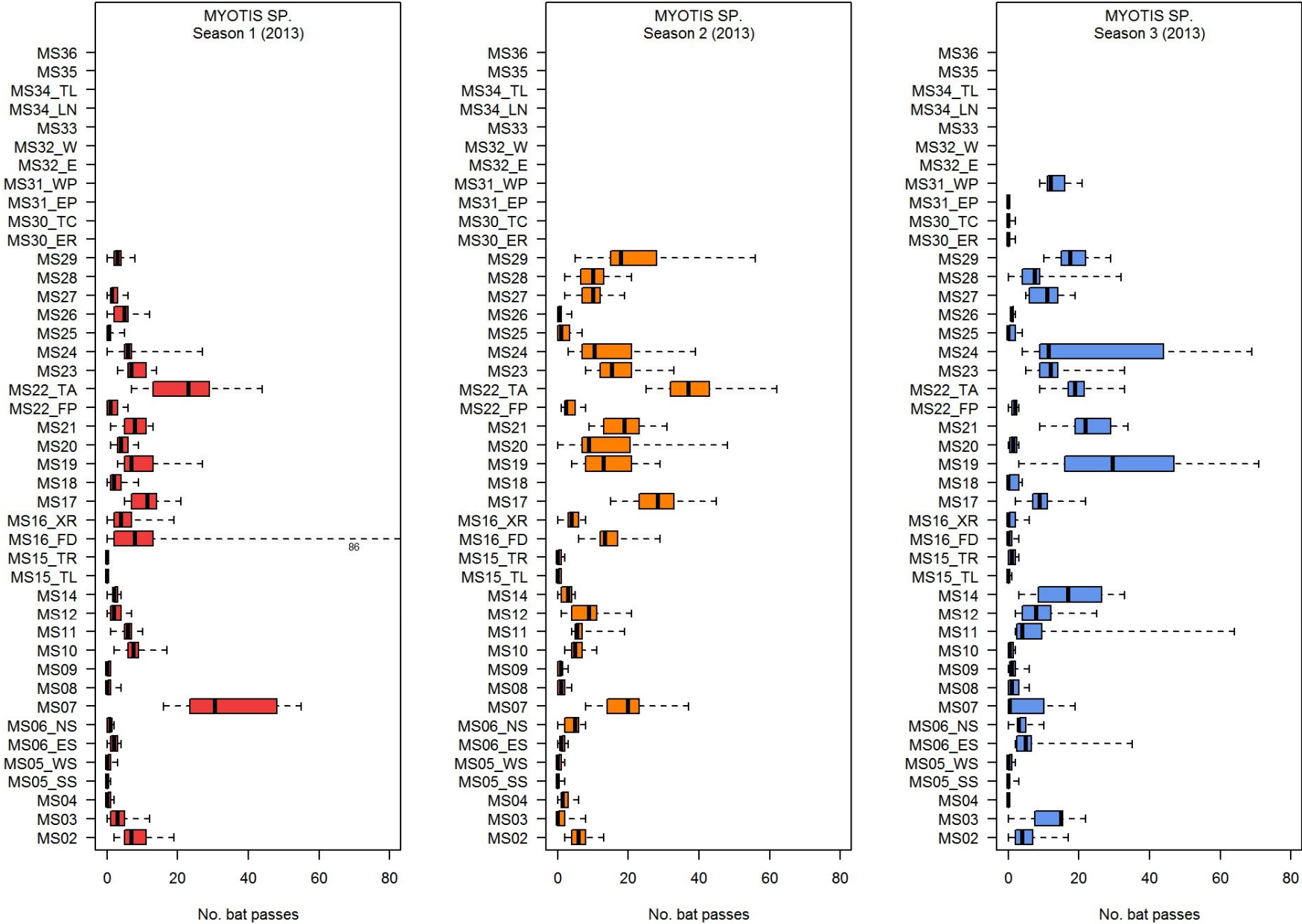
A3: DESCRIPTIVE STATISTICS BY MS



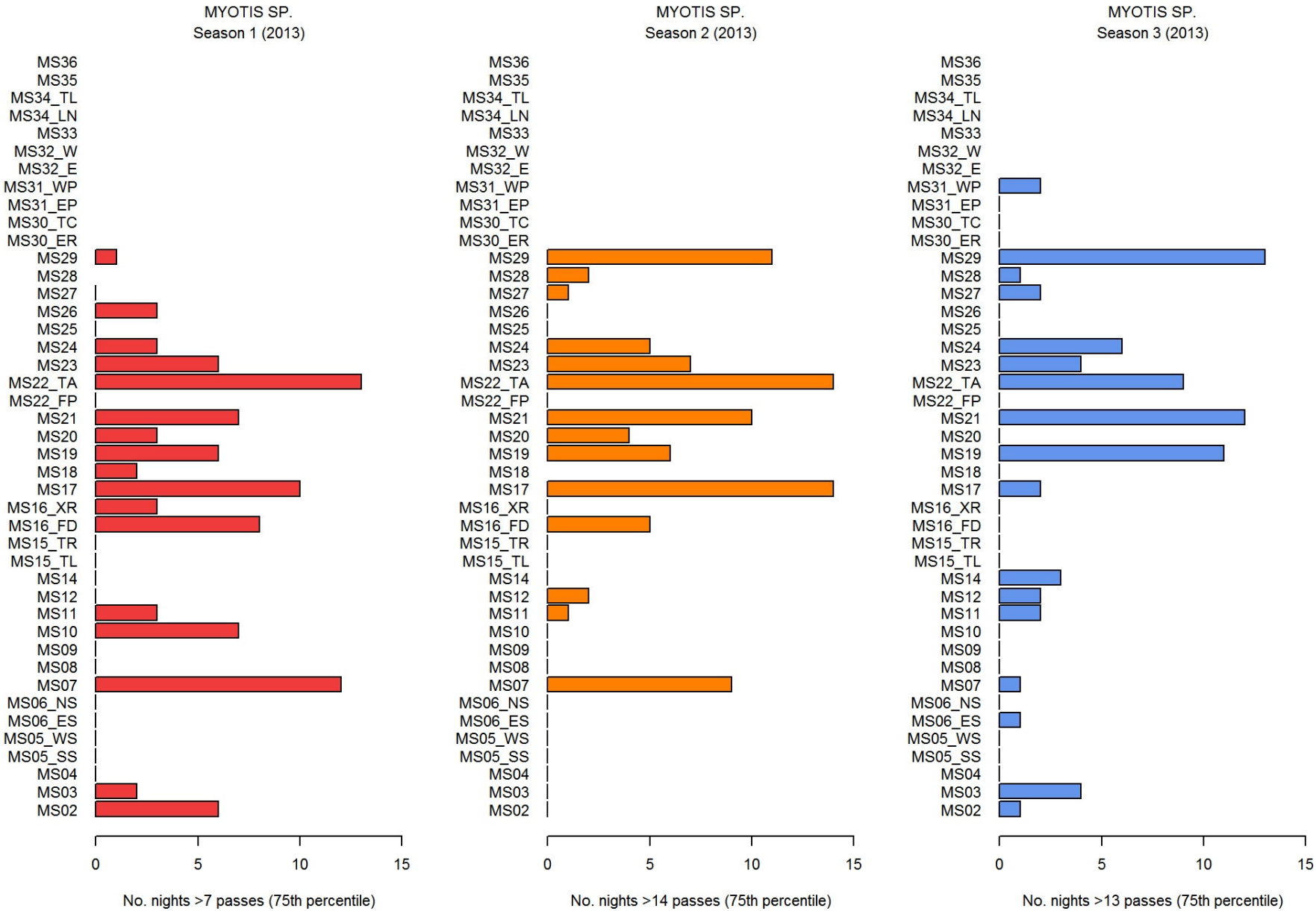
A3: DESCRIPTIVE STATISTICS BY MS



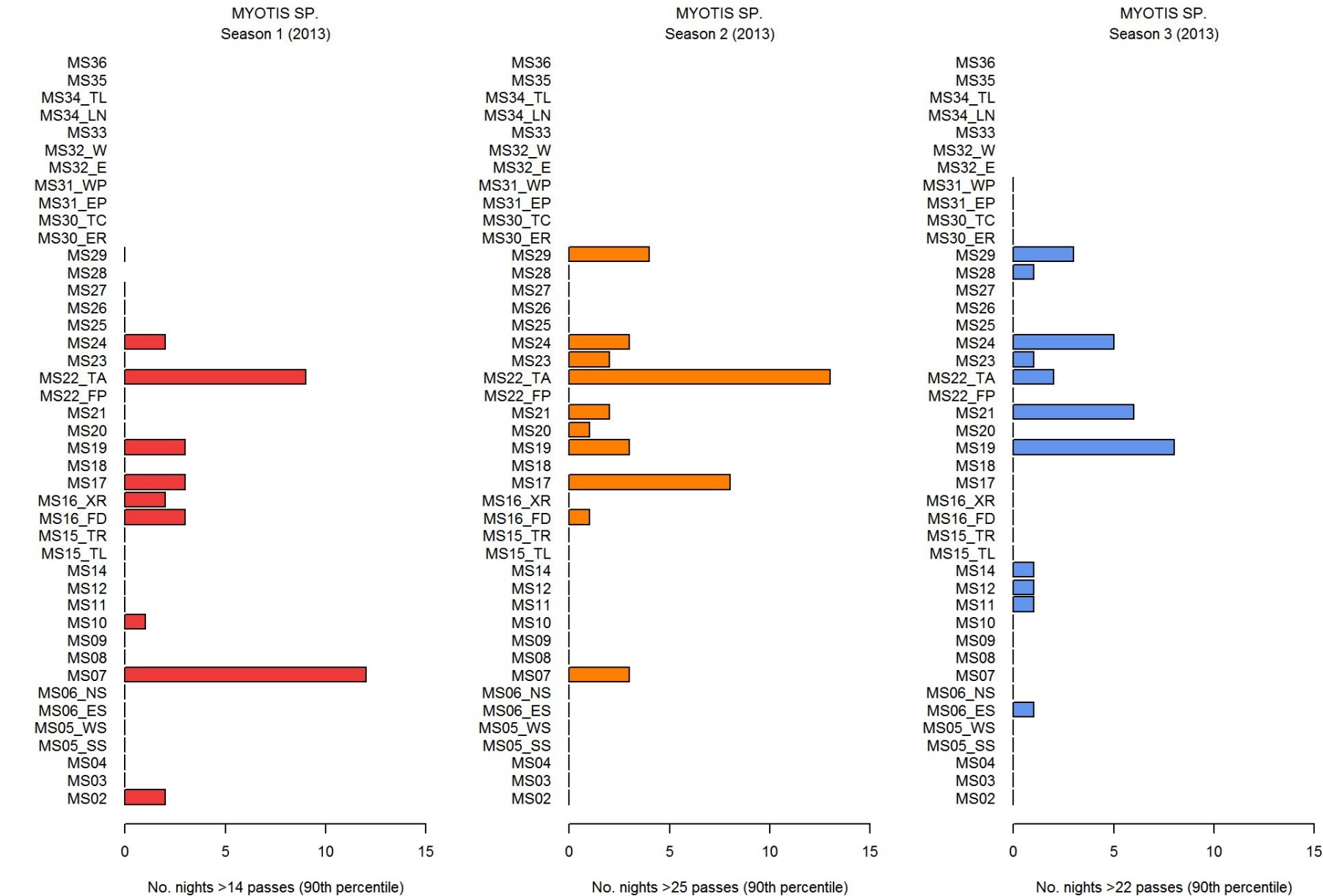
A3: DESCRIPTIVE STATISTICS BY MS



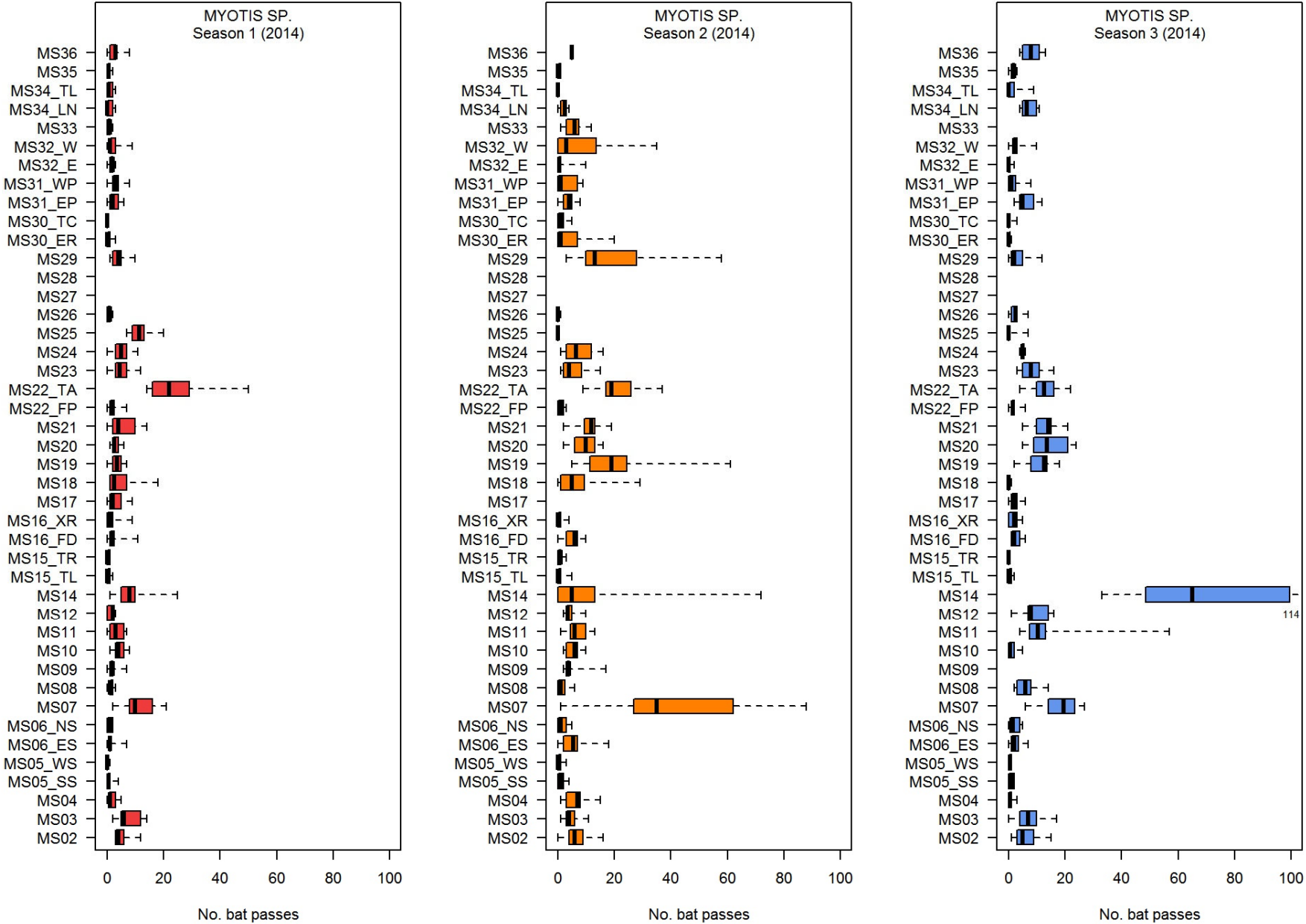
A3: DESCRIPTIVE STATISTICS BY MS



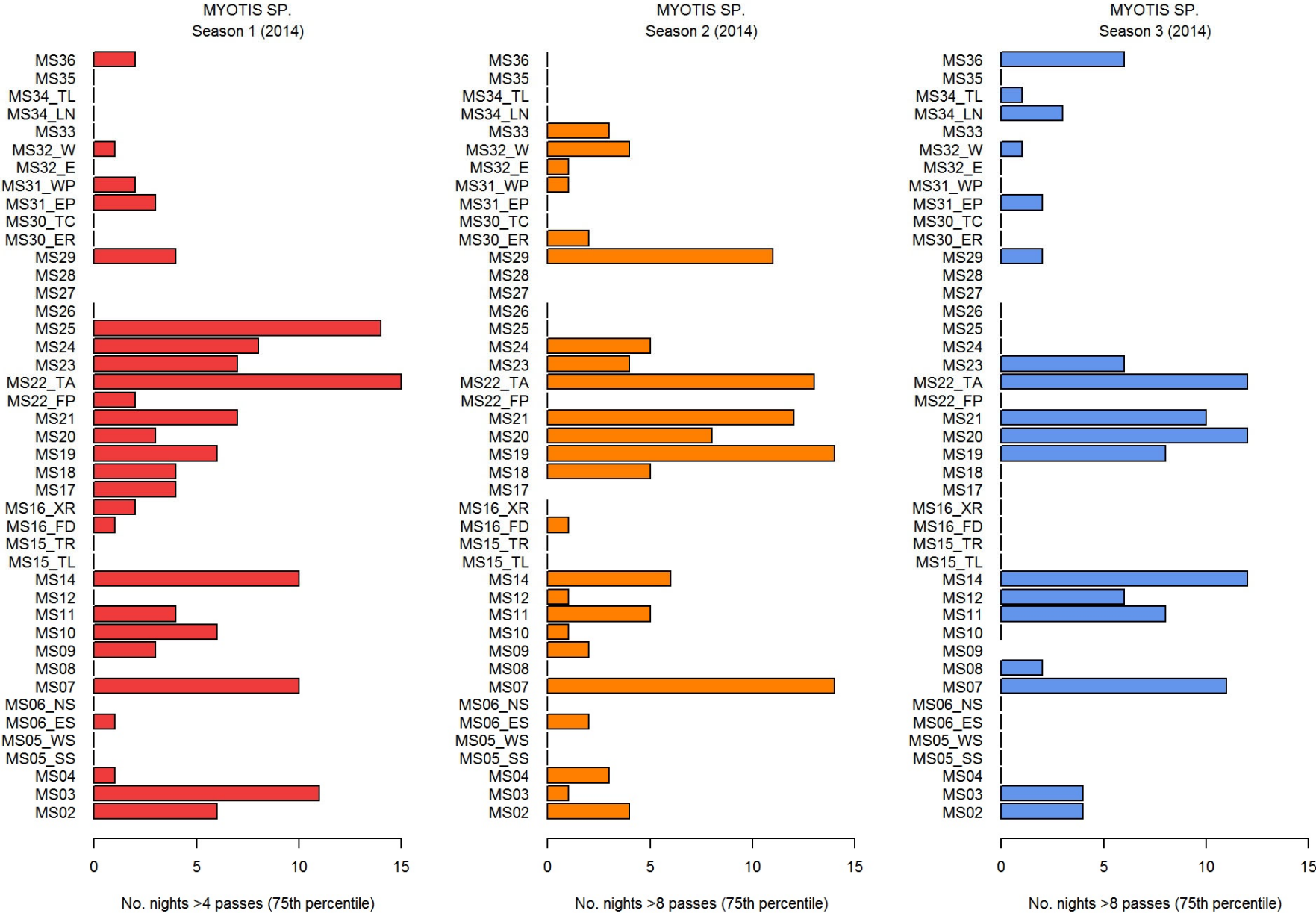
A3: DESCRIPTIVE STATISTICS BY MS



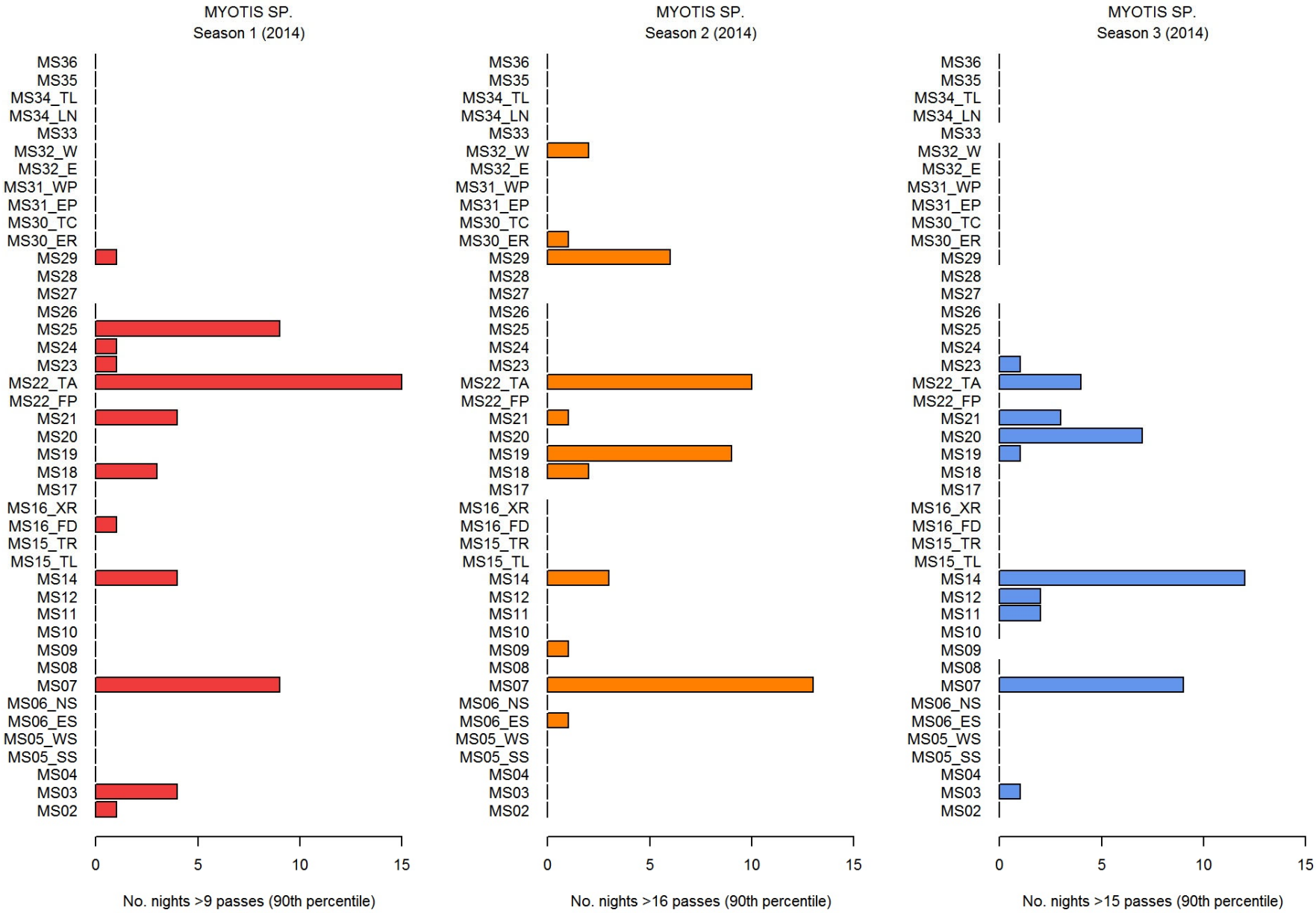
A3: DESCRIPTIVE STATISTICS BY MS



A3: DESCRIPTIVE STATISTICS BY MS



A3: DESCRIPTIVE STATISTICS BY MS



## A3: DESCRIPTIVE STATISTICS BY MS

### A3.2. Time-code descriptive statistics by MS

- A3.2.1. For a number of species/species groups, the data from all seasons and both years was combined by MS, and the proportion of passes for that monitoring station that occurred in TC1-3 (TCs 1-4 for *Myotis*) was calculated.
