Bat survey report for Cwm Gwyn, Llanbrynmair, Powys, SY19 7DY

Oakwood Ecology

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Summary

This report presents an assessment of the activity of bats at Cwm Gwyn, Llanbrynmair, Powys, SY19 7DY. The proposed development involves the renovation of the buildings and garden for residential use. It includes the results of a desk-study, a building inspection, a series of activity surveys and a winter survey. Industry-standard survey methodologies were followed.

There are no statutorily designated sites within 2 km of the development site. There are just seven historical records of bats within the search area, the closest record being 955m away.

Cwm Gwyn is surrounded by pastoral farmland and connectivity with the surrounding countryside is good. The habitats present significant potential for roosting, commuting and foraging bats.

The building inspection revealed evidence of bats roosting in the building and moderate potential for more, with field signs indicating a moderate level of usage.

Two activity surveys and a passive detector survey were carried out and the following species of bat were heard and/or seen: common and soprano pipistrelle, noctule, whiskered bat, Brandt's bat, Daubenton's bat, Natterer's bat, indeterminate Myotid species, long-eared bat, lesser horseshoe bat and indeterminate bat species. No consistent flight-lines related to the building were observed during the surveys.

A total of five bats were recorded using three different roost access points, including two Common Pipistrelle, one Soprano Pipistrelle, and two indeterminate Myotids Due to the low numbers of roosting bats present in the middle of the maternity period, all of these roosts are considered to be occupied by males or non-breeding females. A Lesser Horseshoe was recorded by the passive detector, and it is likely that it uses part of the building as a night roost. The crevices in the stonework may also be occupied by hibernating bats over the winter. Given the numbers of bats involved and the common and widespread nature of these species in this area, the roosts are deemed to be of only local value. The surrounding land-use fabric is common in the region, and so these habitats are also of only local value.

In the absence of any mitigation measures, all of the roosts will be lost as a result of the proposed development and bats may be physically harmed during this process. A mitigation strategy is proposed that would allow the development to go ahead with negligible adverse impact through a mixture of careful timing and specific working methods, along with compensation in the form of additional new roosts integrated into the renovated building. The legally protected status of all bat species means that a development licence must be granted before any works can take place, and a program of post-construction monitoring will be adopted.

1 Introduction

1.1 Background

1.1.1 This bat survey report was commissioned by Stewart Roberts to inform a planning application at Cwm Gwyn, Llanbrynmair, Powys, SY19 7DY (planning ref. 19/0481/HH, grid reference SH90510445, **Figures 1 & 2**).

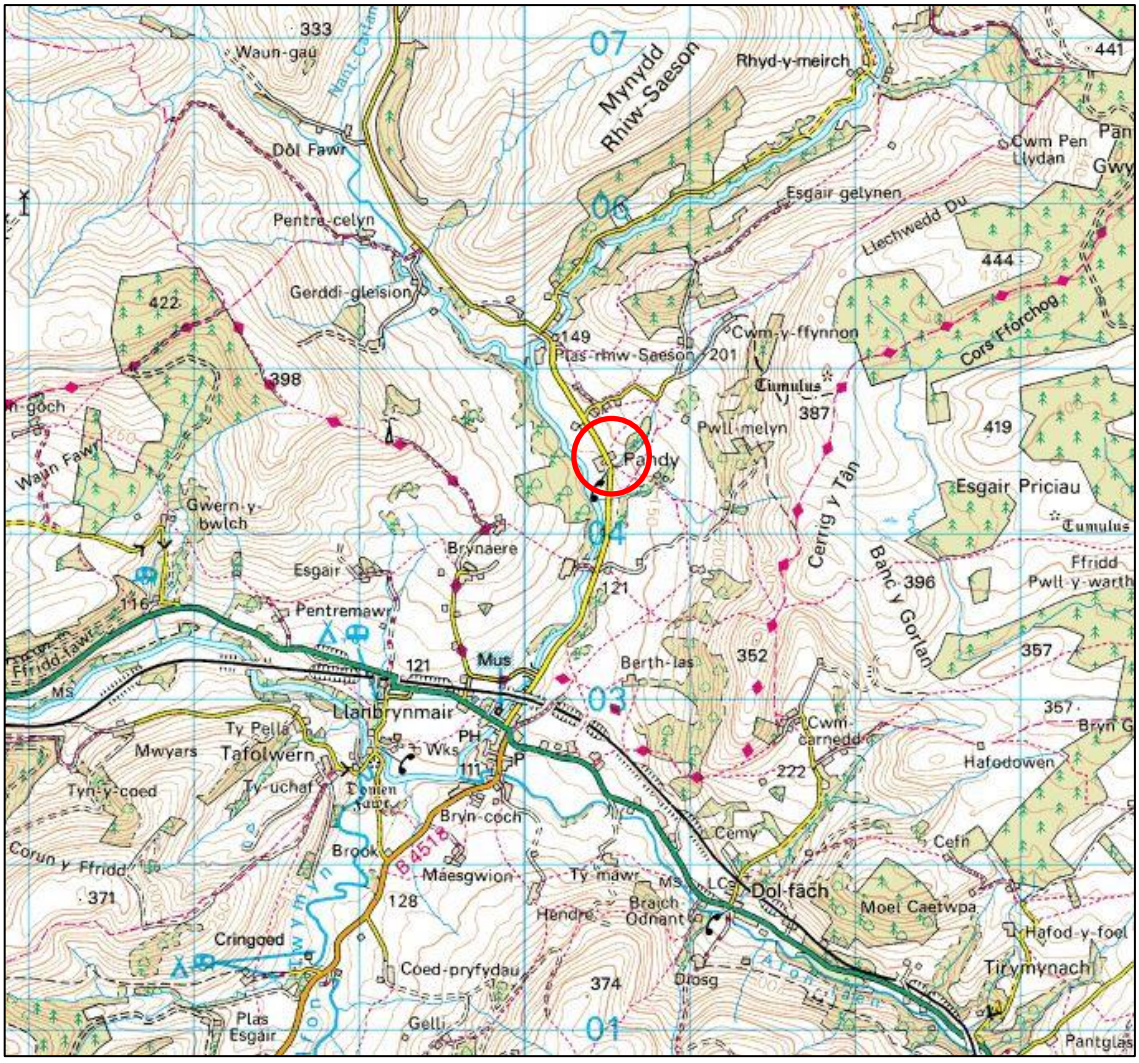

Figure 1. Location map of the development site at Cwm Gwyn (circled red).

(Reproduced under licence from Ordnance Survey, Licence No. 100056340).

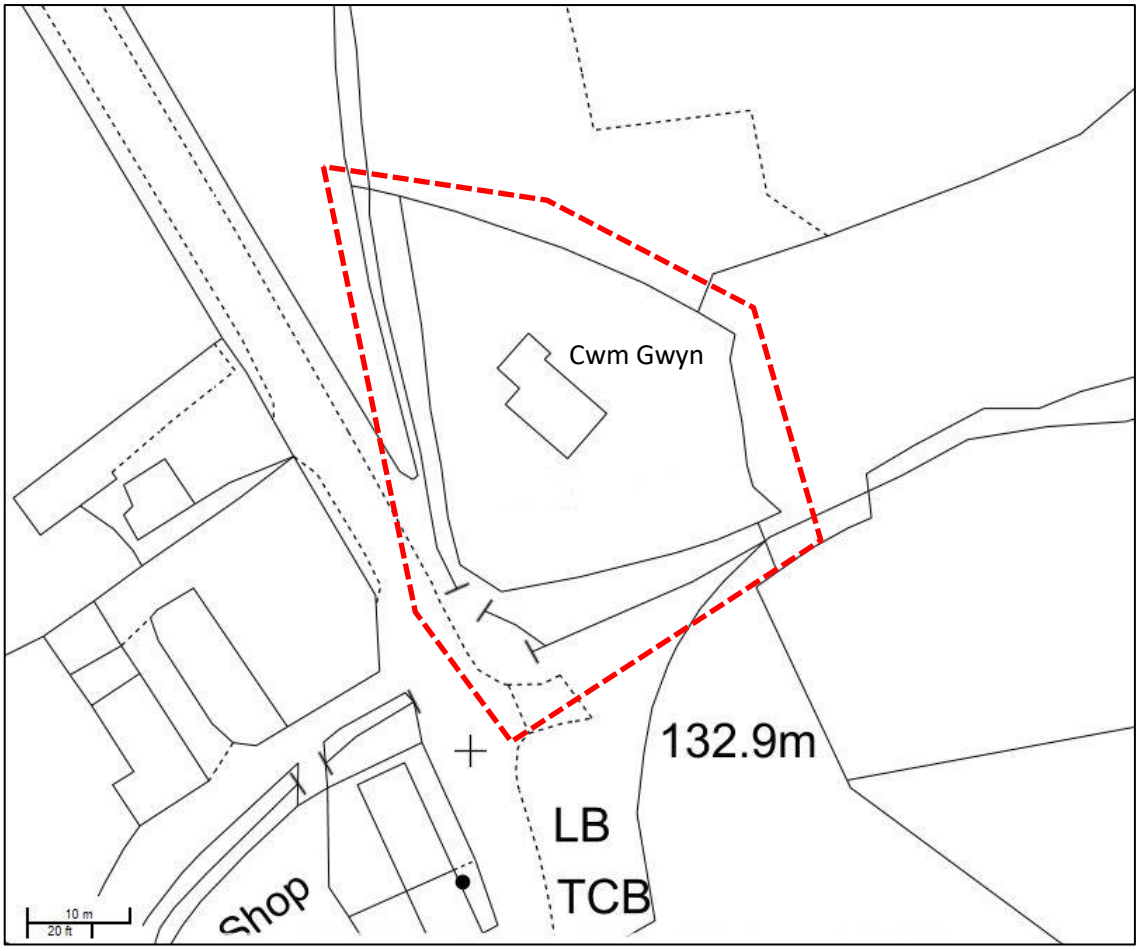

Figure 2. Map showing the layout of the existing buildings at Cwm Gwyn.