- A3.2.2. All the data were plotted on scatter-plots (Fig 8 a-e) and the records are set out in Tables 3.1a-e. As there are over 200 'monitoring events' for each species/species group, only records where the number of passes exceeded a threshold (stated for each species/group) are shown within the tables, but all monitoring events are shown on the scatter-plots. Results of note have been incorporated into Section 3.6 above.

Figure 8a – Percentage activity within TCs 0-3 for barbastelle (all monitoring events)

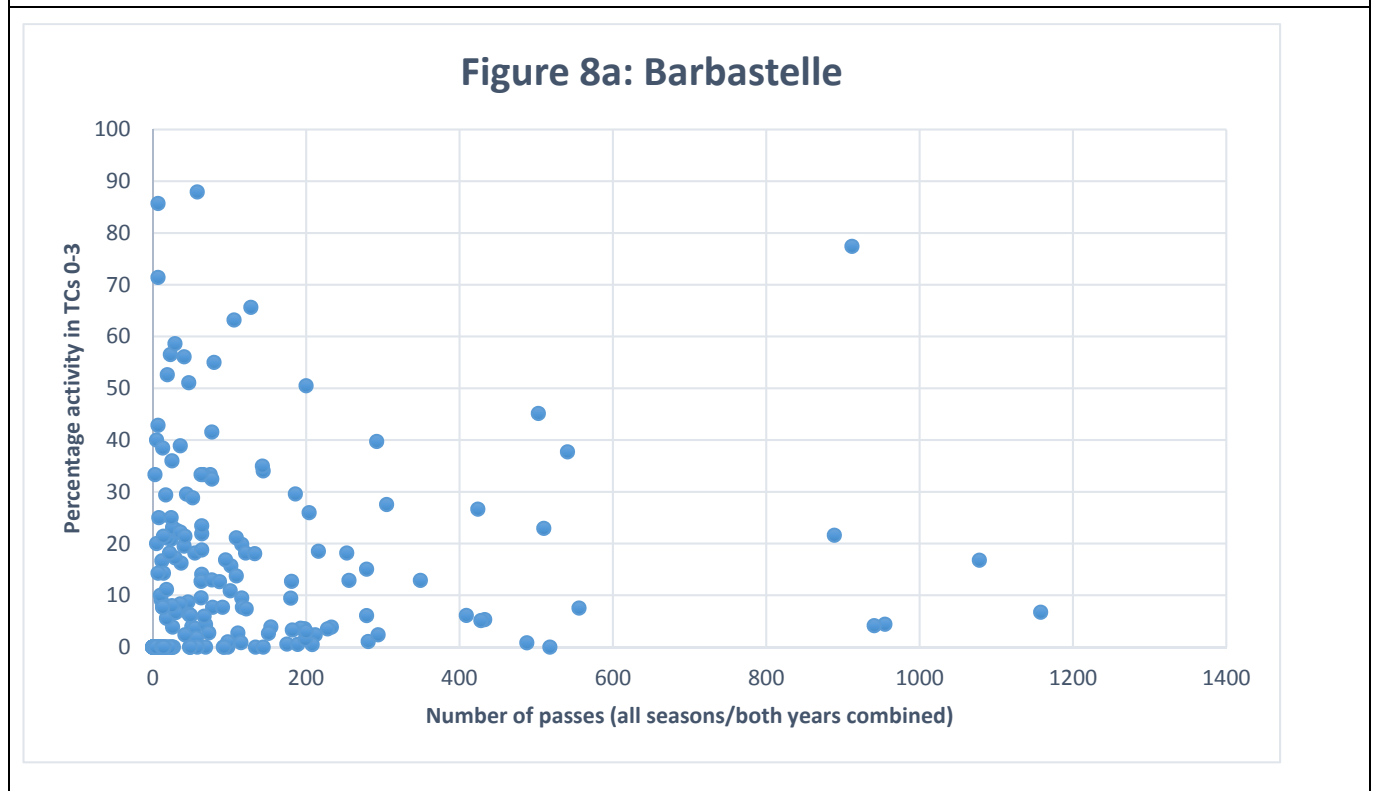


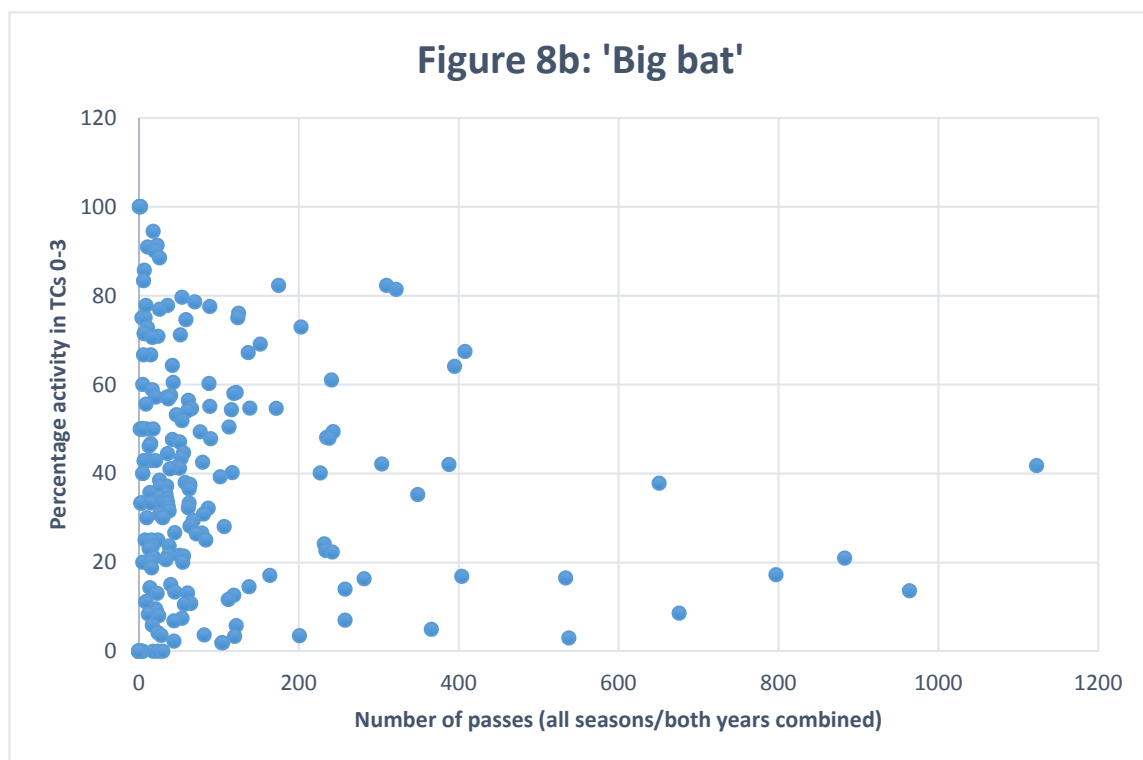
Table A3.1 - a Monitoring events where barbastelle activity exceeded 20 passes in TCs 1-3 (early activity below this threshold was not considered significant).

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2013	1	MS24	51	58	88
2013	1	MS20	706	912	77
2013	2	MS20	84	128	66
2013	1	MS19	67	106	63
2013	3	MS22 FP	23	41	56
2014	3	MS11	44	80	55
2014	3	MS07	24	47	51
2013	1	MS23	101	200	51
2014	1	MS07	227	503	45
2014	3	MS10	32	77	42
2014	2	MS20	116	292	40
2014	2	MS19	204	541	38
2014	2	MS16_XR	50	143	35

### A3: DESCRIPTIVE STATISTICS BY MS

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2013	2	MS10	49	144	34
2013	2	MS12	25	75	33
2013	3	MS12	22	66	33
2014	2	MS22_TA	21	63	33
2014	2	MS07	25	77	32
2013	2	MS11	55	186	30
2014	2	MS11	84	305	28
2014	1	MS19	113	424	27
2014	3	MS04	53	204	26
2014	1	MS11	117	510	23
2014	3	MS14	192	889	22
2014	2	MS23	23	109	21
2013	1	MS04	23	116	20
2014	1	MS20	40	216	19
2013	1	MS10	22	121	18
2014	2	MS29	24	133	18
2013	3	MS22_TA	46	253	18
2013	1	MS07	181	1078	17
2014	3	MS06_ES	42	279	15
2013	1	MS22_TA	45	349	13
2013	1	MS17	33	256	13
2014	3	MS34_LN	23	181	13
2013	2	MS14	42	556	8
2014	1	MS22_TA	78	1158	7
2014	1	MS14	25	409	6
2013	1	MS14	23	433	5

Figure 8b – Percentage activity within TCs 0-3 for 'big bats' (all monitoring events bar one). Note that the data point for MS12 2013 S2 has not been plotted as it would compress all the other data points. Only 8% of passes were recorded in TCs 1-3 for this monitoring event.



### A3: DESCRIPTIVE STATISTICS BY MS

Table A3.1 – b. Monitoring events where ‘big bat’ passes exceeded 30 passes in TCs 0-3 (the threshold was set a little higher for ‘big bats’ than for barbastelle because of the large number of monitoring events with early activity).

This exercise was repeated separately for bat passes labelled specifically as ‘serotine’ but only seven monitoring events recorded activity in TC0-3 (four of these at MS21). Activity in these early TCs ranged from 1-11 passes and are therefore not plotted separately (they are included in the ‘big bat’ plot above).

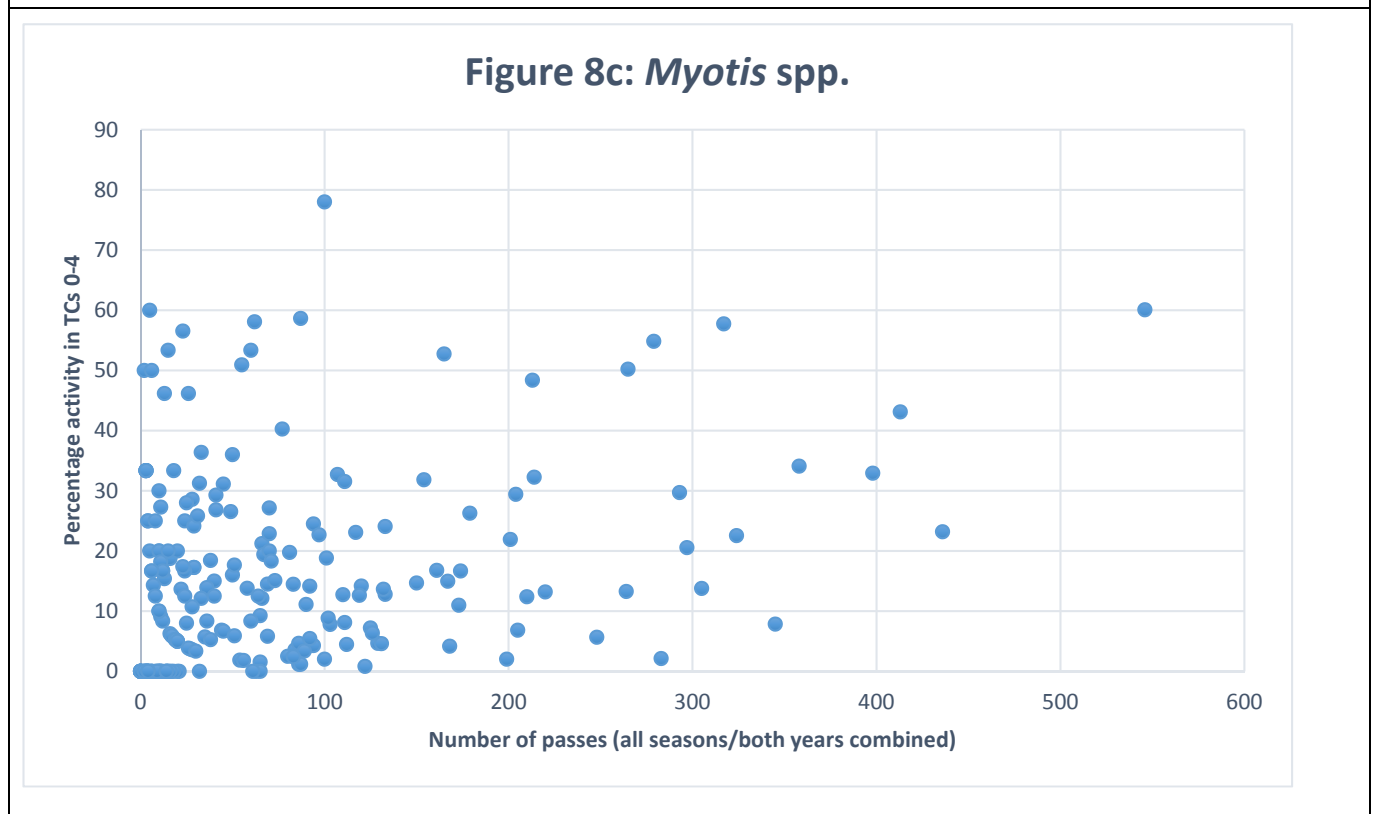
Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2014	1	MS05_SS	144	175	82
2014	3	MS03	255	310	82
2014	1	MS21	262	322	81
2013	3	MS23	43	54	80
2014	1	MS09	55	70	79
2014	1	MS05_WS	69	89	78
2013	3	MS17	95	125	76
2013	1	MS24	93	124	75
2014	1	MS04	44	59	75
2014	3	MS02	148	203	73
2014	1	MS18	37	52	71
2014	1	MS31_WP	105	152	69
2014	1	MS03	275	408	67
2013	2	MS05_WS	92	137	67
2013	1	MS02	253	395	64
2013	1	MS21	147	241	61
2014	3	MS36	53	88	60
2013	2	MS05_SS	71	122	58
2014	3	MS32_W	69	119	58
2013	3	MS21	35	62	56
2014	3	MS21	49	89	55
2014	1	MS02	76	139	55
2013	1	MS03	94	172	55
2014	3	MS23	36	66	55
2014	1	MS17	63	116	54
2013	1	MS19	33	61	54
2013	1	MS12	120	243	49
2013	2	MS28	38	77	49
2014	1	MS35	113	235	48
2013	1	MS17	114	238	48
2013	2	MS29	43	90	48
2014	1	MS34_TL	34	80	43
2014	2	MS33	128	304	42
2013	1	MS07	163	388	42
2013	2	MS21	469	1123	42
2013	1	MS11	47	117	40
2013	2	MS17	91	227	40
2014	2	MS21	246	651	38

### A3: DESCRIPTIVE STATISTICS BY MS

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2014	1	MS16_FD	123	349	35
2014	3	MS07	56	232	24
2014	1	MS07	53	234	23
2014	2	MS11	54	242	22
2013	2	MS07	185	883	21
2013	2	MS10	137	797	17
2013	2	MS06_ES	68	404	17
2013	2	MS11	88	534	16
2014	2	MS10	46	282	16
2013	2	MS06_NS	36	258	14
2014	1	MS12	131	964	14
2014	2	MS12	58	676	9
2013	2	MS12	316	3856	8

Figure 8c – Percentage activity within TCs 0-4 for *Myotis* (all monitoring events)

Note that two data points have not been plotted to avoid overly compressing the data: MS14 2014 S3 (872 passes; 18% activity in TCs 0-4); MS07 2014 S2 (628 passes; 23% in TCs0-4).



### A3: DESCRIPTIVE STATISTICS BY MS

Table A3.1 – c. Monitoring events where *Myotis* activity exceeded 20 passes in TCs 0-4 (TC4 was included because *Myotis* tend to emerge a little later than other species).

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2013	1	MS21	78	100	78
2013	2	MS22_TA	328	546	60
2014	1	MS21	51	87	59
2013	1	MS20	36	62	58
2013	1	MS22_TA	183	317	58
2014	2	MS22_TA	153	279	55
2014	1	MS10	32	60	53
2014	2	MS21	87	165	53
2013	2	MS06_NS	28	55	51
2013	2	MS21	133	265	50
2013	2	MS19	103	213	48
2013	1	MS07	178	413	43
2013	2	MS10	31	77	40
2014	1	MS22_TA	122	358	34
2013	2	MS17	131	398	33
2013	1	MS10	35	107	33
2013	3	MS22_TA	69	214	32
2013	1	MS17	49	154	32
2013	1	MS23	35	111	32
2013	2	MS07	87	293	30
2013	2	MS23	60	204	29
2014	3	MS22_TA	47	179	26
2013	2	MS02	23	94	24
2013	1	MS19	32	133	24
2014	2	MS07	147	628	23
2013	3	MS19	101	436	23
2014	3	MS36	27	117	23
2013	2	MS11	22	97	23
2014	2	MS19	73	324	23
2013	2	MS16_FD	44	201	22
2013	2	MS29	61	297	21
2014	3	MS14	153	872	18
2013	2	MS20	27	161	17
2014	3	MS21	29	174	17
2014	2	MS14	25	167	15
2014	1	MS07	22	150	15
2013	3	MS21	42	305	14
2013	3	MS29	35	264	13
2014	3	MS07	29	220	13
2013	2	MS24	26	210	12
2013	3	MS24	27	345	8

Figure 8d – Percentage activity within TCs 0-3 for Nathusius' pipistrelle (all monitoring events)

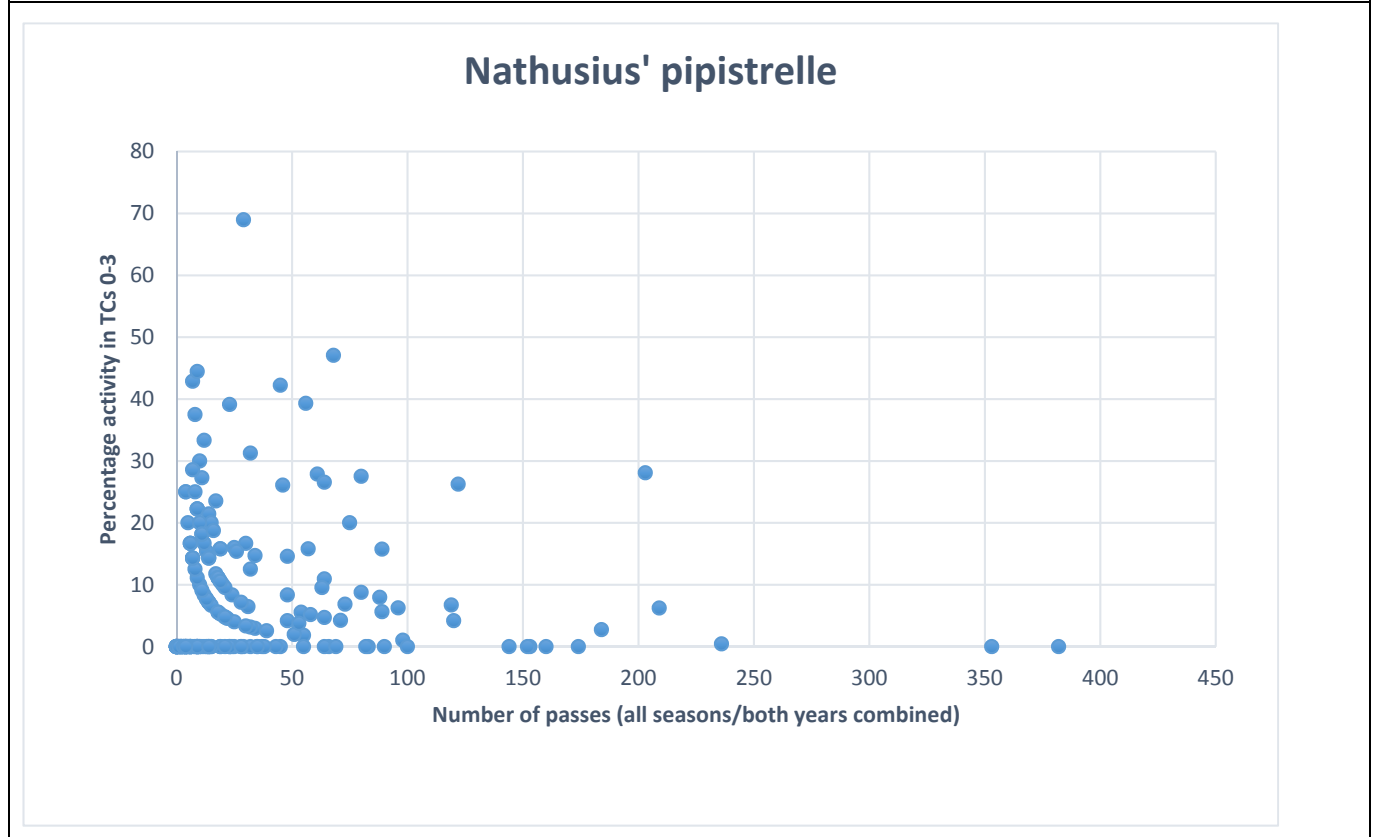


Table A3.1 – d. Monitoring events where Nathusius' pipistrelle activity exceeded 10 passes in TCs 0-3 (all early activity above ten passes was included because of the low number of records of this species).