(Reproduced under licence from Ordnance Survey, Licence No. 100056340).

1.1.2 The proposed development involves the demolition of part of the dwelling, the erection of an extension, the excavation of land and all associated works (part retrospective) (**Figures 3 & 4**). The majority of the site has recently been completely cleared of vegetation, including some large trees, and significant earthworks have already taken place. It is not possible to comment on the potential for roosting bats that may have existed in this vegetation before clearance. Renovation work has also already started inside the house, and scaffolding was erected around the two chimneys of the house at some point between the building inspection and the start of the activity surveys.

Figure 3. Architect's plans of the existing building at Cwm Gwyn.

Figure 4. Architect's plans of the proposed development at Cwm Gwyn.

1.2 Aims of study

1.2.1 The aims of the surveys were:

- To establish the presence or likely absence of bats (Order Chiroptera) on the site, and;
- If they are found to be present, to carry out further survey work to determine the types of use, so that a suitable management strategy can be implemented, i.e., mitigation and/or compensation measures.

1.3 Authors qualifications

1.3.1 My formal qualifications include an MSc in Biological Recording from Birmingham University. I have attended many relevant short courses as part of my programme of Continuing Professional Development (including survey techniques, difficult sonogram analysis, ecological impact assessment and mitigation).

1.3.2 I am an active member of the Montgomeryshire and Shropshire Bat Groups, I am a licensed Roost Visitor and Surveyor in Wales and England (NRW Licence no. S086636/1) and I have been a self-employed Ecological Consultant since 2004, having worked with a wide range of habitats and species.

1.3.3 It is the policy of Oakwood Ecology, in accordance with the CIEEM Code of Professional Conduct and in compliance with the legal requirements of EPS survey licences, that all biological records collected during these surveys are submitted to the relevant local biological records centre.

2 Legislation and policy guidance

2.1 Legislation overview

2.1.1 All British bat species are protected by statutory law. Historically, national laws such as the Wildlife and Countryside Act (1981) (as amended) and the CRoW Act (2000) have provided partial protection, but the most wide-ranging and comprehensive legislation now stems from European legislation, which, in England and Wales, is enacted by the Conservation of Habitats and Species Regulations 2018.

2.1.2 Under these regulations, it is an offence to: deliberately capture, injure, kill or disturb any bat; damage or destroy a breeding site or resting place of a bat; be in possession of, or to control, transport, sell or exchange or to offer for sale or exchange any bat (living or dead) or part of a bat. With regard to bats, the term 'disturb' includes any roost, whether occupied or not, where the disturbance will a) impair their ability to survive, reproduce or rear their young, or to hibernate, and b) affect significantly the local distribution or abundance of that species.

2.1.3 With regards to the Local Authority policy, the presence of a protected species is a 'material consideration' in the planning process. It is, therefore, essential that the presence or otherwise of a protected species, the extent to which they will be affected by the development, and any mitigation and compensation measures are established before planning permission is granted.

2.2 Licensing

2.2.1 In order to carry out work which may affect any European Protected Species (EPS) in the ways outlined above, an EPS License is required. For an ecological surveyor in Wales, this means a Survey Licence. For a particular development, a project-specific derogation must be granted in the form of a development licence from Natural Resources Wales (NRW).

2.2.2 In order to qualify for a development licence, the development must meet the 'three tests':

- It must preserve public health or public safety or satisfy other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment (Reg. 55 (2) (e));
- There is no satisfactory alternative (Reg. 55 (9) (a)), and;
- The action authorised will not be detrimental to the maintenance of the species concerned at a favourable conservation status in their natural range (Reg. 55 (9) (b).

3 Methodology

3.1 Desk study

3.1.1 Bats are highly mobile species, so the desk-study search area covers a two-kilometre radius from the development site and includes all records of these species and all designated sites.

3.1.2 The following sources were consulted:

- Powys Biodiversity Information Service (BIS) (www.bis.org.uk)
- The MAGIC GIS website (http://www.magic.gov.uk/MagicMap.aspx)

3.2 Field survey

3.2.1 All landscape-scale habitat features in the immediate vicinity that may be used by bats are identified, including any habitats suitable for foraging, commuting, or roosting.

3.2.2 The building inspection and dusk/dawn activity survey methodologies follow the guidelines published in Mitchell-Jones & McLeish (2004) and Collins (2016). The materials used in building construction can influence which species may be present, and specific design details can provide opportunities for a range of British bat species, so these features are noted as part of the survey.

3.2.3 This survey involves an external and internal examination of the whole building to check for bats and the field signs that they produce, and an assessment of the habitats in the immediate vicinity to assess their suitability for commuting and foraging bats.

3.2.4 Field signs can include: live bats present, bat corpses, droppings, feeding remains, oil and/or urine staining, or a distinctive smell, all of which, by virtue of their location or other characteristics, can be species-specific. The presence of suitable holes and crevices is also noted, although, by themselves, these are not evidence of occupation.

3.2.5 Various items of specialist equipment are used to aid the building inspection, including: ladders, powerful torches (1 million candlepower), an endoscope and mirrors for investigating crevices and inaccessible nooks and crannies, close-focussing binoculars, a measuring tape, a compass, and a camera.

3.2.6 Based on the findings of the building inspection, a proportionate number of activity surveys were carried out to ascertain the species and number of bats present on the site, and the specific features used by them. Dusk surveys run from 15 minutes before sunset for two hours 15 minutes, and dawn survey run from two hours before sunrise until sunrise. A suitable number of surveyors were used to provide effective coverage of each building, with most attention being directed towards the

areas deemed most likely to harbour bats, as highlighted by the building inspection. If applicable, a bat detector was also left inside the building overnight to passively record bat activity.

3.2.7 Specialist equipment used during these surveys includes: Anabat Walkabout, SD2 and Wildlife Acoustics Echometer Touch 2 Pro bat detectors (with real-time sonogram display), Elekon Batscanner heterodyne bat detectors, Anabat Express bat detectors for passive recording, Yukon 1×24 Night Vision Goggles with infra-red torches, a Yukon Exelon 3 × 50 night-vision scope, and a set of Binatone Walkie-Talkies to assist in tracking bats between surveyors.

3.2.8 All of the full spectrum bat detectors are capable of recording sonograms, and these were analysed using specialist computer software (Anabat Insight and AnalookW) to identify individuals to species level where possible. Each of the bat species found in the UK can have significantly different requirements, so this determination may be important when considering appropriate mitigation measures.

3.2.9 The sonograms recorded on these surveys have been identified using the criteria given in Russ (2012), Middleton *et al.* (2014) and from information imparted on training courses (S. Sowler, G. Billington & M. Worsfold pers. comm's.).

3.2.10 Different bat species produce sonograms of varying distinctiveness. The Pipistrelles, and Noctules recorded during these surveys are usually relatively straightforward to identify from a sonogram. The different Myotis species can be difficult to distinguish even when a high-quality sonogram is recorded because they are so similar. Natterer's and Daubenton's bats can sometimes be identified with a reasonably high degree of confidence (80%), whereas Whiskered and Brandt's Bats are less easy to separate (approx. 60% confidence, i.e., the bat is slightly more likely to be a Whiskered than a Brandt's).

3.2.11 A recording on the bat detectors is triggered by an individual bat call (or other similar ultrasound noise). For the purposes of this report, a bat pass is defined as a series of calls which emanate from a bat as it flies past, or the duration of a 15 second Anabat file, whichever is the shorter. The frequency of calls is categorised on a subjective scale ranging from Constant, through Frequent and Occasional to Rare. Continuous calls do not necessarily indicate a steady stream of bats, as all of the calls may be emanating from one bat repeatedly passing within range.

4 Results

4.0.1 Representative photographs of the site and salient features are included in **Appendix 1**; **Appendix 2** tabulates the raw survey data; and **Appendix 3** presents some representative sonograms of bat calls recorded during the activity surveys. The results of the historical records search contain some sensitive information and is only available to third parties by request.