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2014	1	MS04	20	29	69
2013	3	MS24	32	68	47
2013	3	MS30_TC	26	56	46
2013	2	MS11	19	45	42
2014	3	MS30_ER	59	203	29
2013	1	MS11	17	61	28
2013	1	MS07	22	80	28
2014	1	MS07	17	64	27
2013	1	MS29	32	122	26
2013	3	MS12	12	46	26
2013	3	MS29	15	75	20
2013	1	MS16_FD	13	209	6

### A3: DESCRIPTIVE STATISTICS BY MS

Figure 8e – Percentage activity within TCs 0-3 for *Pipistrellus* spp. (all monitoring events)

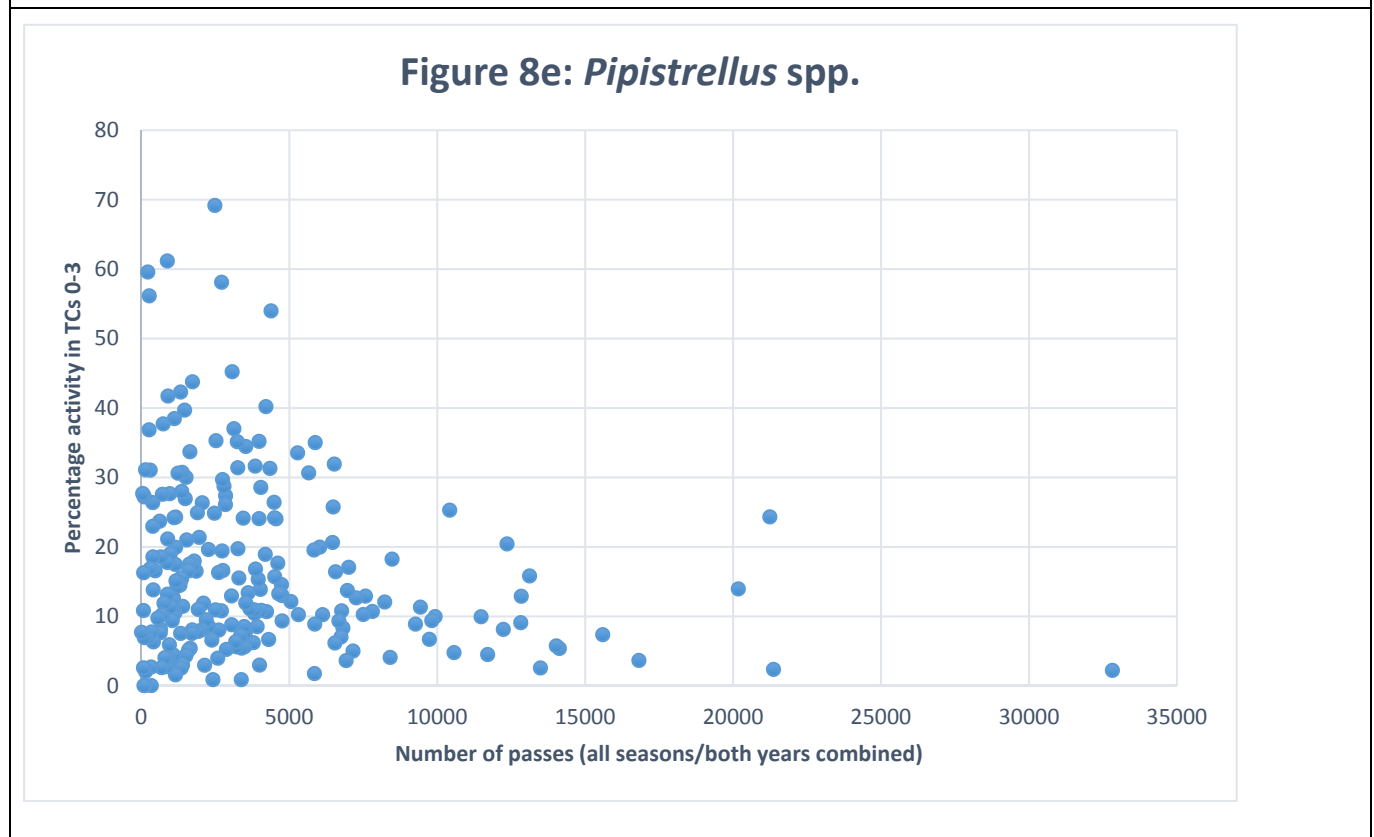


Table A3.1 – e. Monitoring events where pipistrelle activity exceeded 30 passes in TCs 0-3. While all monitoring events have been plotted, only those where early activity exceeded 25% are listed below.

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2014	3	MS18	1721	2489	69
2013	3	MS18	540	883	61
2013	3	MS10	131	220	60
2014	1	MS05_WS	1577	2715	58
2013	1	MS09	151	269	56
2014	1	MS23	2367	4387	54
2013	3	MS23	1390	3075	45
2013	2	MS19	758	1733	44
2013	1	MS03	563	1332	42
2013	3	MS15_TL	376	902	42
2013	2	MS15_TL	1692	4212	40
2014	3	MS30_ER	582	1467	40
2013	3	MS30_ER	431	1121	38
2013	3	MS19	279	740	38
2014	1	MS21	1159	3133	37
2014	3	MS31_WP	98	266	37
2013	2	MS11	890	2524	35
2014	1	MS16_XR	1400	3981	35

### A3: DESCRIPTIVE STATISTICS BY MS

Year	Season	MS	Bat passes in TC 1-3	Total bat passes	Percentage
2014	3	MS21	1140	3244	35
2013	3	MS12	2059	5883	35
2013	1	MS18	1216	3532	34
2014	1	MS17	553	1642	34
2013	1	MS23	1771	5284	34
2013	3	MS24	2083	6527	32
2013	3	MS21	1218	3854	32
2013	3	MS16_XR	1023	3261	31
2013	2	MS23	1361	4350	31
2013	3	MS28	46	148	31
2014	2	MS31_WP	94	303	31
2014	1	MS30_TC	425	1384	31
2013	1	MS27	1734	5661	31
2014	3	MS11	381	1245	31
2014	3	MS30_TC	455	1517	30
2014	3	MS19	815	2746	30
2014	3	MS03	804	2798	29
2013	1	MS26	1153	4041	29
2013	2	MS26	382	1366	28
2013	3	MS16_FD	266	962	28
2013	3	MS14	197	715	28
2014	3	MS12	780	2852	27
2013	3	MS31_WP	401	1489	27
2013	1	MS22_FP	1185	4490	26
2013	1	MS06_ES	102	387	26
2013	1	MS12	542	2059	26
2013	2	MS28	742	2845	26
2014	3	MS23	1668	6486	26

# ANNEX 3: SUPPORTING INFORMATION

## A4. NOTES ON DEPLOYMENT

### A4.1. Location and rationale of monitoring stations and years of surveying

Table A4 - 1. Location and rationale of monitoring stations and years of surveying.

Monitoring Station [MS]	Stereo or Mono Microphone (mic)	Session	Reason for Inclusion (initials give codes for mic placements for stereo units)	Years Surveyed
1	Stereo		Potential commuting route north; one microphone in the woodland (WD), the other to the north along the field boundary (FB).	2013
2	Mono	1	Potential commuting route north. This is a patchy treeline contiguous with The Grove.	2013 + 2014
3	Mono	1	Potential commuting route north. This is a treeline contiguous with Black Walks, which leads to Ash Wood.	2013 + 2014
4	Mono	1	Upper Abbey track; north-south bridleway (important commuting route; location of proposed environmental corridor/buffer).	2013 + 2014
5	Stereo	1	On the SW corner of Ash Wood. One mic on western edge (WS); one on southern edge (SS).	2013 + 2014
6	Stereo	1	On the NE corner of Ash Wood. One mic on eastern edge (ES); one mic on northern edge (NS) (in vicinity of Roost 9)	2013 + 2014
7	Mono	1	Track between The Grove (where there are several roosts identified) and Goose Hill, potential north-south and east-west corridor	2013 + 2014
8	Mono	1	On tree-line/hedge leading into arable fields north of Kenton Hills.	2013 + 2014
9	Mono	1	Upper Abbey track: north-south bridleway identified as an important commuting route	2013 + 2014
10	Mono	1	On a potential commuting route south from the corner of Ash Wood. [See also M32]	2013 + 2014
11	Mono	1	Cross roads within Goose Hill	2013 + 2014
12	Mono	2	Cross roads within Goose Hill – towards the eastern edge	2013 + 2014
13	Mono	2	Access restrictions. Replaced by M30.	Not deployed.
14	Mono	1	Upper Abbey track: north-south bridleway identified as an important commuting route.	2013 + 2014
15	Stereo	1	On tree-line /hedge leading into arable fields north of Kenton Hills. One mic further into field (TL); one closer to Kenton Hills track (TR)	2013 + 2014

## SUPPORTING INFORMATION

Monitoring Station [MS]	Stereo or Mono Microphone (mic)	Session	Reason for Inclusion (initials give codes for mic placements for stereo units)	Years Surveyed
16	Stereo	2	Cross road on the edge of Goose Hill. One mic on crossroad (XR); one in the adjacent field to the east (FD).	2013 + 2014
17	Mono	2	Potential commuting route adjacent to southern boundary of Campus Option 1.	2013 + 2014
18	Mono	1	Commuting corridor along peripheral ride.	2013 + 2014
19	Mono	1	Commuting corridor along peripheral ride.	2013 + 2014
20	Mono	2	Junction between northern Sizewell Belts and Goose Hill.	2013 + 2014
21	Mono	2	Located within Leiston Abbey Woodland, west of Upper Abbey track. This woodland is just to the N, and at the end, of a strong east-west commuting corridor which links to the Leiston Abbey ruins, further to the west.	2013 + 2014
22	Stereo	2	Strong east-west commuting corridor; both west and east of Upper Abbey track. One mic closer to track (TA); one mic within Fiscal Policy woodland (FP).	2013 + 2014
23	Mono	2	Edge of Sizewell Belts (area used for foraging).	2013 + 2014
24	Mono	2	Junction between northern Sizewell Belts and Goose Hill.	2013 + 2014
25	Mono	2	Fields to the south; adjacent to the proposed SSSI habitat creation scheme.	2013 + 2014
26	Mono	2	Fields to the south; close to Broom Covert (south of Sandy Lane).	2013 + 2014
27	Mono	2	On edge of Coronation Wood.	2013
28	Mono	2	Fields to the south; on Lover's Lane	2013
29	Mono	2	Junction between SSSI and Grimseys	2013 + 2014
30	Stereo	1	Eastbridge Road (ER) and lane to Upper Abbey Farm (TC). This MS replaced M13 due to access restrictions.	2013 + 2014
31	Stereo	2	Fields to the south. One mic closer to Broom Covert (WP); the other mic closer to Rookyard/drains (EP).	2013 + 2014
32	Stereo	1	Stonewall Belt, running south from Ash Woods. One mic to east of tree line (E); the other mic to west of tree line (W).	2014
33	Mono	2	Consultees requested monitoring at Reckham Pits.	2014

## SUPPORTING INFORMATION

Monitoring Station [MS]	Stereo or Mono Microphone (mic)	Session	Reason for Inclusion (initials give codes for mic placements for stereo units)	Years Surveyed
34	Stereo	2	Replaced M1 due to access restrictions. One mic to NW on treeline (TL); the other mic further SE on lane (LN).	2014
35	Mono	2	Proposed SSSI bridge location.	2014
36	Mono	2	Reedbed area to south of SSSI to replicate SSSI area.	2014

A4.1.1. No monitoring of the proposed platform was undertaken in 2013/2014, as very low levels of activity had been recorded in the previous studies (2007-2012).

A4.1.2. No detectors were installed on the coastal strip as the risk of damage to/theft of unattended equipment was assessed to be unacceptably high.

### A4.2. Weather and temporal data

A4.2.1. Table A4 - 2 to Table A4 - 4 give the maximum and minimum temperatures for the survey periods in 2013 and 2014.

A4.2.2. Table A4 - 5 to Table A4 - 7 give the sunset and sunrise times for the same period.