4.1 Desk study

Designated sites

4.1.1 There are no designated sites within the 2km search radius (**Figure 5**).

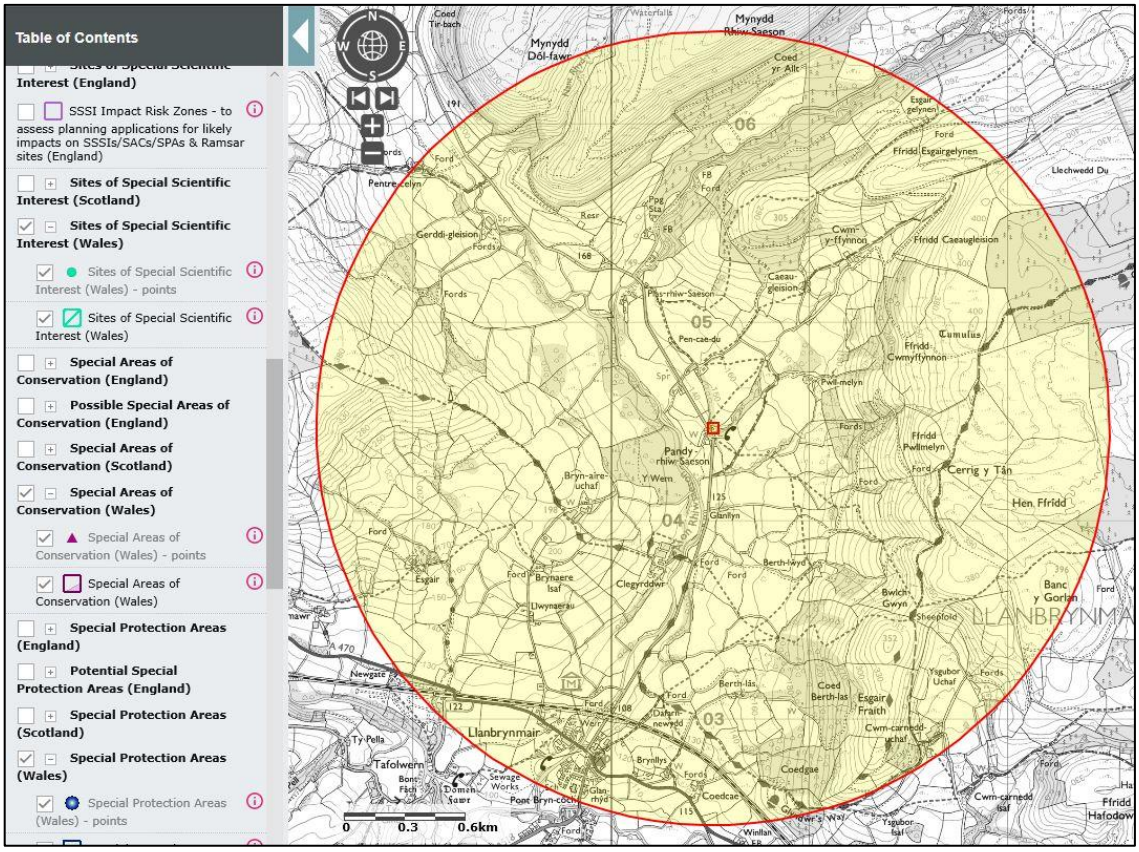

Figure 5. Screenshot showing the lack of designated sites within 2km of Cwm Gwyn.
(Imagery from MAGIC website).

Historical records

4.1.2 There are seven historical records of bats within the 2km search radius. These include undifferentiated pipistrelle species, brown long-eared bat (*Plecotus auritus*), and indeterminate bats. Three of these records are noted as roosts, the remainder do not specify the type of record, and the closest was of an indeterminate bat 955m from Cwm Gwyn.

4.2 Preliminary field survey

Habitat description

4.2.1 The buildings and surrounding site at Cwm Gwyn were surveyed on the 14th of May 2019 (see photographs in **Appendix 1**).

4.2.2 Due to recent clearance work, the plot itself is mostly bare soil and gravel hard-standing, with the remains of a small overgrown garden at the front (SW side) of the house. The property as a whole is surrounded by mostly pastoral farmland, and the habitats in the immediate vicinity include grassland, reasonably intact hedgerows with mature trees and woodlands are nearby, a small river (the Afon Rhiw-saeson) runs north-south approximately 150m to the west, and a wooded dingle runs along the southern boundary of the site(**Figure 6**).

Figure 6. Aerial photograph showing the habitats in the vicinity of Cwm Gwyn.
(Imagery dates from 2009, courtesy of Google Earth)

4.2.3 The grasslands are either permanently grazed or they are shut up for silage. There are some small groups of trees nearby, and there are significant woodlands within one kilometre. Connectivity with the surrounding countryside is good, and this mixture of habitats presents significant potential for roosting, foraging and commuting bats.

Building inspection

4.2.4 There are two buildings on the site - the house and a small shed. Both are of pre-20th century origin. The house has been built in at least two phases; the oldest part has solid rubble-filled walls faced with dressed field stone. A single-storey lean-to extension has been added on to the north-western end of the house, and the north-eastern wall of this has been removed at some point. Internally, an extra layer of concrete blocks has been added to parts of the walls. A more modern two-storey extension has been added to the south-eastern end of the house, with walls constructed of concrete block (probably with an internal cavity). Internally, there has been some recent renovation work, and all rooms in two-storey part of the house are plaster-boarded and have been used as living space.

4.2.5 The house roof is of traditional timber frame construction, with trusses and purlins supporting rafters and battens. The entire roof is covered with slates and is pitched to a central ridge. The eaves are mostly closed by boarding, although this has collapsed in places. The second-floor room extends to the apex of the roof, and there are no lofts.

4.2.6 The walls of the shed are constructed of similar materials to the older part of the house, and the roof is constructed of timbers (rafters and battens) and covered with slate.

4.2.7 In terms of potential roost features for bats, there were raised ridge tiles and slates, holes in some of the coverings over the eaves, gaps in the stone walls where mortar had fallen out, and a gap between the original wall and the new concrete block wall inside the north-western lean-to extension, all of which formed crevices suitable for roosting bats. The back door of the house, the door of the shed and the north-eastern wall of the north-western lean-to were all missing, which would allow fly-in access inside these rooms for bats.

4.2.8 The only evidence of bat-roosting encountered during the inspection was 12 fresh droppings found stuck to the concrete block wall inside the north-western lean-to extension. The size and shape of these indicated that they were produced by a small species of bat (Pipistrelle or small Myotid). They were located under an obvious crevice in the top of the wall, partially covered by a rafter.

4.3 Bat activity surveys

4.3.1 One dusk emergence survey and one dawn re-entry survey were carried out and the physical parameters of these are presented in **Table 1**, along with a summary of activity levels. A full list of sonograms recorded is presented in **Appendix 2** and sample sonograms are presented in **Appendix 3**. The locations of the vantage points are shown on **Figure 7**; these were chosen to provide effective coverage of the parts of the building that offered significant potential for roosting sites, and the surveyors included Simon Cope, Nicola Wheeler (licence no. S086637/1), Tony Hodges

(S085038/1), Simon Mootz and Kirsty Martuccio (the latter two are unlicensed but suitably experienced and supervised trainees).

4.3.2 The species recorded during the dusk and dawn surveys included common and, soprano pipistrelle (*Pipistrellus pipistrellus* and *P. pygmaeus*) (Ppip and Ppyg respectively in the tables below), indeterminate pipistrelle species (Pip), whiskered bat (Mmys), Brandt's bat (*Myotis Brandtii*; Mbr), Daubenton's bat (*M. daubentonii*), indeterminate Myotid species (Myotis), long-eared Bat (Plec), and indeterminate bat species (Unknown; usually due to an indistinct sonogram).

Survey #1: 28th June 2019, Start: 21:27, Finish: 23:42		
Weather:	Dry, no wind, no cloud	
Temperature:	21.1 - 16.7°C	
Recorder	**Location**	**Activity observed**
Simon Cope	VP1 (NE side)	**One Ppip emerged** from inside lean-to extension Frequent passes of Ppip Occasional passes of Ppyg, Pip and Mmys Rare passes of Myotis, Plec and Unknown (quiet bat flying inside lean-to extension at 23:37)
Simon Mootz	VP2 (NW gable)	No bats observed Constant or frequent passes of Ppip Occasional passes of Ppyg and Myotis Rare passes of Plec, Md and Mmys
Nicola Wheeler	VP3 (SW side)	No bats observed emerging from roosts Occasional passes of Ppip Rare passes of Pip, Ppyg and Myotis
Survey #2: 3rd August 2019, Start: 03:35, Finish: 05:35		
Weather:	Dry, no wind, up to 1/3 cloud cover	
Temperature:	14.9 - 12.0°C	
Recorder	**Location**	**Activity observed**
Simon Cope	VP1 (NE side)	**1 quiet bat and 1 Myotis entered** gaps behind block wall in lean-to extension (03:41 & 04:01 respectively), both emerged (Myotis sonograms) at 04:55 **1 Ppyg entered roost** above NW wall inside lean-to extension **1 Ppip entered roost** in lean-to (roost identified during building inspection) Frequent passes of Ppip until 04:15, then occasional Occasional passes of Myotis and Md Rare passes of Plec and Mmys
Kirsty Martuccio	VP2 (NW gable)	No bats observed entering roosts Frequent passes of Ppip Occasional quiet bats flying overhead

Recorder	Location	Activity observed
Tony Hodges	VP3 (SW side)	No bats observed entering roosts Constant or frequent passes of Ppyg throughout survey Occasional passes of Ppip Rare passes of Plec, Myotis and Unknown
Nicola Wheeler	VP4 (SE gable)	No bats observed entering roosts Frequent passes of Ppip and Ppyg throughout survey Occasional passes of Plec, Myotis and Md Rare passes of Pip and Unknown

Table 1. Survey parameters recorded, and roosting bats and activity levels observed during the activity surveys at Cwm Gwyn.

4.3.4 Over the two activity surveys, a total of five bats were recorded using four different roost access points (**Figure 6**). These included:

- Two common pipistrelles (possibly the same bat emerging and entering from the roost identified during the building inspection);
- Two indeterminate Myotids (either whiskered or Daubenton's bats judging by the sonograms), which entered a gap between the concrete block wall and the original house wall inside the lean-to extension and then were observed emerging later on in the same survey. The purpose of this roost is unclear - it may simply be a resting place, or it could be a mating roost (chasing behaviour was observed during the August survey);
- One soprano pipistrelle, which entered a roost above the northwest wall of the lean-to extension (probably under the lining of the roof near the eaves).

4.3.5 No consistent flight-lines were recorded.

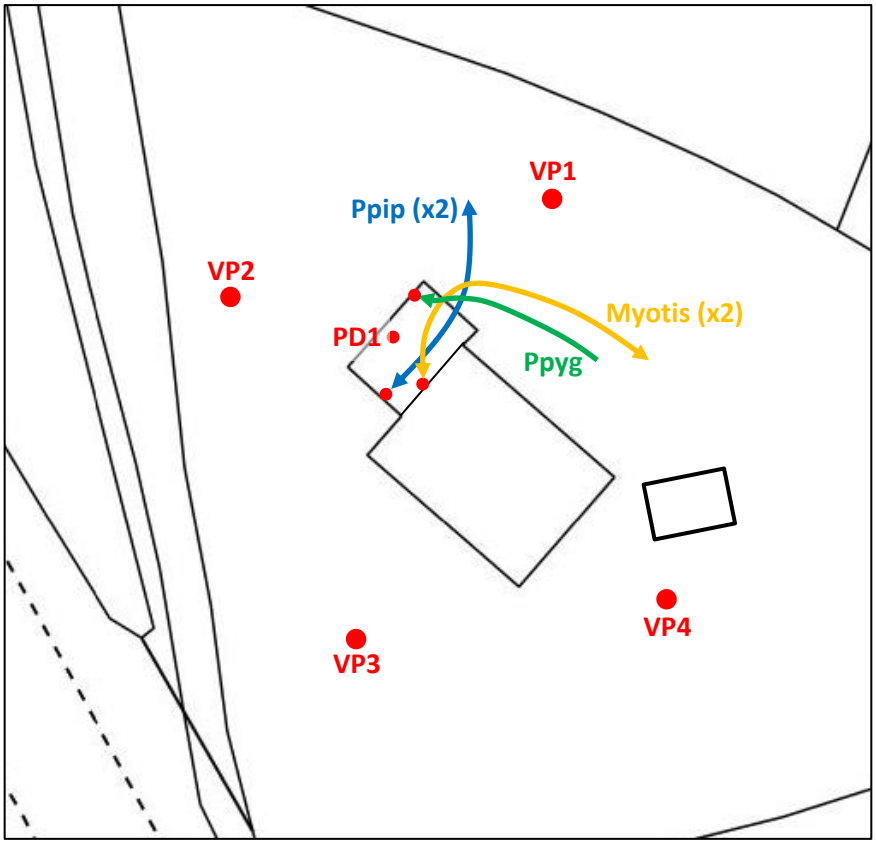

Figure 6. Map showing the location of the evidence of roosting bats found during the building inspection, the vantage points used, the location of passive detector (PD1) and the roost access points observed during the activity surveys (also see photographs in **Appendix 1**).

4.3.5 A passive detector was deployed inside the lean-to extension over five nights (03/08 - 07/08/2019). **Figure 8** shows the bat activity recorded by this detector.

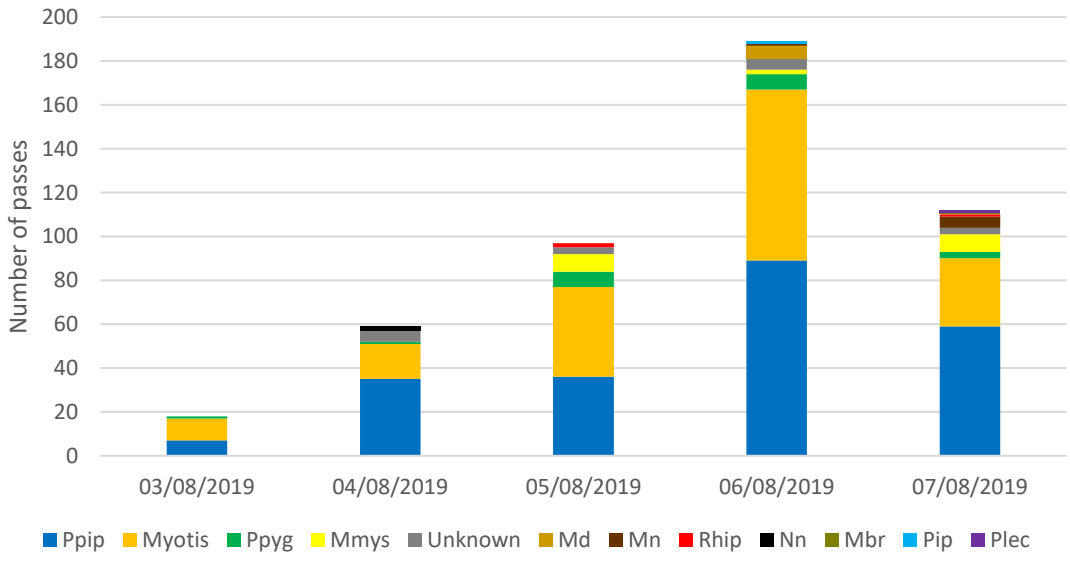

Figure 8. Graph showing activity levels recorded on the passive detector deployed in the north-west lean-to extension.

4.3.6 Unsurprisingly, given the observations recorded during the activity surveys, the passive detector recorded large numbers of passes by common pipistrelle and indeterminate Myotids, along with smaller numbers of calls produced by soprano pipistrelle, long-eared bats, and other Myotids.

4.3.7 Additional species recorded by the passive detector included Natterer's and lesser horseshoe bats, both of which are normally relatively quiet bats that are usually only detected when passing relatively close to a detector. This implies that both of these species were flying inside the lean-to extension. Lesser horseshoe bats in particular habitually use open built structures as night roosts, to rest or feed while hanging up. The occurrence of lesser horseshoe calls on two of the five nights makes it likely that the lean-to extension is used for this purpose.

4.4 Roost characterisation

4.4.1 All of the roosts were occupied by solitary bats or small numbers of species that are normally colonial in their maternity roosts, so they are all considered to be day roosts occupied by solitary males or non-breeding females; no obvious maternity roosts were recorded.

4.4.2 It is likely that the various access points lead directly into small crevices. The surrounding materials included rough-sawn timber (beams and wooden planks), stone, slates, and concrete blocks. Given these materials and their aspects, the roosts are unlikely to be warm and are probably used by bats that go into torpor every day. It is possible that these roosts could be used by hibernating bats, but probably not by significantly more bats than were recorded during these surveys.

4.4.3 There was no artificial lighting directly illuminating any of the access points.

5 Assessment

5.0.1 The principles of this assessment are based on best practice guidelines published by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2019).

5.1 Constraints

Survey information

5.1.1 All parts of the building were open to inspection and weather conditions were good during the surveys. The scaffolding erected around the chimneys partially obscured views of the chimneys, parts of the roof and walls of the house, and may have obstructed bat roost access points.

5.1.2 All of the surveyors were suitably experienced bat workers. Simon Cope, Nicola Wheeler and Tony Hodges are licensed, and Kirsty Martuccio and Simon Mootz are trainee bat workers who competently fulfilled their role as reliable observers and recorders under close supervision.

Equipment used

5.1.3 There were no constraints with regards to equipment.

5.2 Current Value of the site

Designated sites

5.2.1 The development site does not lie within, and is not immediately adjacent to, any designated sites. There are no designated sites within 2km of the proposed development site.

Bat roosts

5.2.2 The species definitely roosting within the house at Cwm Gwyn include common and soprano pipistrelle, and indeterminate Myotid bats. These individuals are considered to be solitary male or non-breeding female bats, with the pipistrelles occupying occasional day roosts. The Myotids were recorded inside their roost for just over 1 hour; this does qualify as a roost, but its purpose is unclear. It is also likely that lesser horseshoe bats utilise the lean-to extension as an occasional night roost. No bats were observed roosting in the small shed.

5.2.3 All bat species are protected by European legislation. At a national (UK and Wales-only) level, the populations of the species recorded at this site are considered to be either stable or increasing (Bat Conservation Trust, 2019). There are no available data on the regional or local population numbers and trends.

5.2.4 Given the relatively common and widespread nature of the species involved and the small numbers of bats present, the roosts are deemed to be of only local value.

Foraging and commuting habitat

5.2.5 The presence of semi-natural grassland, hedgerow, and woodland near to the site, and the proximity of flowing water, qualifies this area as high-quality foraging habitat for a wide range of bat species. The nearby hedgerows, stream and river are also highly suitable as linear commuting routes. This land-use fabric is common in the region, and so these habitats are of only local value. None will be significantly affected by the proposed development.

5.3 Impact assessment

5.3.1 The potential impacts of the development at Cwm Gwyn comprise those felt in both the short- and long-term and include any impacts that may continue to be felt after the development has been completed. In the absence of any mitigation measures, the following impacts can be predicted:

- **Disturbance, and risk of injury and/or death** - it is certain that individual bats could be disturbed and/or physically harmed during the development, especially when roofing materials and wooden fixtures are removed. This would be a temporary, reversible impact only, during the development phase;
- **Roost loss** –it is certain that all of the roosts accessed inside the lean-to extension will be obstructed or destroyed during the renovation. Given the numbers of bats involved, this is likely to have a minor but permanent, irreversible negative impact at a local level.
- **Fragmentation and isolation** – the site has already been cleared of most vegetation in the immediate vicinity of the building. An aerial photograph of the site (**Figure 6**) shows the building standing amidst what is effectively woodland, and tree stumps remaining around the buildings corroborate this. The impact of the loss of this vegetation is not known due to the lack of baseline survey data recorded before site clearance. There are no plans to alter any of the habitats further afield.
- **Post-development interference** - in the long-term, an increase in external artificial light levels around the property will curtail the foraging and commuting activities of light-avoiding species that were recorded in low numbers during the surveys (i.e., Lesser Horseshoe Bats, Long-eared Bats and Myotid species).