## SUPPORTING INFORMATION

Table A4 - 2. Maximum and minimum temperatures for Season 1 survey periods in 2013 and 2014<sup>10</sup>

Season	Session	2013			2014		
		Date	Temp High (°C)	Temp Low (°C)	Date	Temp High (°C)	Temp Low (°C)
1	1	29/05/2013	12	7	28/05/2014	16	11
		30/05/2013	12	9	29/05/2014	16	11
		31/05/2013	19	9	30/05/2014	16	9
		01/06/2013	14	9	31/05/2014	17	5
		02/06/2013	17	7	01/06/2014	19	10
		03/06/2013	17	4	02/06/2014	18	9
		04/06/2013	18	3	03/06/2014	18	12
		05/06/2013	18	7	04/06/2014	15	7
		06/06/2013	19	7	05/06/2014	19	4
		07/06/2013	18	7	06/06/2014	19	7
		08/06/2013	14	8	07/06/2014	23	12
		09/06/2013	13	9	08/06/2014	24	12
		10/06/2013	13	8	09/06/2014	24	12
		11/06/2013	18	6	10/06/2014	23	13
		12/06/2013	19	14	11/06/2014	21	8
		13/06/2013	18	11	12/06/2014	23	12
	2	11/06/2013	18	6	11/06/2014	21	8
		12/06/2013	19	14	12/06/2014	23	12
		13/06/2013	18	11	13/06/2014	23	12
		14/06/2013	19	7	14/06/2014	19	12
		15/06/2013	18	10	15/06/2014	17	12
		16/06/2013	17	9	16/06/2014	17	11
		17/06/2013	19	9	17/06/2014	19	11
		18/06/2013	22	11	18/06/2014	18	10
		19/06/2013	24	14	19/06/2014	19	7
		20/06/2013	19	12	20/06/2014	19	7

<sup>10</sup> All temperature data obtained from [www.wunderground.com](http://www.wunderground.com)

2013 -

[http://www.wunderground.com/history/airport/EGUW/2013/5/17/MonthlyCalendar.html?req\\_city=Sizewell&req\\_state=&req\\_statename=United Kingdom&reqdb.zip=00000&reqdb.magic=16&reqdb.wmo=03596](http://www.wunderground.com/history/airport/EGUW/2013/5/17/MonthlyCalendar.html?req_city=Sizewell&req_state=&req_statename=United%20Kingdom&reqdb.zip=00000&reqdb.magic=16&reqdb.wmo=03596)

2014 -

[http://www.wunderground.com/history/airport/EGUW/2014/5/17/MonthlyCalendar.html?req\\_city=Sizewell&req\\_state=&req\\_statename=United Kingdom&reqdb.zip=00000&reqdb.magic=16&reqdb.wmo=03596](http://www.wunderground.com/history/airport/EGUW/2014/5/17/MonthlyCalendar.html?req_city=Sizewell&req_state=&req_statename=United%20Kingdom&reqdb.zip=00000&reqdb.magic=16&reqdb.wmo=03596)

## SUPPORTING INFORMATION

Season	Session	2013			2014		
		Date	Temp High (°C)	Temp Low (°C)	Date	Temp High (°C)	Temp Low (°C)
		21/06/2013	21	13	21/06/2014	22	11
		22/06/2013	18	11	22/06/2014	22	9
		23/06/2013	18	12	23/06/2014	23	13
		24/06/2013	15	9	24/06/2014	21	10
		25/06/2013	19	6	25/06/2014	18	7
		26/06/2013	21	8	26/06/2014	19	8

## SUPPORTING INFORMATION

Table A4 - 3. Maximum and minimum temperatures for Season 2 survey periods 2013 and 2014

Season	Session	2013			2014		
		Date	Temp High (°C)	Temp Low (°C)	Date	Temp High (°C)	Temp Low (°C)
2	1	15/07/2013	27	12	15/07/2014	22	15
		16/07/2013	27	14	16/07/2014	26	14
		17/07/2013	28	15	17/07/2014	25	16
		18/07/2013	25	13	18/07/2014	28	16
		19/07/2013	25	12	19/07/2014	26	17
		20/07/2013	19	14	20/07/2014	23	17
		21/07/2013	23	14	21/07/2014	24	15
		22/07/2013	30	13	22/07/2014	23	14
		23/07/2013	25	17	23/07/2014	27	14
		24/07/2013	27	14	24/07/2014	26	13
		25/07/2013	26	16	25/07/2014	27	15
		26/07/2013	26	13	26/07/2014	27	14
		27/07/2013	27	15	27/07/2014	23	16
		28/07/2013	24	15	28/07/2014	20	14
		29/07/2013	24	14	29/07/2014	24	13
		30/07/2013	20	13	30/07/2014	23	12
	2	30/07/2013	20	13	28/07/2014	20	14
		31/07/2013	23	14	29/07/2014	24	13
		01/08/2013	29	16	30/07/2014	23	12
		02/08/2013	24	17	31/07/2014	25	12
		03/08/2013	24	14	01/08/2014	24	13
		04/08/2013	24	12	02/08/2014	24	14
		05/08/2013	24	15	03/08/2014	23	9
		06/08/2013	20	11	04/08/2014	23	10
		07/08/2013	20	9	05/08/2014	24	11
		08/08/2013	22	9	06/08/2014	24	16
		09/08/2013	23	15	07/08/2014	24	13
		10/08/2013	20	11	08/08/2014	21	15
		11/08/2013	22	11	09/08/2014	23	13
		12/08/2013	19	9	10/08/2014	21	13
		13/08/2013	19	10	11/08/2014	21	11
					12/08/2014	20	11
					13/08/2014	22	10

14/08/2014

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Table A4 - 4. Maximum and minimum temperatures for Season 3 survey periods in 2013 and 2014.

Season	Session	2013			2014		
		Date	Temp High (°C)	Temp Low (°C)	Date	Temp High (°C)	Temp Low (°C)
3	1	10/09/2013	15	8	03/09/2014	21	12
		11/09/2013	14	10	04/09/2014	21	11
		12/09/2013	19	11	05/09/2014	19	13
		13/09/2013	18	12	06/09/2014	18	11
		14/09/2013	14	7	07/09/2014	19	11
		15/09/2013	14	4	08/09/2014	20	8
		16/09/2013	14	6	09/09/2014	20	9
		17/09/2013	13	6	10/09/2014	18	9
		18/09/2013	16	6	11/09/2014	17	8
		19/09/2013	14	6	12/09/2014	21	11
		20/09/2013	18	11	13/09/2014	19	9
		21/09/2013	16	9	14/09/2014	20	11
		22/09/2013	21	11	15/09/2014	22	11
		23/09/2013	18	9	16/09/2014	23	12
		24/09/2013	19	9	N/A		
	2	24/09/2013	19	9	16/09/2014	23	12
		25/09/2013	19	11	17/09/2014	20	14
		26/09/2013	18	9	18/09/2014	24	14
		27/09/2013	16	7	19/09/2014	24	16
		28/09/2013	18	8	20/09/2014	16	14
		29/09/2013	17	11	21/09/2014	17	10
		30/09/2013	17	10	22/09/2014	17	8
		01/10/2013	17	7	23/09/2014	18	8
		02/10/2013	17	12	24/09/2014	17	8
		03/10/2013	18	13	25/09/2014	19	4
		04/10/2013	20	12	26/09/2014	20	14
		05/10/2013	17	10	27/09/2014	21	12
		06/10/2013	19	7	28/09/2014	22	15
		07/10/2013	18	7	29/09/2014	18	10
		08/10/2013	21	9	30/09/2014	20	11

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Table A4 - 5. Sunrise and sunset times for Season 1 in 2013 and 2014<sup>11</sup>

Season	Session	2013			2014		
		Date	Sunrise	Sunset	Date	Sunrise	Sunset
1	1	29/05/2013	04:40	21:01	28/05/2014	04:41	21:00
		30/05/2013	04:39	21:03	29/05/2014	04:40	21:01
		31/05/2013	04:38	21:04	30/05/2014	04:39	21:02
		01/06/2013	04:37	21:05	31/05/2014	04:38	21:03
		02/06/2013	04:36	21:06	01/06/2014	04:37	21:05
		03/06/2013	04:36	21:07	02/06/2014	04:37	21:06
		04/06/2013	04:35	21:08	03/06/2014	04:36	21:07
		05/06/2013	04:34	21:09	04/06/2014	04:35	21:08
		06/06/2013	04:34	21:10	05/06/2014	04:35	21:09
		07/06/2013	04:33	21:11	06/06/2014	04:34	21:10
		08/06/2013	04:33	21:12	07/06/2014	04:33	21:10
		09/06/2013	04:32	21:12	08/06/2014	04:33	21:11
		10/06/2013	04:32	21:13	09/06/2014	04:33	21:12
		11/06/2013	04:32	21:14	10/06/2014	04:32	21:13
		12/06/2013	04:32	21:14	11/06/2014	04:32	21:14
		13/06/2013	04:31	21:15	12/06/2014	04:32	21:14
	2	11/06/2013	04:32	21:14	11/06/2014	04:32	21:14
		12/06/2013	04:32	21:14	12/06/2014	04:32	21:14
		13/06/2013	04:31	21:15	13/06/2014	04:31	21:15
		14/06/2013	04:31	21:16	14/06/2014	04:31	21:15
		15/06/2013	04:31	21:16	15/06/2014	04:31	21:16
		16/06/2013	04:31	21:17	16/06/2014	04:31	21:16
		17/06/2013	04:31	21:17	17/06/2014	04:31	21:17
		18/06/2013	04:31	21:17	18/06/2014	04:31	21:17
		19/06/2013	04:31	21:18	19/06/2014	04:31	21:18
		20/06/2013	04:32	21:18	20/06/2014	04:31	21:18
		21/06/2013	04:32	21:18	21/06/2014	04:32	21:18
		22/06/2013	04:32	21:18	22/06/2014	04:32	21:18
		23/06/2013	04:32	21:18	23/06/2014	04:32	21:18
		24/06/2013	04:33	21:18	24/06/2014	04:33	21:18
		25/06/2013	04:33	21:18	25/06/2014	04:33	21:18
		26/06/2013	04:34	21:18	26/06/2014	04:34	21:18

<sup>11</sup> All sunrise and sunset times obtained from [www.explorebritain.info](http://www.explorebritain.info)

2013 - <http://dev.explorebritain.info/locality-suffolk-sizewell-tm4761/suntimes/201308>

2014 - <http://dev.explorebritain.info/locality-suffolk-sizewell-tm4761/suntimes/201404>

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Table A4 - 6. Sunrise and sunset times for Season 2 in 2013 and 2014.

Season	Session	2013			2014		
		Date	Sunrise	Sunset	Date	Sunrise	Sunset
2	1	15/07/2013	04:51	21:07	15/07/2014	04:51	21:07
		16/07/2013	04:52	21:06	16/07/2014	04:52	21:06
		17/07/2013	04:53	21:05	17/07/2014	04:53	21:05
		18/07/2013	04:55	21:04	18/07/2014	04:54	21:04
		19/07/2013	04:56	21:03	19/07/2014	04:56	21:03
		20/07/2013	04:57	21:01	20/07/2014	04:57	21:02
		21/07/2013	04:59	21:00	21/07/2014	04:59	21:00
		22/07/2013	05:00	20:59	22/07/2014	05:00	20:59
		23/07/2013	05:02	20:57	23/07/2014	05:01	20:58
		24/07/2013	05:03	20:56	24/07/2014	05:03	20:56
		25/07/2013	05:05	20:54	25/07/2014	05:04	20:55
		26/07/2013	05:06	20:53	26/07/2014	05:06	20:53
		27/07/2013	05:08	20:51	27/07/2014	05:07	20:52
		28/07/2013	05:09	20:50	28/07/2014	05:09	20:50
		29/07/2013	05:11	20:48	29/07/2014	05:10	20:49
		30/07/2013	05:12	20:47	30/07/2014	05:12	20:47
	2	30/07/2013	05:12	20:47	28/07/2014	05:09	20:50
		31/07/2013	05:14	20:45	29/07/2014	05:10	20:49
		01/08/2013	05:15	20:43	30/07/2014	05:12	20:47
		02/08/2013	05:17	20:42	31/07/2014	05:13	20:45
		03/08/2013	05:18	20:40	01/08/2014	05:15	20:44
		04/08/2013	05:20	20:38	02/08/2014	05:16	20:42
		05/08/2013	05:22	20:36	03/08/2014	05:18	20:40
		06/08/2013	05:23	20:35	04/08/2014	05:20	20:39
		07/08/2013	05:25	20:33	05/08/2014	05:21	20:37
		08/08/2013	05:26	20:31	06/08/2014	05:23	20:35
		09/08/2013	05:28	20:29	07/08/2014	05:24	20:33
		10/08/2013	05:30	20:27	08/08/2014	05:23	20:31
		11/08/2013	05:31	20:25	09/08/2014	05:28	20:29
		12/08/2013	05:33	20:23	10/08/2014	05:29	20:27
		13/08/2013	05:34	20:21	11/08/2014	05:31	20:25
					12/08/2014	05:32	20:24
					13/08/2014	05:34	20:22
					14/08/2014	05:36	20:20

Table A4 - 7. Sunrise and sunset times for Season 3 in 2013 and 2014.