5.3.2 Overall, the proposed development will have a minor negative ecological impact at a local level. Given the relatively low ecological value of the roosts at a regional or national level, the overall conservation status of the species involved will not be significantly affected.

6 Recommendations and mitigation

6.1 Further survey work

6.1.1 No further survey work is required. The surveys undertaken to date are proportionate to the development and allow the usage of the site by bats to be described adequately.

6.2 Mitigation measures

6.2.1 The principle of mitigation in the broad sense involves a hierarchy of desirable outcomes designed to maintain or promote the conservation status of the species concerned, as follows:

- Avoidance – can the development be designed so that there will be no negative impacts?
- Mitigation – can the development be designed to reduce the negative impacts?
- Compensation – can the unavoidable impacts be compensated for?

Avoidance

6.2.2 There is no scope within the curtilage of the proposed development for avoidance, i.e., there no other buildings that may be used as dwellings instead.

Mitigation for bat roosts

6.2.3 The renovation of the house at Cwm Gwyn will necessitate the destruction of all of the bat roosts contained within it. The loss of these roosts will be compensated for by the provision of new purpose-made roosts, and the negative impact of this loss, and the possibility of harm and/or disturbance to the bats, can be mitigated by the following recommendations (based on guidance given in Mitchell-Jones, 2004):

- A suitably qualified ecologist will be appointed as the Ecological Clerk of Works (ECoW), and he/she will attend and supervise the crucial phases of the development so that any bats that are found can be preserved.
- Three bat boxes (one for each species) will be erected in suitable places in the vicinity of the building (under the advice of the ECoW) at least two months before work commences. A suitable proprietary bat box is the Schwegler 1FD B bat box (bat boxes that are also used by birds are not suitable; the presence of internal baffles prevents this), or a home-made box along the lines of the 'Kent Bat Box' is also suitable (**Appendix 4**).
- All site workers will receive a toolbox talk on the legal protection of bats and how to proceed if a bat is encountered – namely, re-cover the bat if possible, without causing harm, stop all work and notify the ECoW.

- The destructive parts of the works will be timed to avoid the possibility of disturbing hibernating bats, i.e., it will be carried out in the active season between March and November.
- The stonework will only be re-pointed during the bats active season (March – November). To exclude the bats, all crevices in the stonework (and behind the concrete block wall in the lean-to extension) will be investigated using an endoscope by a suitably qualified ecologist to ensure the absence of bats. If no bats are present, the entrance will be blocked with a removable rag until it is re-pointed. If a bat is present in a crevice, or if the cavity cannot be fully observed, a one-way door will be installed on the entrance (in accordance with guidance given in Mitchell –Jones & McLeish, 2004) and work will be delayed for up to four suitable flying nights or until the bat is observed to leave the roost. A suitable flying night is one that has a temperature above 6°C, with light winds and little or no rain.
- The existing roosts underneath roof coverings and/or wooden fixtures will be dismantled gently by hand. The ECoW will be on hand to deal with any bats that are found, and these will be captured and detained during daylight hours in a suitable container, to be released at the point of capture at dusk on the same day. The current roosts will be made unsuitable in one day so that the bats cannot return to them. In general, the guidelines presented in the 'Rescue and Collection' section of the Bat Care Guidelines (Miller, 2016) will be followed for the care of any captured bats.

Compensation for the loss of bat roosts

6.2.4 Bats currently use the building for day roosting in, possibly as a night roost and a mating roost. To compensate for the loss of these functions, the following will be implemented:

- Replacement roosts will be integrated within the renovated buildings. In the spirit of a 'like-for-like' provision, most of these will be small crevices that replicate those previously occupied by small numbers of bats (**Figures 9 & 10**), following the principles outlined in Gunnell *et al.* (2013). Crevices will be formed behind all fascia and barge boards, and underneath four raised ridge tiles.
- All timber that could come into contact with bats, i.e., in and around roosts, will be rough-sawn and untreated (or treated with suitable bat-friendly preservatives - detailed advice and a list of suitable products can be found at https://www.gov.uk/guidance/bat-roosts-use-of-chemical-pest-control-products-and-timber-treatments-in-or-near-them).
- No spun-bonded Breathable Roofing Membranes (BRM's) will be used in the renovated building where they will come into contact with bats; all membranes in bat roosts will be hessian-backed bitumen roofing felt (type 1F). It is a common misconception that bitumen roofing felt is no longer allowed by Building Regulations, but this is not true. The regulations that apply to this situation are parts L1B (domestic) and Part C (condensation and ventilation). Part L1B states that contractors must "assess the condensation risk within the roof space and make appropriate

provisions in line with part C relating to the control of condensation". Part C then goes on to recommend meeting the recommendations made in BS 5250:2011. In this document, it is made clear that both High resistance (bitumen) and Low resistance (BRM) underlays are acceptable as long as appropriate ventilation is provided. The materials must comply with British Standards, national technical certificate, or another acceptable EU certificate (which bitumen felt does).

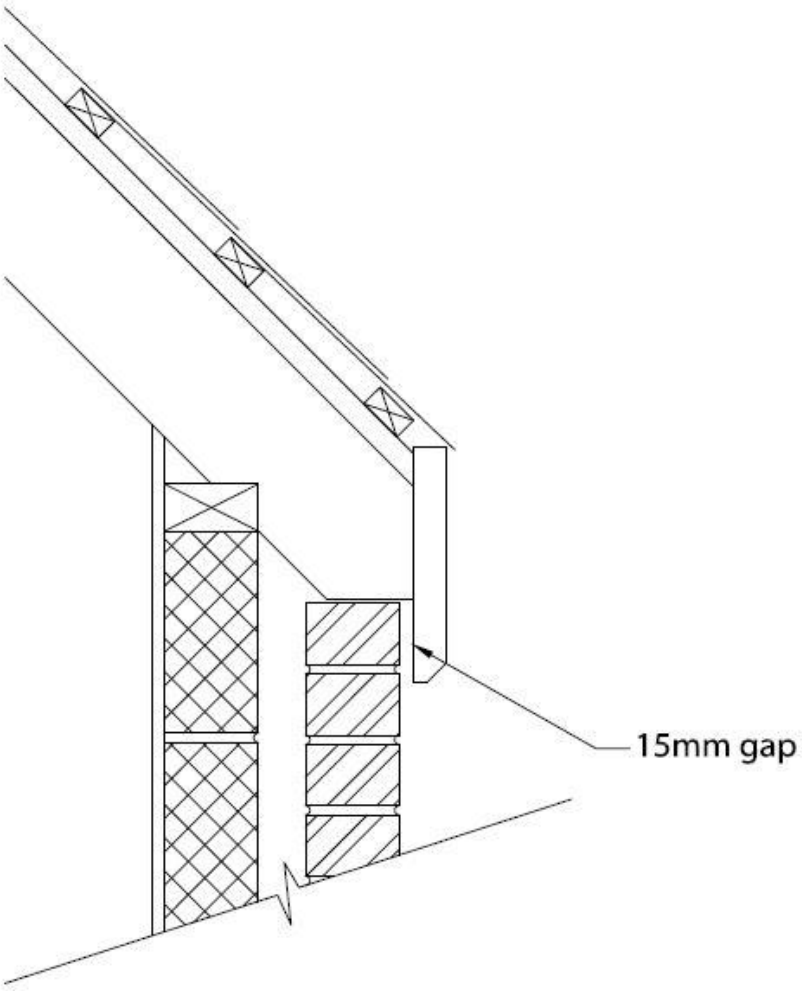

Figure 9. Generic diagram of replacement crevice roost behind all new fascia boards and barge boards on the renovated buildings.