Season	Session	2013			2014		
		Date	Sunrise	Sunset	Date	Sunrise	Sunset
3	1	10/09/2013	06:20	19:19	03/09/2014	06:09	19:36
		11/09/2013	06:22	19:17	04/09/2014	06:10	19:34
		12/09/2013	06:24	19:14	05/09/2014	06:12	19:31
		13/09/2013	06:25	19:12	06/09/2014	06:13	19:29
		14/09/2013	06:27	19:10	07/09/2014	06:15	19:27
		15/09/2013	06:29	19:07	08/09/2014	06:17	19:24
		16/09/2013	06:30	19:05	09/09/2014	06:18	19:22
		17/09/2013	06:32	19:03	10/09/2014	06:20	19:20
		18/09/2013	06:34	19:00	11/09/2014	06:22	19:17
		19/09/2013	06:35	18:58	12/09/2014	06:23	19:15
		20/09/2013	06:37	18:56	13/09/2014	06:25	19:13
		21/09/2013	06:38	18:53	14/09/2014	06:27	19:10
		22/09/2013	06:40	18:51	15/09/2014	06:28	19:08
		23/09/2013	06:42	18:48	16/09/2014	06:30	19:06
		24/09/2013	06:43	18:46	N/A		
	2	24/09/2014	06:43	18:46	16/09/2014	06:30	19:06
		25/09/2014	06:45	18:44	17/09/2014	06:32	19:03
		26/09/2014	06:47	18:41	18/09/2014	06:33	19:01
		27/09/2014	06:48	18:39	19/09/2014	06:35	18:59
		28/09/2014	06:50	18:37	20/09/2014	06:36	18:56
		29/09/2014	06:52	18:34	21/09/2014	06:38	18:54
		30/09/2014	06:53	18:32	22/09/2014	06:40	18:51
		01/10/2014	06:55	18:30	23/09/2014	06:41	18:49
		02/10/2014	06:57	18:27	24/09/2014	06:43	18:47
		03/10/2014	06:59	18:25	25/09/2014	06:45	18:44
		04/10/2014	07:00	18:23	26/09/2014	06:46	18:42
		05/10/2014	07:02	18:21	27/09/2014	06:48	18:40
		06/10/2014	07:04	18:18	28/09/2014	06:50	18:37
		07/10/2014	07:05	18:16	29/09/2014	06:51	18:35
		08/10/2014	07:07	18:14	30/09/2014	06:53	18:33

## A5. SURVEY CONSTRAINTS

### A5.1. Constraints and Limitations 2013 – 2014

- A5.1.1. The detection rate of bats varies between species dependent upon the parameters of their echolocation calls. In particular, long-eared bats have a very quiet echolocation call. Species such as long-eared bat may therefore be under-reported by automated detectors.
- A5.1.2. The number of nights during each two-week survey period for which automated detectors recorded varied throughout the two years. Variations in the number of functional nights were related to the filling up of SD (data) cards, lost or stolen mics and chewed cables.
- A5.1.3. In 2013 it was found that there were occasions in which the two SD cards that had been assigned to each detector had been filled up prior to the end of the two-week survey period and, where this occurred, detectors were unable to record for the entirety of the two-week period. This constraint was addressed in 2014 through the assignment of additional SD cards to each detector so that each detector contained the maximum complement of four SD cards. It is important to note, however, that the total number of passes recorded by each detector cannot be used to compare relative bat activity.
- A5.1.4. On retrieval of SM2 detectors, mics were found to be missing or dislodged on two occasions in 2013 and on two occasions in 2014. At these locations, deployments of SM2 detectors were subsequently subject to minor alterations in positioning to provide improved coverage or more secure positioning.
- A5.1.5. Cables connecting an SM2 detector to the battery and/or mic were found, on occasion, to have been chewed by small mammals, disrupting the recording of bat activity. This constraint was addressed through the wrapping of cables in a secondary layer of cable wrap that had been soaked in a solution to discourage small mammals.
- A5.1.6. All bat echolocation calls recorded by automated detectors during 2013 and 2014 were identified through the auto-identification software SonoChiro, which uses an extensive library of pre-identified bat calls and related parameters to determine the identification of an echolocation call from an unidentified bat species.
- A5.1.7. The decision was made to use auto-identification software rather than to undertake identifications manually due to the large number of locations (>30) which were monitored for a two-week period three times a year. This level of survey effort generated an extensive amount of data, for which manual identification would not have been practical. A series of detailed trials was undertaken to ensure that the most accurate and suitable system for this particular data-set was employed. Details of the trials undertaken are provided in Annex 2: A4.4 and A4.5.
- A5.1.8. While auto-identification is in its relative infancy and has its flaws, it is likely to be no less accurate overall than the subjective identification by a number of human observers over large volumes of data, even if a human is likely to be more accurate in dealing with small numbers of calls. Individuals differ, and can make mistakes. By using auto-identification software, such errors are more likely to be consistent and therefore an identifiable risk.

## A6. AUTO-IDENTIFICATION SOFTWARE

### A6.1. Introduction

- A6.1.1. A large-scale automated detector survey can be expected to generate a large amount of data. Due to both this, and the need to analyse all collected data to ensure that the maximum amount of information was obtained, it was determined that manual identification would not be practicable. It was therefore determined that bat call auto-identification software would be employed.
- A6.1.2. A number of bat call auto-identification programmes are currently available, including Kaleidoscope Pro; SonoChiro and iBats. A series of trials were undertaken to determine the most accurate and suitable programme for the identification of recorded bat passes.
- A6.1.3. For the analysis of data collected from SM2s within the main development site, it was important that the chosen auto-identification software provided accurate identifications for as many recordings as possible; in particular, for those species considered to require more detailed attention, including barbastelle and Nathusius' pipistrelle.

### A6.2. Manual Identification

- A6.2.1. To provide a basis against which to assess the effectiveness of auto-identification software, the recordings from ten dates, relating to three MSs (chosen due to their location close to historic monitoring sites which had identified high levels of barbastelle activity), were manually analysed in BatSound (a bat call viewer programme for recordings in .wav format) by two experienced bat call analysts<sup>12</sup>. The chosen MSs, dates and number of recordings analysed are set out in Table A6- 1 below:

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<sup>12</sup> At the time of writing, Will Trehwella had twelve years' experience of bat detector survey work and the analysis of bat calls recorded on time expansion, frequency division and full spectrum bat detectors. Kathryn Skinner had over two years' experience of bat detector survey work and the analysis of bat calls recorded on time expansion, frequency division and full spectrum bat detectors.

Table A6- 1. Location and dates of manually identified bat pass recording samples for comparison to auto-identification software

Monitoring Station	Dates	Number of Recordings
3	15.07.2013	149
	16.07.2013	478
	17.07.2013	272
	20.07.2013	106
	22.07.2013	113
	28.07.2013	120
	29.07.2013	66
6 - Left	16.07.2013	94
6 – Right	16.07.2013	67
11	16.07.2013	171
<b>Total</b>		1,636

- A6.2.2. Two additional experienced bat-call analysts undertook verification using BatSound, of all manually-identified passes where there was uncertainty in their identification and for those species of particular interest (barbastelle and Nathusius's pipistrelle).<sup>13</sup>
- A6.2.3. Following this verification, it was presumed, for the purposes of the trials undertaken, that manual identifications were correct.
- A6.2.4. The outputs of auto-identification trials, detailed below, were compared to the manual identifications to determine their accuracy. Manual identification was categorised to one of five levels:
- Level 1 = Species level identification;
  - Level 2 = Genus level identification;
  - Level 3 = Group (i.e. 'big bat') level identification;
  - Level 4 = Between groups (i.e. *Myotis*/long-eared) level identification; and
  - Level 5 = Bat sp. level identification.
- A6.2.5. Manual and auto-identifications were considered to match if the auto-identification fell within the ID level of the manual identification; that is, if the manual identification was

<sup>13</sup> At the time of writing, David Wells had over 28 years' experience of bat detector survey work, and 14 years' experience of the analysis of bat calls recorded on time expansion, frequency division and full spectrum bat detectors. He is regularly commissioned by ecological consultancies to provide training on bat detector survey and bat call analysis. Nick Downs has over 20 years' experience of bat detector survey work, and 11 years' experience of the analysis of bat calls recorded on time expansion, frequency division and full spectrum bat detectors. During this time, he has attended several courses on the subject, and delivered one.

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'big bat' and the auto-identification was serotine, or if the manual identification was *Nyctalus* sp. and the auto-identification was noctule.

- A6.2.6. Initial trials focused on the use of Kaleidoscope Pro, as this programme was developed by Wildlife Acoustics specifically for the conversion and auto-identification of recordings made by Wildlife Acoustic bat detectors, including the SM2 automated detectors used within the main development site.

### A6.3. About Kaleidoscope Pro

- A6.3.1. Kaleidoscope Pro (v 1.1.20) is a conversion and bat call auto-identification software package created by Wildlife Acoustics specifically for use with recordings made by Wildlife Acoustic bat detectors including the SM2 detector.
- A6.3.2. At the time of the trials, 2013, Kaleidoscope Pro was capable of identifying 11 species or groups of British bats, using version 1.0.5 of Wildlife Acoustics 'Bats of the United Kingdom' classifiers (barbastelle; serotine; *Myotis* sp.; Leisler's bat; noctule; Nathusius' pipistrelle; common pipistrelle; soprano pipistrelle; brown long-eared bat; greater horseshoe and lesser horseshoe). At the time of the trials, the programme was unable to provide species level identifications for species of the *Myotis* genus, and was capable of identifying only a single species within a recording, regardless of how many species had been recorded. Therefore only the calls of the loudest and/or clearest species recorded within a bat pass could be identified using this version.
- A6.3.3. Files considered to contain only background noise can be filtered out during the conversion and/or auto-identification process and saved to a 'Noise' folder separate to those recordings considered by Kaleidoscope Pro to contain bat calls. Regardless of the filtering of noise files, identifications are provided by Kaleidoscope Pro only to those recordings considered to contain bat calls. Therefore an identification of 'No ID' is only applied by Kaleidoscope Pro to those recordings that are considered to contain a bat call but that provide insufficient detail to enable a specific identification. For the purpose of comparison to manual identifications a 'No ID' identification is therefore considered to correspond to a 'Bat sp.' manual identification.

### A6.4. Kaleidoscope Pro Trials

- A6.4.1. Six trials of Kaleidoscope Pro were undertaken, using the same data that had been manually identified, to determine the accuracy of its auto-identification capabilities under varying settings. The details of the settings used for simultaneous conversion and auto-identification for each trial are provided in Table A6- 2 below:

Table A6- 2. Kaleidoscope Pro conversion and auto-identification settings in trials

Setting Option	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Time expansion	10	10	1	1	1	1
Division ratio	8	8	8	8	8	8
Noise files filtered	N	Y	Y	Y	Y	Y
Frequency (kHz)	16 - 120	16 – 120	16 – 120	16 – 120	16 – 120	16 – 120
Call length (ms)	2 – 500	2 – 500	0 – 500	0 – 500	0 – 500	0 – 500
Minimum number of calls	2	1	1	1	1	1
Classifier sensitivity	0	0	0	0	-1	+1

### *Trial One*

- A6.4.2. Trial One indicated that over one third (35.5%) of all manually identified calls were missed by Kaleidoscope Pro. Where identifications were made, 88.6% corresponded with the manual identification provided, of which 93.6% were matches at the species level. 'No ID' auto-identifications accounted for 8.6% of identifications, of which 2.9% related to recordings that had been identified as blank or noise files through manual identifications.
- A6.4.3. When considered at the species level, auto-identification of a number of species was notably poorer than manual identifications. This was especially noted for species of particular interest including barbastelle and Nathusius' pipistrelle as well as noctule. Conversely serotines, and to a lesser extent Leisler's and lesser horseshoe bats were identified to a greater extent by the auto-identification software than by manual identification. Details of the number of calls assigned to selected species that may be of greater interest are provided in Table A6- 3 below.
- A6.4.4. However it should be noted that an element of the greater identification by auto-identification may be partially due to the manual identification of some calls into groups (i.e. level 2 or above) rather than the species level (level 1). Details of these variations are provided in Table A6- 3 below.

### *Trial Two*

- A6.4.5. Trial Two looked to reduce the number of bat passes that were manually identified to a species, but missed by the auto-identification. To achieve this, a broader range of settings was applied (detailed in Table A6- 2).
- A6.4.6. The results of Trial Two reduced the percentage of manually-identified passes that were missed by Kaleidoscope Pro to 27.4%. However, these alterations also resulted in a reduction in the number of identifications that matched between manual and auto-identifications to 78%. The increase in the overall percentage of auto-identifications was observed to have resulted in an increase in the percentage (19.2%) of 'No ID' auto-identifications. Therefore, an increase in the overall number of identifications was noted to not necessarily indicate an increase in useful identifications.
- A6.4.7. As in Trial One, Kaleidoscope Pro was found to identify considerably greater numbers of some species of interest, and considerably lower numbers of other species of interest, when compared to manual identifications. A detailed breakdown of these identifications is provided in Table A6- 3 below.

### *Trial Three*

- A6.4.8. A further trial with still broader settings (detailed in Table A6- 2) was run following discussions with Wildlife Acoustics in relation to concerns that initial trials had raised with Kaleidoscope Pro. These concerns included: the loss of bat calls (not limited to barbastelle) within noise files; ensuring that only confirmed or high-likelihood pipistrelle sp. calls were identified; and ensuring that when more than one species was present within a pass, these additional species were not left unidentified.

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- A6.4.9. It was advised by Wildlife Acoustics that on the basis of the setup of the SM2 detectors, a time expansion setting of 10 was not required, and conversion and auto-identification could be undertaken at a time expansion of 1.
- A6.4.10. The advised alterations resulted in a decrease in the number of manually identified species that were missed by Kaleidoscope Pro to just 2.1%. However, the percentage of auto-identified species that matched manual identifications dropped severely to 56%, of which 93.7% matched at the species level. The remaining identified calls were identified as 'No ID'.
- A6.4.11. As in previous trials, Kaleidoscope Pro was found to identify considerably greater numbers of some species of interest, and considerably lower numbers of other species of interest, when compared to manual identifications. A detailed breakdown of these identifications is provided in Table A6- 3 below.

### *Trial Four*

- A6.4.12. Having increased the number of recordings identified as bats by Kaleidoscope Pro in Trial Three, Trial Four attempted to improve the accuracy of Kaleidoscope Pro's identifications.
- A6.4.13. Recordings identified as containing bat calls in Trial Three were used as the input data for Trial Four; the auto-identification process was then re-run on this data using the same settings as used in Trial Three (detailed in Table A6- 2).
- A6.4.14. No variations in the results of Trial Four were noted when compared to the results of Trial Three. The results of all trials for species of interest are provided in Table A6- 3 below.

### *Trial Five*

- A6.4.15. Trial Five attempted to improve upon Kaleidoscope Pro's identifications from Trials Three and Four through the alteration of the classification sensitivity.
- A6.4.16. The recordings identified as containing bat calls in Trial Three were used as the input data for Trial Five; the auto-identification process was then re-run on this data using the same settings as used in Trial Three, with the exception of the classifier sensitivity which was set to -1 (more sensitive). Details of the settings used are provided in Table A6- 2 above.
- A6.4.17. The results indicated only very minor (tenths of a percentage point) improvements on the results of Trial Three. As in previous trials, barbastelle, Nathusius' pipistrelle and noctule were all identified to a reduced degree by Kaleidoscope Pro compared to manual identifications, and serotine, Leisler's and lesser horseshoe were identified to a greater degree. Detailed results are provided in Table A6- 3 below.

### *Trial Six*

- A6.4.18. Trial Six attempted to improve upon Kaleidoscope Pro's identifications from previous trials through further alteration of the classification sensitivity.
- A6.4.19. The recordings identified as containing bat calls in Trial Three were used as the input data for Trial Six; the auto-identification process was then re-run on this data using the same settings as used in Trial Three, with the exception of the classifier sensitivity

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which was set to +1 (more accurate). Details of the settings used are provided in Table A6- 2 above.

A6.4.20. The setting of the classifier sensitivity to +1 (more accurate) had a noticeable impact on the identifications assigned by Kaleidoscope Pro, with 71.9% of all identifications being assigned to 'No ID'.

A6.4.21. At the species level, as detailed in Table A6- 3, those species (serotine, Leisler's and lesser horseshoe) which had previously been over-identified by Kaleidoscope Pro were found to be identified to the same level as they had been in manual identifications. No improvement was noted amongst those species (barbastelle, Nathusius's pipistrelle and noctule) which had previously been under-identified by Kaleidoscope Pro.

Table A6- 3. Results of auto-identifications versus manual identifications for species of interest across the six Kaleidoscope Pro trials

Trial	Identification	Species					
		Barbastelle	Noctule	Nathusius' pipistrelle	Serotine	Leisler's	Lesser horseshoe
1	Manual	49	30	5	18	0	0
	Auto	2	17	2	34	4	2
2	Manual	49	30	5	18	0	0
	Auto	2	18	2	35	4	2
3	Manual	49	30	5	18	0	0
	Auto	2	18	2	35	4	2
4	Manual	49	30	5	18	0	0
	Auto	2	18	2	35	4	2
5	Manual	49	30	5	18	0	0
	Auto	2	18	2	35	4	2
6	Manual	49	30	5	18	0	0
	Auto	2	12	2	18	0	0

## A6.5. Alternative Auto-identification Programme Trials

A6.5.1. Following the trials of Kaleidoscope Pro, and concerns about the suitability of this programme for analysis of collected data from SM2 detectors within the main development site, conversations regarding the pros and cons of other auto-identification programmes were undertaken with persons experienced in their use including Kate Jones (University College, London) and Stuart Newson (British Trust for Ornithology). In particular, conversations focused on the use of two alternative auto-identification programmes, iBatsID and SonoChiro.

A6.5.2. The software 'iBatsID' is a 'freely available and easily accessible' continental-scale bat call classifier (Walters *et al.*, (2012). It is an on-line tool which allows anyone to classify European calls in an objective and consistent way, which provides an estimate of classification error for each species. The rationale behind the programme is

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summarised on <https://sites.google.com/site/ibatsresources/iBatsID>, the iBats web-site.

- A6.5.3. SonoChiro (v 3.3.1) is bat call auto-identification software created by Le Club Biotope (<http://www.biotope.fr/fr/accueil-innovation/sonochiro>). It does not provide a similarly-transparent estimate of classification error.
- A6.5.4. A trial was undertaken in which the outputs of Trial 5 from Kaleidoscope Pro trials (settings detailed in Table A6- 2), iBats and SonoChiro were compared both with each other and to manual identifications.
- A6.5.5. SonoChiro was trialled with analyses restricted to UK species at the recommended sensitivity setting of seven (for further information, refer to the manufacturer's recommendations). iBat was trialled with an 'acceptable call quality' of 0.55 and potentially all European species being considered, as there is not an option to restrict analyses to species of a particular geographical region.
- A6.5.6. The results of these comparisons are detailed in Table A6- 4 below. All auto-identification programmes performed more poorly than (the assumed correct) manual identification. Nonetheless, following consideration of the outputs of this trial, it was decided that auto-identification was an appropriate methodology to analyse the bat calls within passes. It is worth noting that, in relation to accuracy, manual identification itself is subjective, and therefore subject to an unquantifiable level of error between and within analysts<sup>14</sup>.

Table A6- 4. Comparison of auto-identification programmes to manual identification of bat recordings.

Species	Auto-identification Programme			Manual ID
	Kaleidoscope Pro	iBats	SonoChiro	
Barbastelle	2	8	34	47
'Big bat'	11	9	29	37
Common pipistrelle	298	245	299	420
Noctule	16	16	21	29
Long-eared bat	0	1	2	2
<i>Myotis</i> or long-eared bat	0	0	0	2
<i>Myotis</i> sp.	16	12	45	72
Nathusius' pipistrelle	2	4	3	12

<sup>14</sup> There is some basis for quantifying variation between human bat analysts (Jennings *et al.*, 2008). At that point in time, the automated system used performed a little better than the humans tested. Although the testing above implies that auto-ID software now performs less well (hence the need for extensive ground-truthing and verification), the difference is more likely to be due to the 'real world' nature of the calls tested. That is, the calls used in training and testing the original system described were typical 'search phase' calls, and sample sizes were small. In the current trials, the auto ID analyses used data that was of variable quality and not filtered for call types. Note also that Auto-ID offers a consistency of approach to calls which is unlikely to be matched by a pool of human analysts.

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Species	Auto-identification Programme			Manual ID
	Kaleidoscope Pro	iBats	SonoChiro	
<i>Nyctalus</i> sp.	10	12	18	24
Pipistrelle sp.	8	13	18	25
Serotine	13	7	9	17
Soprano pipistrelle	340	335	316	521
<b>Total</b>	<b>716</b>	<b>662</b>	<b>793</b>	<b>1,208</b>

- A6.5.7. From the assessment of the capabilities of each programme, SonoChiro was considered the most suitable auto-identification programme based on performance in the trial and the capabilities of the programme.
- A6.5.8. SonoChiro provided identifications that were significantly closer to the number of manually assigned identifications for several species and species groups including species of particular interest such as barbastelle, as well as for 'big bats', noctule and *Myotis* spp. Further, in the trial it was found to process data at a significantly faster rate than other trialled programmes, a necessary consideration given the amount of data requiring identification.
- A6.5.9. Further benefits of using SonoChiro were identified in relation to the ability to focus analysis on British bat species, and perhaps most significantly, the ability of SonoChiro to identify up to three different bat species within a single recording. Manual identifications of a small proportion of collected data had indicated that the presence of more than one bat species on a recording occurred to a sufficient degree that this would need to be taken into consideration, and neither Kaleidoscope Pro nor iBat, at the time of these trials, possessed the ability to do so. Instead these auto-identification programmes provided an identification for the clearest call (or sequence of calls) within a recording. This was considered particularly important due to the large number of pipistrelle calls which could have obscured a significant number of other, quieter species.
- A6.5.10. SonoChiro provides identifications at both a 'species' and 'group' level, with an overall identification indicating the level at which the programme can provide an identification in which the rules for the level of 'confidence' (user-selected) are satisfied.
- A6.5.11. The capabilities and processes used by SonoChiro are described in more detail in the following section.

### A6.6. Detailed Notes on the use of SonoChiro and Manual Interpretation

- A6.6.1. At the time these surveys commenced, SM2 detector recordings were created and saved in the WAC0 form of the .wac format, Wildlife Acoustics' proprietary compressed file format. To enable auto-identification of these recordings in SonoChiro, the files must first be converted into the .wav format through Kaleidoscope Pro.
- A6.6.2. While updates to both Kaleidoscope Pro and SonoChiro have become available since analysis of SM2 detector recordings began in 2013, these have not been used due to the potential for new parameters to be uploaded as part of these updates which may render results pre and post update incomparable.

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### Data Conversion

- A6.6.3. The auto-identification function of Kaleidoscope Pro was determined, following extensive trials, to be insufficient for the requirements of this analysis and has therefore not been used. However; the file conversion function has been used to enable the conversion of files from .wac to .wav format.
- A6.6.4. File conversion was undertaken using Kaleidoscope Pro set to convert the raw .wac files to .wav files at a time-expansion setting of 1, indicating that the data had not been recorded in a time-compressed manner and that expansion of this data was therefore not required.
- A6.6.5. Where data had been recorded by a stereo SM2 detector (that is, a detector with two mics (left and right) recording simultaneously); conversion to .wav format was undertaken with Kaleidoscope Pro set to split channels. Split channels refers to the separation of data recorded by the left and right mics. Following conversion to .wav format, separated data is distinguished through the presence of either ‘\_0\_’ or ‘\_1\_’ prior to the recording date within the file name. A ‘0’ within the file name indicates that the recording was made by the left mic while a ‘1’ within the file name indicates that the recording was made by the right mic.
- A6.6.6. Kaleidoscope Pro has the ability to apply a number of filters to the input data, for the purposes of conversion and auto-identification (the latter not used for these analyses). This includes an ability to filter out recordings that the software determines to be noise; to restrict the signals of interest (frequency, call duration, number of calls) and to apply signal enhancement.
- A6.6.7. To ensure that no restrictions were applied to the data converted, Kaleidoscope Pro was set to not filter noise, ensuring that all recordings, regardless of the presence of a bat call, were converted. Additionally signal enhancement was used to ensure the maximum amount of data was carried across the conversion process and signals of interest were set to as broad a range as possible (frequency 0-120kHz, call duration 0-500ms, and a minimum number of calls of 1) ensuring that no bat calls would be lost in the conversion process.
- A6.6.8. The conversion of files from .wac to .wav format results in the creation of a new set of files in .wav format and leaves the original ‘raw’ data untouched.

### Auto-identification

- A6.6.9. At the time of these analyses, SonoChiro was capable of identifying all known British bat species (including vagrants) to a group or species level. A full list of the classifications used by SonoChiro is provided in Table A6- 5 below:

Table A6- 5. Species and Group level identifications used by SonoChiro.

SonoChiro Classification	Species or Species Group
Barbar	Barbastelle
Eptnil	Northern bat ( <i>Eptesicus nilssonii</i> )
Eptser	Serotine
Myobec	Bechstein’s bat
Myonat	Natterer’s bat

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SonoChiro Classification	Species or Species Group
Nyclei	Leisler's bat
Nycnoc	Noctule
Pipkuh	Kuhl's pipistrelle ( <i>Pipistrellus kuhlii</i> )
Pipnat	Nathusius' pipistrelle
PippiT	Common pipistrelle
Pippyg	Soprano pipistrelle
Pleaur	Brown long-eared bat
Pleaus	Grey long-eared bat
Rhifer	Greater horseshoe
Rhipip	Lesser horseshoe
ENVsp	<i>Eptesicus/Nyctalus/Vespertilio</i> sp. ('big bat')
Myosp	<i>Myotis</i> sp.
Pip35	Kuhl's/Nathusius'/Savi's pipistrelle ( <i>Hypsugo savii</i> )
Pip50	Common/soprano pipistrelle
Plesp	Long-eared Bat
Rhipsp	Greater/lesser horseshoe bat
Chiro sp.	Bat sp.
Parasi	N/A – SonoChiro has not identified a bat call but cannot entirely rule out the potential for a bat call to be present.

- A6.6.10. SonoChiro provides bat call identifications through a two-stage process, with an initial detection stage and a secondary classification stage. The initial detection stage locates all recordings with the potential to contain bat calls; the programme has been devised to be highly sensitive at this stage to ensure maximum detection of bat calls. This can result in a large number of recordings not containing bat calls being considered as potential bat calls. However, such calls are filtered out during the second, classification stage.
- A6.6.11. At the classification stage, SonoChiro bases its identifications on an extensive library of pre-identified bat calls and related parameters, which are applied to an unknown bat call (or sequence of calls) to determine its identification. Classification initially identifies whether there is more than one species present within a recording. SonoChiro is capable of identifying up to three distinct bat call sequences on a recording. Where calls of only a single bat species are present, classification is undertaken on all calls within the recording; where multiple species are identified, classification is undertaken on the calls of each species separately.
- A6.6.12. SonoChiro provides identification results on three levels, based on a confidence scale. Identification is provided for the potential species represented by a call sequence (species-level identification), and this identification is assigned a confidence level on a scale of one to ten, with one indicating the lowest level of confidence in the accuracy of the identification and ten indicating the greatest level of confidence. A further

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identification is provided to the group level, and this is similarly provided with a confidence level on the same one-to-ten scale. A final, overall, identification is then provided. This overall identification is the one in which that SonoChiro has the greatest level of confidence in being correct. A threshold confidence level of five is the default setting provided by SonoChiro and this is applied at the species and group-level identifications stages to enable a determination of the overall identification to be made; this is described in greater detail below.

- A6.6.13. Starting from the species level identification, a threshold value of five is enforced. Where a species-level identification is greater than five, this identification is then provided as the overall identification. Where a species-level identification is less than or equal to five, the species-level identification is discarded and the group-level identification is considered. In this scenario, the same threshold value of five is enforced on the group-level identification; where this is greater than five the group-level identification is provided as the overall identification. Where it is less than or equal to five the group level identification is discarded and an overall identification of 'Chiro sp.' is used. An identification of 'Chiro sp.' indicates that there is a bat call (or calls) present, but that the auto-identification software cannot derive sufficient information from these to provide, to a suitably confident level, a species or group identification.
- A6.6.14. SonoChiro outputs are provided in a .csv spreadsheet format, which provides details of the three levels of identification (species, group and overall) and related confidence indices, as well as information on the time and date of the recording, the number of calls on which the identification has been based, and a range of call parameter values.

### *Auto-identification Process:*

- A6.6.15. SonoChiro was set to auto-identify those calls from bat species occurring within the British Isles within recordings made by SM2 detectors at a time-expansion setting of 1 which occur for a minimum of 0.5ms. The advised (default) sensitivity level of 7 was used and files deemed by the software as containing no bat calls were retained to allow for later manual verification as required.
- A6.6.16. The **overall** identification (defined above) provided by SonoChiro has been used in all analyses as this is the identification in which SonoChiro has the greatest confidence. It is this **overall** identification that has been used for further manual interpretation of these results.

### *Manual Interpretation*

- A6.6.17. SonoChiro identifications were provided in separate spreadsheets for each MS on each survey occasion. These outputs were summarised to provide indication of call frequency at each monitoring.
- A6.6.18. Further summarisation was undertaken through the grouping of similar species to provide an indication of the call frequency of each group across all MSs. The species groups used for this summarisation are provide in Table A6- 6 below:

Table A6- 6. Species groups used for manual interpretation and further analysis.

Species Group	Calls included
Barbastelle	Barbastelle
<i>Myotis</i> sp.	Natterer's; Bechstein's bat; <i>Myotis</i> sp.