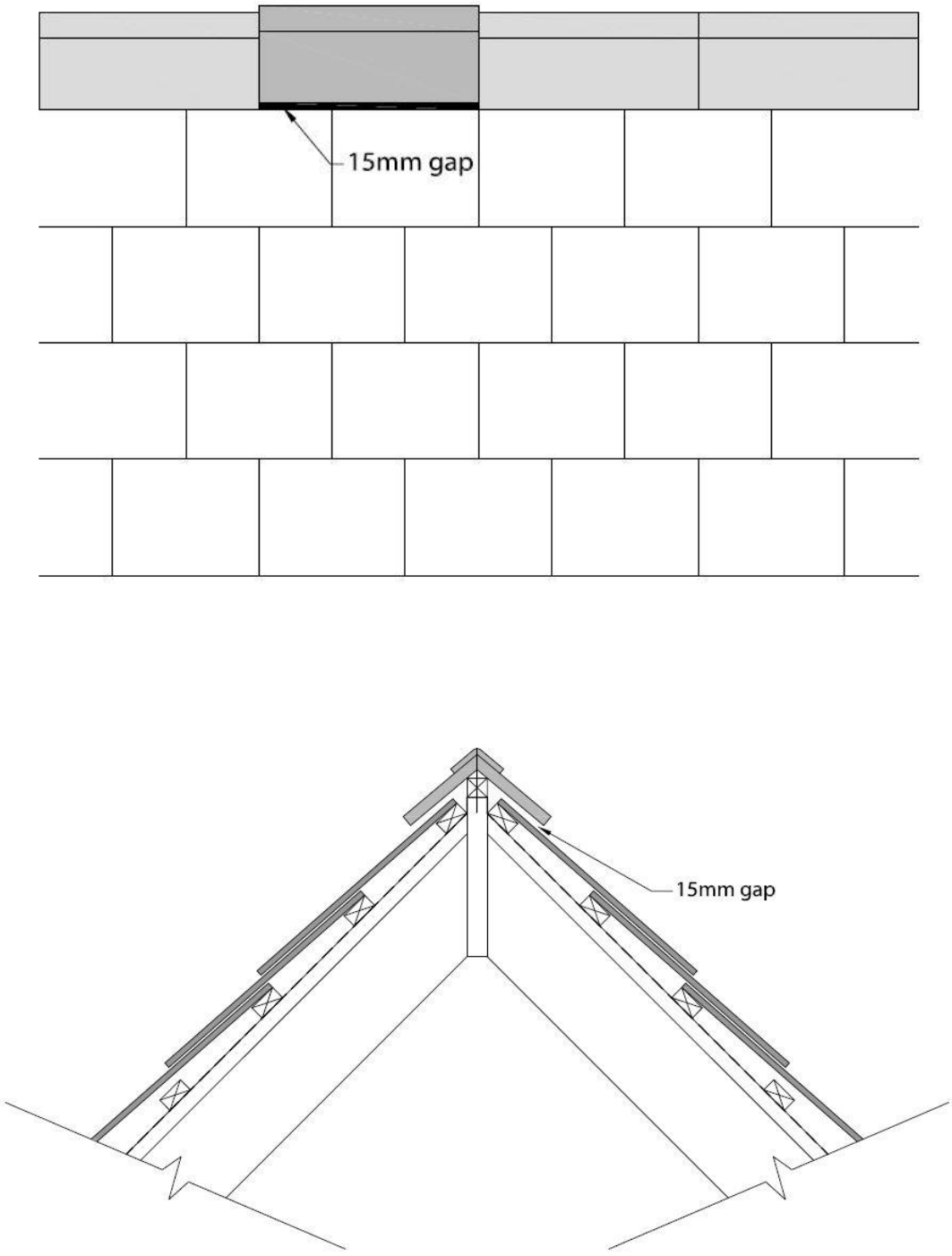

Figure 10. Replacement crevices under ridge tiles (× 4).

- The entrances to roosts will not be directly illuminated by artificial lighting. All external artificial lighting will be installed at as low a height, intensity and spacing as practicable; it will be directed towards the ground by cowling and movement-activated by Passive Infra-Red (PIR) sensors on a short period timer (≤ 1 minute). 'Warm white' (long-wavelength (>510nm)) bulbs with reduced UV output will be used,

blue/white bulbs will be avoided. There will be no external lighting that is permanently left on.

- The loss of the probable lesser horseshoe night roost in the lean-to extension will be compensated for by leaving a fly-in access to the renovated shed through a permanently open window or door.

Mitigation for foraging and commuting habitat

6.2.5 There will be a negligible impact on the surrounding habitats, so no mitigation will be necessary.

Post-construction monitoring

6.2.6 Post-construction monitoring will be carried out to ascertain the continued usage of the site and the success of these mitigation and compensation measures. This will involve one emergence survey carried out between mid-May and August in the second year after the completion of the development, and an inspection of the renovated shed to check for signs of use as a night roost. The records of any bats found will be submitted to the local Biological Records Centre.

Requirement for Habitats Regulations (EPS) licences

6.2.7 It is thought that all of the adverse impacts can be overcome if the mitigation and compensation measures outlined above are adopted in full. However, proven bat roosts will be destroyed, and bats may be disturbed, so a site-specific EPS Licence will be necessary after planning permission is granted.

6.3 Schedule of work

	Timing	Action
1	As soon as possible	Installation of three bat boxes
2	During active season 2019 or 2020 (March - November inclusive)	Exclusion of bats and destruction of roosts with ECoW on site
3	2019 - 2020 (but after Step 2)	Renovation of buildings, with construction of integrated replacement roosts
4	Summer 2022	Post-completion monitoring survey

7 References

Bat Conservation Trust (2019) 'The National Bat Monitoring Programme Annual Report 2018.' Bat Conservation Trust, London.

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Mitchell-Jones, A.J. (2004) 'Bat mitigation guidelines.' English Nature, Peterborough.

Mitchell-Jones, A.J. & McLeish, A.P. (2004) 'Bat Workers Manual.' 3rd Edition, JNCC, Peterborough.

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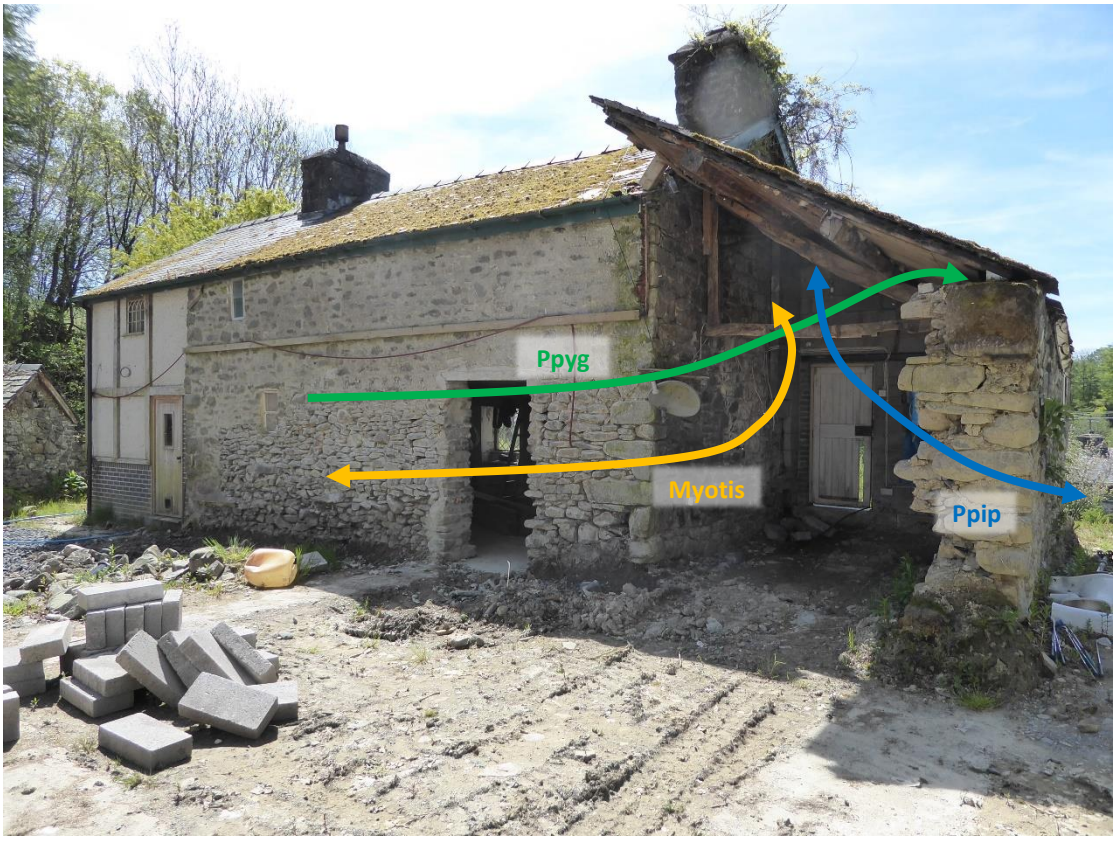
Appendix 1
Photographs



Photo's 1 & 2. Views of the buildings at Cwm Gwyn from VP1 (above) and VP2 (below). Emergences and re-entries of bat are indicated with arrows.

Photo's 3 & 4. Views from VP3 (above) and VP4 (below).

Photo's 5 & 6. Renovation has already started inside the house. No evidence of roosting bats was recorded inside any rooms inside the main house during any of the surveys.

Photo's 7 & 8. Potential roost features were located under raised ridge tiles (above) and where boxed soffits had come adrift (below).

Photo's 9 & 10. During the building inspection, potential roost features were identified inside the lean-to extension on the north-west end of the house.

A suitable gap was identified behind the concrete block wall and the original house wall (left). Droppings resembling those produced by pipistrelle bats were recorded stuck to the wall below a suitable roost access point (left and below), and a common pipistrelle was recorded entering and emerging from this access point (below).