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Species Group	Calls included
Big Bat sp.	Noctule; Serotine; Leisler's; Northern; <i>Eptesicus/Nyctalus/Vespertilio</i> sp.
Nathusius' pipistrelle	Nathusius's pipistrelle; Kuhl's pipistrelle; Nathusius'/Kuhl's/Savi's pipistrelle
Pipistrelle sp.	Common pipistrelle; soprano pipistrelle; Nathusius' pipistrelle; Kuhl's pipistrelle; common/soprano pipistrelle; Nathusius'/Kuhl's/Savi's pipistrelle
Long-eared sp.	Brown long-eared; grey long-eared; long-eared sp.

A6.6.19. Within grouped species summary tables, files that had not been given an identification were considered to be noise files and were therefore not included. Additionally, files that were identified by SonoChiro as 'Parasi' or 'Chiro' sp. were also not included. Files that had been identified by SonoChiro as greater horseshoe bat, lesser horseshoe bat or to the horseshoe bat group were also not included and were considered to be the result of constant high frequency background noise which can mimic the call parameters of horseshoe bats. This was considered acceptable, given the known distribution of greater and lesser horseshoe bats in the UK. However, as a single lesser horseshoe bat has been identified in Suffolk in the west of the county (many kilometres outside of the current known range), manual verification of a sample of recordings identified as greater or lesser horseshoe or horseshoe sp. was undertaken to confirm this assumption (see below).

### A6.7. Detailed Notes on the Manual Verification of SonoChiro Outputs

- A6.7.1. To ensure that the identifications provided through auto-identification by SonoChiro were accurate, and that recordings, particularly those for species of interest, were not being missed or wrongly identified, a series of manual verifications were undertaken.
- A6.7.2. All samples extracted for manual verification were taken randomly from throughout the survey period or MS, unless otherwise stated.

#### Noise Recording Verifications

- A6.7.3. To consider what proportion of bat calls may be being missed by SonoChiro (i.e. those not being provided with an identification and therefore being dismissed as 'noise' files), samples from 11 MSs (detailed in Table A6- 7 below) were considered following collection of SM2 data in seasons 1 (June) and 2 (July) of 2013.
- A6.7.4. The sample of recordings that was considered for verification was 10%, where this did not exceed 1,000 recordings (with the exception of the single set of recordings considered from S2) of the total number of recordings that had been dismissed as containing only 'noise' for that location by SonoChiro. These samples were taken at random from a complete list of the recordings considered as 'noise' by SonoChiro.

Table A6- 7. Summary of manual verification of SonoChiro identified 'noise' files.

Year	Season	Session	Monitoring Station	Number of 'noise' files checked	Percentage of 'noise' files found to have bat calls	Percentage of identified calls belonging to Pipistrelle sp.*
2013	1	1	2	633	39.97	52.43
2013	1	1	3	573	7.16	68.18
2013	1	1	4	197	16.24	96.97
2013	1	1	5	734	1.09	87.50
2013	1	1	6	1000	4.00	69.57
2013	1	1	8	208	21.15	95.74
2013	1	1	9	86	0.00	N/A
2013	1	1	11	195	19.49	72.50
2013	1	1	18	401	19.95	89.01
2013	1	2	20	465	64.73	91.08
2013	2	1	3	1350	11.11	70.13
Total				5842	16.9	75.83

\*including common pipistrelle, soprano pipistrelle, common/soprano pipistrelle or pipistrelle species. Not including Nathusius' pipistrelle.

- A6.7.5. Only 1.7% of those 'noise' recordings containing a bat call were manually identified as barbastelle and only 0.8% as Nathusius' pipistrelle. It was therefore determined that manual verification of all 'noise' recordings would not be undertaken. It was considered that the impracticalities of manually checking all 'noise' recordings, in relation to the number of recordings this would include and the time that such verification would require, was not justifiable based on the low number of calls from species of interest that were identified. More importantly, the loss of very low numbers of (often poor quality) bat calls within 'noise' recordings, in relation to the volume of data collected and correctly identified, would not prevent a clear picture of how the main development site is being used by bat species from emerging.

### Species Identification Verifications

#### *Barbastelle Identification Verification*

- A6.7.6. As a species of particular interest in relation to the consideration of the impacts of the proposed development, it was considered vital to ensure that use of SonoChiro for auto-identification of recordings recorded by SM2 detectors across the main development site accurately identified barbastelle recordings. Therefore a sample of recordings identified as barbastelle were manually verified
- A6.7.7. Approximately half of the barbastelle recordings identified in S1 session 1 (1,098 passes) from six MSs were manually verified to ensure that barbastelle recordings were being correctly identified. 99.5% of barbastelle recordings verified were found to be correct. The 0.5% of passes (six passes) that were not correctly identified were identified as soprano pipistrelle social calls which have been noted to be mistaken for

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barbastelle calls by others (Dean Waters; <http://vespero-consulting.blogspot.co.uk/>). The six calls found to be wrongly identified were all the secondary call (or call sequence) on a recording. It was noted through manual verification that a number of the correctly identified barbastelle calls were very faint, thereby indicating that SonoChiro is able to identify barbastelle calls that are only weakly recorded.

- A6.7.8. It was considered that the large amount of data collected over the two-year automated detector survey period, in addition to emergence and radio-tracking surveys, would ensure that the minor inaccuracy (0.5%) noted in barbastelle identification would not prevent a clear picture from being developed of how the main development site is used by barbastelle.

### *Nathusius' Pipistrelle Identification Verification*

- A6.7.9. As for barbastelle, a sample of recordings that were identified as Nathusius' pipistrelle were manually verified.
- A6.7.10. Manual verification was undertaken of all recordings identified as Nathusius' pipistrelle or Pip35 by SonoChiro for MS15 (along the tree-line) in S2 (July) session 1 in 2013. This MS, during this season, was chosen due to the unusually high number of recordings identified to the Nathusius' pipistrelle group (153 recordings).
- A6.7.11. While manual identifications did not always agree with the specific Nathusius' pipistrelle group identification (that is, some of the passes identified by SonoChiro as Pip35 were manually identified as Nathusius' pipistrelle and some identified by SonoChiro as Nathusius' pipistrelle were manually identified as Nathusius'/common pipistrelle), no recordings were manually identified to a species or species group outside of those already including in the Nathusius' pipistrelle grouping (see Annex 1: A1.1 for details of species groupings).
- A6.7.12. It was therefore considered that further manual verification of Nathusius' pipistrelle recordings was not required.

### *'Big bat' Identification Verification*

- A6.7.13. Due to the abnormally high number of recordings identified to the 'big bat' group (see Table A6- 6 for details of species groups) for MS12 in S2, 2013, a 10% sample (399 passes) of recordings identified as species falling within the 'big bat' species group were manually verified.
- A6.7.14. Manual verification indicated that 95.5% of passes within the sample were correctly identified. Of the remaining 4.5% of passes, the manual verification was found to disagree with the *species-level* identification provided by SonoChiro. However, in each case, the *overall* identification provided by SonoChiro was 'big bat', and the manual identification was of a species or species group that occurred within the 'big bat' species grouping.
- A6.7.15. Additional verification was undertaken of all passes of species assigned to the 'big bat' group occurring within TCs1&2; that is, between sunset and 40 minutes after sunset. Manual verifications of these passes was undertaken to determine if more detailed identification could be assigned to any of these, many of which had been identified as only ENVsp ('big bat') by SonoChiro.

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- A6.7.16. A total of 337 'big bat' calls were identified within TCs1&2; 15 within TC1 and 322 within TC2. Of these, 259 calls had been identified as ENVsp by SonoChiro.
- A6.7.17. Within TC1, manual verification identified eight of the SonoChiro ENVsp identifications as noctule while the remaining six were manually identified as *Nyctalus* sp. Five of the *Nyctalus* sp. manual identifications were considered to be a better fit for noctule rather than Leisler's bat; however a single *Nyctalus* sp. manual identification appeared to be a better fit for Leisler's bat. However this call sequence was within the parameters for both species and, as an isolated instance, it was considered that it did not provide conclusive evidence for the presence of Leisler's bat within the survey area.
- A6.7.18. Within TC2 manual verification identified 116 of the SonoChiro ENVsp identifications as noctule while the remaining 129 were manually identified as *Nyctalus* sp. Fifty-five of the *Nyctalus* sp. manual identifications were considered to be a better fit for noctule rather than Leisler's bat. No *Nyctalus* sp. identifications within TC 2 were considered to be a better fit for Leisler's bat.
- A6.7.19. A single pass within TC2, identified by SonoChiro as a 'Northern bat', was manually identified as serotine. No other serotine calls were identified within TCs1 or 2 by either SonoChiro or manual verification.
- A6.7.20. Further verification was undertaken of calls identified as 'Northern bat' by SonoChiro as the UK is outside of the known range of this species (vagrants are occasionally recorded in south-east England). A total of 416 calls were identified as Northern bat by SonoChiro over the two years of automated detector surveying. A 20% sample (85 calls) of these calls was manually checked to enable verification.
- A6.7.21. It was found that all (bar one) manually-checked calls identified by SonoChiro as Northern bat were found to be constant low-frequency background or electronic noise. Such constant low-frequency background noise (26-29kHz) can be mistaken for the echolocation calls of the Northern bat, as this species uses a call with a long constant-frequency element.
- A6.7.22. It was therefore determined that all calls that had been identified as Northern bat at the overall identification level would not be included in any further analysis. Additionally any calls that had been identified as Northern bat at the species identification level were also omitted from any further analysis, regardless of the overall identification provided.

### *Leisler's Bat Identification Verification*

- A6.7.23. Identification of Leisler's bats from echolocation recordings has been noted to be extremely difficult (Russ, 2012); it is therefore often considered necessary to identify such calls as *Nyctalus* sp.<sup>15</sup>
- A6.7.24. Only 16 recordings from automated detector surveys in 2013 and 2014 were identified as Leisler's by SonoChiro, all of which were recorded within 2014. Manual verification of all 16 recordings was therefore undertaken by an experienced bat call analyst. The

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<sup>15</sup> See also: Cornes, B. (2011). *Why can't you say for sure whether or not it's a Leisler's?* from *Bats in Beds: the newsletter for the Bedfordshire Bat Group*. Accessed at: <http://www.bedsbatgroup.org.uk/wordpress/wp-content/uploads/2011/06/2011-7-leislars.pdf>

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manual identification of these 16 recordings returned an identification of *Nyctalus* sp. for 15 of these calls; this was due to the lack of confidence with which a species level identification could be provided manually. The sixteenth call identified as Leisler's by SonoChiro was determined to contain insufficient information to enable identification as a bat echolocation call.

- A6.7.25. For this reason, 2,561 recordings previously captured by BSG on behalf of Amec were re-examined (2010: 991 calls; 2011: 1,570 calls). A filter within the software package AnaLook was applied to filter out all calls/elements of calls below 24kHz; i.e. those that within the noctule range that could not be distinguished from noctule. Each call was then analysed to determine whether any calls indicative of a two-part call (often referred to as a 'chip chop' pattern) indicating a Leisler's rather than serotine, were still present. From these, just 38 (2010: 21; 2011: 17) merited further examination.
- A6.7.26. The analysis focussed on the 'quasi constant frequency' component of the call. Each call was examined to determine if it was either: a) a high probability of being a Leisler's bat; b) a high probability of being other than a Leisler's bat; c) more likely to be two bats rather than an alternating two-part call. Of these, 10 (of 23) had a high probability of being Leisler's bat in 2010; 6 (of 17) had a high probability of being Leisler's bat in 2011; and 3 (of 17) were considered to be Leisler's bats.
- A6.7.27. *Based on the call parameters provided by Russ (2012), it can be assumed therefore that Leisler's bats are present. It is not possible to determine the proportion of 'big bat' calls that can be assigned to Leisler's bat with confidence; however, the low prevalence of calls that fit closely to Leisler's parameters rather than noctule would indicate that they are likely to be less common.*

### *Horseshoe Bat Identification Verification*

- A6.7.28. SonoChiro returned a number of recordings with identifications of 'lesser horseshoe', 'greater horseshoe' or 'horseshoe species' in both 2013 and 2014. Only a single lesser horseshoe bat has been recorded in Suffolk, in the north-west of the county, between 1996 and 2008, and no greater horseshoes are known to have been recorded within Suffolk. It was therefore considered that SonoChiro identifications of these species were likely to be a result of constant high frequency background noise which can produce noise at similar frequencies as those at which greater and lesser horseshoe bats echolocate.
- A6.7.29. To confirm this, a 10% (470) sample of calls identified as lesser horseshoe; greater horseshoe or horseshoe bat from MS15 in S3, 2013 was manually verified (this location was chosen due to the high number of identifications recorded to 'horseshoe'). All recordings within the considered sample were found to contain constant high-frequency background/electronic noise.

### *Bat species Identification Verification*

- A6.7.30. SonoChiro returned a number of recordings with an identification of 'Chiro sp.' indicating that a bat species was considered to be present but that insufficient information was present to enable a species or group-level identification to a suitable level of confidence. Such calls may often be recorded by automated detectors due to the sensitivity of the mics, which enables even very faint calls to be recorded. Calls of this nature are often very difficult, if not impossible, to identify even when considered manually.

## SUPPORTING INFORMATION

- A6.7.31. To determine the likelihood that identifiable calls, to the species or group level, were being missed within the Chiro sp. identification provided by SonoChiro, the species and group level identifications, and related confidence levels provided by SonoChiro were considered.
- A6.7.32. All Chiro sp. identifications from one mic from M15 in S2, 2014, were considered for verification due to the high number of Chiro sp. identifications at this location (5,134). SonoChiro will provide a species and group level identification to any recording not considered definitively to be noise, regardless of the confidence with which such identifications are made. Consideration of the species- and group-level identifications provided by SonoChiro clearly indicated a very low level of confidence in both identifications: for example, 99% of Chiro sp. that were identified as barbastelle at the species level had a species identification confidence level of 0; while 98.5% of Chiro sp. that were identified as barbastelle at the species group level had a group identification confidence level of 0, indicating that there was no confidence in these identifications.
- A6.7.33. For this reason, it was determined that recordings identified as Chiro sp. were highly unlikely to contain sufficient information to enable a species- or group-level identification even under manual consideration. Thus, calls identified as Chiro sp, were not considered during any further analyses.

END