Appendix 2
Raw survey data

Vantage point	Date	Time	Species	Number of passes
VP1	2019/06/28	21:53	Ppip	1
VP1	2019/06/28	21:57	Ppip	1
VP1	2019/06/28	21:58	Ppip	1
VP1	2019/06/28	21:59	Ppip	1
VP1	2019/06/28	22:01	Ppip	1
VP1	2019/06/28	22:02	Ppip	2
VP1	2019/06/28	22:06	Ppip	1
VP1	2019/06/28	22:10	Ppyg	1
VP1	2019/06/28	22:16	Mmys	1
VP1	2019/06/28	22:18	Ppyg	1
VP1	2019/06/28	22:22	Plec	1
VP1	2019/06/28	22:29	Ppip	1
VP1	2019/06/28	22:31	Mmys	1
VP1	2019/06/28	22:31	Ppip	1
VP1	2019/06/28	22:32	Ppip	1
VP1	2019/06/28	22:35	Ppip	4
VP1	2019/06/28	22:38	Ppip	2
VP1	2019/06/28	22:39	Ppip	1
VP1	2019/06/28	22:40	Plec	1
VP1	2019/06/28	22:41	Plec	1
VP1	2019/06/28	22:41	Ppip	1
VP1	2019/06/28	22:42	Ppyg	1
VP1	2019/06/28	22:43	Pip	1
VP1	2019/06/28	22:44	Ppip	2
VP1	2019/06/28	22:44	Ppyg	1
VP1	2019/06/28	22:45	Ppip	3
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VP1	2019/06/28	22:51	Ppip	1
VP1	2019/06/28	22:59	Ppip	2
VP1	2019/06/28	23:09	Ppip	1
VP1	2019/06/28	23:12	Myotis	3
VP1	2019/06/28	23:13	Mmys	2
VP1	2019/06/28	23:13	Myotis	1
VP1	2019/06/28	23:14	Mmys	2
VP1	2019/06/28	23:14	Unknown	1
VP1	2019/06/28	23:17	Pip	1
VP1	2019/06/28	23:20	Ppip	2
VP1	2019/06/28	23:22	Ppip	1
VP1	2019/06/28	23:23	Pip	2
VP1	2019/06/28	23:24	Pip	2
VP1	2019/06/28	23:25	Mmys	1
VP1	2019/06/28	23:25	Pip	1
VP1	2019/06/28	23:26	Mmys	1
VP1	2019/06/28	23:27	Myotis	1
VP1	2019/06/28	23:27	Ppyg	1
VP1	2019/06/28	23:28	Mmys	1
VP1	2019/06/28	23:28	Ppip	1
VP1	2019/06/28	23:29	Ppyg	2
VP1	2019/06/28	23:31	Mmys	3
VP1	2019/06/28	23:31	Ppyg	1
VP1	2019/06/28	23:32	Mmys	1
VP1	2019/06/28	23:32	Ppip	1
VP1	2019/06/28	23:33	Ppyg	5
VP1	2019/06/28	23:34	Ppyg	2
VP1	2019/06/28	23:35	Ppip	4
VP1	2019/06/28	23:35	Ppyg	1
VP1	2019/06/28	23:36	Mmys	2

Vantage point	Date	Time	Species	Number of passes
VP1	2019/06/28	23:36	Pip	1
VP1	2019/06/28	23:36	Ppip	1
VP1	2019/06/28	23:37	Ppip	1
VP1	2019/06/28	23:37	Ppyg	1
VP1	2019/06/28	23:38	Myotis	1
VP1	2019/06/28	23:38	Pip	2
VP1	2019/06/28	23:38	Ppyg	1
VP1	2019/06/28	23:40	Pip	2
VP1	2019/06/28	23:41	Pip	2
VP1	2019/06/28	23:41	Ppyg	1
VP1	2019/08/03	03:33	Ppip	5
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VP1	2019/08/03	03:37	Ppip	3
VP1	2019/08/03	03:38	Ppip	1
VP1	2019/08/03	03:38	Ppyg	2
VP1	2019/08/03	03:39	Ppip	1
VP1	2019/08/03	03:40	Ppip	3
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VP1	2019/08/03	03:45	Ppip	1
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VP1	2019/08/03	03:50	Ppip	1
VP1	2019/08/03	03:52	Ppip	1
VP1	2019/08/03	03:55	Ppip	1
VP1	2019/08/03	03:56	Ppyg	1
VP1	2019/08/03	03:57	Ppip	2
VP1	2019/08/03	03:58	Ppip	2
VP1	2019/08/03	03:59	Ppip	1
VP1	2019/08/03	04:01	Myotis	1
VP1	2019/08/03	04:05	Ppip	3
VP1	2019/08/03	04:06	Ppip	3
VP1	2019/08/03	04:11	Ppip	1
VP1	2019/08/03	04:11	Ppyg	1
VP1	2019/08/03	04:13	Ppip	1
VP1	2019/08/03	04:14	Ppip	2
VP1	2019/08/03	04:26	Plec	1
VP1	2019/08/03	04:27	Plec	1
VP1	2019/08/03	04:28	Ppip	1
VP1	2019/08/03	04:31	Ppyg	1
VP1	2019/08/03	04:32	Ppip	2
VP1	2019/08/03	04:39	Myotis	1
VP1	2019/08/03	04:41	Plec	1
VP1	2019/08/03	04:42	Ppyg	1
VP1	2019/08/03	04:43	Ppyg	2
VP1	2019/08/03	04:46	Md	1
VP1	2019/08/03	04:46	Myotis	1
VP1	2019/08/03	04:46	Ppyg	1
VP1	2019/08/03	04:48	Ppip	1
VP1	2019/08/03	04:49	Md	1
VP1	2019/08/03	04:52	Ppyg	1
VP1	2019/08/03	04:54	Md	1
VP1	2019/08/03	04:55	Myotis	1
VP1	2019/08/03	04:57	Ppip	1
VP1	2019/08/03	04:58	Mmys	1
VP1	2019/08/03	04:58	Myotis	2
VP1	2019/08/03	05:00	Myotis	1
VP1	2019/08/03	05:01	Ppip	1
VP1	2019/08/03	05:04	Md	1

Vantage point	Date	Time	Species	Number of passes
VP1	2019/08/03	05:17	Ppyg	1
VP1	2019/08/03	05:25	Ppip	1
VP2	2019/06/28	21:54	Ppip	1
VP2	2019/06/28	22:17	Ppyg	1
VP2	2019/06/28	22:32	Ppip	1
VP2	2019/06/28	22:39	Pip	1
VP2	2019/06/28	22:39	Ppyg	1
VP2	2019/06/28	22:41	Ppip	1
VP2	2019/06/28	22:45	Ppip	1
VP2	2019/06/28	23:25	Pip	1
VP2	2019/06/28	23:28	Myotis	1
VP2	2019/06/28	23:35	Ppip	1
VP2	2019/06/28	23:36	Ppyg	2
VP2	2019/06/28	23:41	Pip	3
VP2	2019/06/28	23:46	Ppip	1
VP3	2019/06/28	21:45	Ppip	1
VP3	2019/06/28	21:53	Ppyg	1
VP3	2019/06/28	21:54	Ppip	1
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VP3	2019/06/28	21:56	Ppip	1
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VP3	2019/06/28	22:13	Ppyg	1
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VP3	2019/06/28	22:27	Ppip	2
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VP3	2019/06/28	23:08	Ppyg	1
VP3	2019/06/28	23:09	Ppip	1
VP3	2019/06/28	23:09	Ppyg	1
VP3	2019/06/28	23:11	Ppyg	1

Vantage point	Date	Time	Species	Number of passes
VP3	2019/06/28	23:13	Myotis	1
VP3	2019/06/28	23:14	Mbr	1
VP3	2019/06/28	23:14	Mmys	1
VP3	2019/06/28	23:14	Plec	1
VP3	2019/06/28	23:14	Unknown	1
VP3	2019/06/28	23:15	Unknown	1
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VP3	2019/06/28	23:27	Ppip	2
VP3	2019/06/28	23:28	Mbr	1
VP3	2019/06/28	23:28	Mmys	3
VP3	2019/06/28	23:28	Ppip	1
VP3	2019/06/28	23:28	Ppyg	2
VP3	2019/06/28	23:29	Ppyg	4
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VP3	2019/06/28	23:37	Ppip	2
VP3	2019/06/28	23:37	Ppyg	1
VP3	2019/06/28	23:38	Pip	2
VP3	2019/06/28	23:38	Ppyg	2
VP3	2019/06/28	23:39	Ppip	3
VP3	2019/06/28	23:39	Ppyg	4
VP3	2019/06/28	23:40	Ppip	2
VP3	2019/06/28	23:40	Ppyg	2
VP3	2019/06/28	23:41	Ppyg	2
VP3	2019/06/28	23:42	Pip	2
VP3	2019/06/28	23:42	Ppyg	2
VP3	2019/08/03	03:37	Ppip	1
VP3	2019/08/03	03:37	Ppyg	1
VP3	2019/08/03	03:38	Ppip	1
VP3	2019/08/03	03:38	Ppyg	6

Vantage point	Date	Time	Species	Number of passes
VP3	2019/08/03	03:39	Ppyg	1
VP3	2019/08/03	03:40	Ppip	3
VP3	2019/08/03	03:40	Ppyg	4
VP3	2019/08/03	03:41	Ppyg	3
VP3	2019/08/03	03:44	Ppyg	1
VP3	2019/08/03	03:45	Ppyg	4
VP3	2019/08/03	03:46	Ppyg	3
VP3	2019/08/03	03:48	Ppyg	3
VP3	2019/08/03	03:49	Ppyg	3
VP3	2019/08/03	03:50	Ppyg	1
VP3	2019/08/03	03:51	Ppyg	1
VP3	2019/08/03	03:52	Ppyg	3
VP3	2019/08/03	03:53	Ppyg	2
VP3	2019/08/03	03:54	Ppyg	2
VP3	2019/08/03	03:55	Ppyg	5
VP3	2019/08/03	03:56	Ppip	1
VP3	2019/08/03	03:56	Ppyg	1
VP3	2019/08/03	03:57	Ppip	1
VP3	2019/08/03	03:59	Ppip	1
VP3	2019/08/03	04:00	Ppip	1
VP3	2019/08/03	04:00	Ppyg	2
VP3	2019/08/03	04:04	Ppip	2
VP3	2019/08/03	04:05	Ppip	3
VP3	2019/08/03	04:06	Ppip	3
VP3	2019/08/03	04:11	Ppip	1
VP3	2019/08/03	04:11	Ppyg	1
VP3	2019/08/03	04:13	Ppip	1
VP3	2019/08/03	04:14	Ppip	2
VP3	2019/08/03	04:17	Ppyg	1
VP3	2019/08/03	04:22	Ppyg	1
VP3	2019/08/03	04:25	Ppyg	1
VP3	2019/08/03	04:26	Plec	2
VP3	2019/08/03	04:26	Ppyg	1
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VP3	2019/08/03	04:34	Ppyg	2
VP3	2019/08/03	04:37	Ppip	2
VP3	2019/08/03	04:38	Ppyg	2
VP3	2019/08/03	04:39	Ppyg	1
VP3	2019/08/03	04:41	Plec	1
VP3	2019/08/03	04:45	Ppyg	1
VP3	2019/08/03	04:48	Myotis	1
VP3	2019/08/03	04:48	Ppip	3
VP3	2019/08/03	04:49	Ppip	1
VP3	2019/08/03	04:55	Ppip	1
VP3	2019/08/03	04:55	Ppyg	1
VP3	2019/08/03	05:07	Ppip	1
VP3	2019/08/03	05:09	Ppyg	1
VP4	2019/08/03	03:32	Ppip	3
VP4	2019/08/03	03:32	Unknown	1
VP4	2019/08/03	03:33	Ppip	2
VP4	2019/08/03	03:34	Ppip	1
VP4	2019/08/03	03:35	Pip	1

Vantage point	Date	Time	Species	Number of passes
VP4	2019/08/03	03:36	Ppip	3
VP4	2019/08/03	03:37	Ppip	1
VP4	2019/08/03	03:37	Ppyg	1
VP4	2019/08/03	03:38	Pip	1
VP4	2019/08/03	03:38	Ppip	3
VP4	2019/08/03	03:38	Ppyg	1
VP4	2019/08/03	03:40	Ppip	4
VP4	2019/08/03	03:41	Ppip	1
VP4	2019/08/03	03:43	Ppip	1
VP4	2019/08/03	03:44	Myotis	1
VP4	2019/08/03	03:44	Ppyg	2
VP4	2019/08/03	03:45	Plec	1
VP4	2019/08/03	03:45	Ppip	1
VP4	2019/08/03	03:45	Ppyg	2
VP4	2019/08/03	03:46	Ppyg	1
VP4	2019/08/03	03:47	Ppip	1
VP4	2019/08/03	03:48	Ppip	2
VP4	2019/08/03	03:49	Ppip	1
VP4	2019/08/03	03:49	Ppyg	1
VP4	2019/08/03	03:50	Ppip	1
VP4	2019/08/03	03:52	Ppip	2
VP4	2019/08/03	03:52	Ppyg	1
VP4	2019/08/03	03:53	Ppip	1
VP4	2019/08/03	03:53	Ppyg	1
VP4	2019/08/03	03:54	Ppip	1
VP4	2019/08/03	03:54	Ppyg	1
VP4	2019/08/03	03:54	Unknown	1
VP4	2019/08/03	03:55	Ppip	1
VP4	2019/08/03	03:55	Ppyg	1
VP4	2019/08/03	03:57	Plec	1
VP4	2019/08/03	03:58	Ppip	2
VP4	2019/08/03	03:59	Ppip	1
VP4	2019/08/03	03:59	Ppyg	1
VP4	2019/08/03	04:00	Ppip	1
VP4	2019/08/03	04:00	Ppyg	1
VP4	2019/08/03	04:01	Md	1
VP4	2019/08/03	04:01	Ppip	1
VP4	2019/08/03	04:02	Ppyg	1
VP4	2019/08/03	04:04	Plec	1
VP4	2019/08/03	04:04	Ppip	1
VP4	2019/08/03	04:04	Ppyg	2
VP4	2019/08/03	04:05	Ppip	3
VP4	2019/08/03	04:06	Ppip	3
VP4	2019/08/03	04:10	Unknown	1
VP4	2019/08/03	04:11	Ppip	1
VP4	2019/08/03	04:11	Ppyg	2
VP4	2019/08/03	04:13	Ppip	1
VP4	2019/08/03	04:14	Ppip	4
VP4	2019/08/03	04:15	Ppip	1
VP4	2019/08/03	04:17	Pip	1
VP4	2019/08/03	04:25	Plec	1
VP4	2019/08/03	04:26	Plec	1
VP4	2019/08/03	04:27	Plec	1
VP4	2019/08/03	04:27	Ppyg	1
VP4	2019/08/03	04:29	Plec	1
VP4	2019/08/03	04:29	Ppip	1
VP4	2019/08/03	04:30	Plec	1

Vantage point	Date	Time	Species	Number of passes
VP4	2019/08/03	04:31	Ppyg	1
VP4	2019/08/03	04:32	Ppip	2
VP4	2019/08/03	04:37	Ppip	2
VP4	2019/08/03	04:38	Ppyg	1
VP4	2019/08/03	04:39	Myotis	1
VP4	2019/08/03	04:41	Plec	3
VP4	2019/08/03	04:42	Ppyg	1
VP4	2019/08/03	04:45	Ppyg	1
VP4	2019/08/03	04:46	Md	1
VP4	2019/08/03	04:46	Myotis	1
VP4	2019/08/03	04:46	Ppyg	2
VP4	2019/08/03	04:48	Ppip	2
VP4	2019/08/03	04:50	Md	1
VP4	2019/08/03	04:52	Ppyg	1
VP4	2019/08/03	04:53	Ppyg	1
VP4	2019/08/03	04:54	Myotis	1
VP4	2019/08/03	04:55	Myotis	3
VP4	2019/08/03	04:55	Ppyg	1
VP4	2019/08/03	04:57	Ppip	1
VP4	2019/08/03	04:58	Md	1
VP4	2019/08/03	05:00	Md	1
VP4	2019/08/03	05:00	Ppip	1
VP4	2019/08/03	05:01	Ppip	1
VP4	2019/08/03	05:02	Ppip	1
VP4	2019/08/03	05:03	Ppip	1
VP4	2019/08/03	05:04	Md	1
VP4	2019/08/03	05:07	Ppip	1
VP4	2019/08/03	05:09	Ppyg	2
VP4	2019/08/03	05:12	Ppyg	1
VP4	2019/08/03	05:25	Ppip	1
PD1	2019/08/03	04:05	Ppip	1
PD1	2019/08/03	04:06	Ppip	1
PD1	2019/08/03	04:43	Ppyg	1
PD1	2019/08/03	04:46	Myotis	1
PD1	2019/08/03	04:48	Ppip	1
PD1	2019/08/03	04:55	Myotis	1
PD1	2019/08/03	04:59	Myotis	1
PD1	2019/08/03	05:01	Myotis	1
PD1	2019/08/03	05:25	Myotis	1
PD1	2019/08/03	23:22	Myotis	1
PD1	2019/08/03	23:33	Ppip	1
PD1	2019/08/03	23:34	Ppip	1
PD1	2019/08/03	23:38	Ppip	1
PD1	2019/08/03	23:45	Myotis	2
PD1	2019/08/03	23:49	Ppip	1
PD1	2019/08/03	23:59	Myotis	2
PD1	2019/08/04	00:48	Myotis	2
PD1	2019/08/04	00:49	Myotis	1
PD1	2019/08/04	01:16	Myotis	1
PD1	2019/08/04	01:36	Myotis	2
PD1	2019/08/04	01:49	Ppip	1
PD1	2019/08/04	01:52	Ppip	1
PD1	2019/08/04	02:11	Myotis	1
PD1	2019/08/04	02:17	Myotis	1
PD1	2019/08/04	02:30	Nn	1
PD1	2019/08/04	02:48	Ppip	1
PD1	2019/08/04	02:50	Ppip	1

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/04	03:18	Ppip	1
PD1	2019/08/04	03:19	Ppip	1
PD1	2019/08/04	03:22	Ppip	1
PD1	2019/08/04	04:46	Ppip	2
PD1	2019/08/04	04:49	Ppip	1
PD1	2019/08/04	04:50	Ppip	1
PD1	2019/08/04	05:25	Ppip	1
PD1	2019/08/04	05:28	Ppip	1
PD1	2019/08/04	05:31	Ppip	1
PD1	2019/08/04	06:01	Unknown	1
PD1	2019/08/04	21:58	Ppip	1
PD1	2019/08/04	22:01	Ppip	3
PD1	2019/08/04	22:03	Ppip	4
PD1	2019/08/04	22:04	Ppip	2
PD1	2019/08/04	22:06	Unknown	1
PD1	2019/08/04	22:08	Ppip	1
PD1	2019/08/04	22:09	Ppip	3
PD1	2019/08/04	22:10	Ppip	1
PD1	2019/08/04	22:11	Ppip	2
PD1	2019/08/04	22:12	Ppip	2
PD1	2019/08/04	22:13	Ppip	1
PD1	2019/08/04	22:28	Myotis	2
PD1	2019/08/04	22:56	Myotis	1
PD1	2019/08/04	23:08	Myotis	1
PD1	2019/08/04	23:09	Nn	1
PD1	2019/08/04	23:15	Myotis	1
PD1	2019/08/04	23:18	Unknown	2
PD1	2019/08/04	23:21	Unknown	1
PD1	2019/08/04	23:23	Ppyg	1
PD1	2019/08/04	23:26	Myotis	1
PD1	2019/08/04	23:42	Myotis	1
PD1	2019/08/04	23:49	Myotis	1
PD1	2019/08/04	23:49	Ppip	1
PD1	2019/08/05	00:03	Myotis	2
PD1	2019/08/05	00:04	Mmys	1
PD1	2019/08/05	00:07	Ppip	1
PD1	2019/08/05	00:17	Myotis	1
PD1	2019/08/05	00:18	Myotis	4
PD1	2019/08/05	00:19	Myotis	3
PD1	2019/08/05	00:20	Myotis	1
PD1	2019/08/05	00:23	Ppyg	1
PD1	2019/08/05	00:25	Myotis	1
PD1	2019/08/05	00:28	Myotis	3
PD1	2019/08/05	00:29	Myotis	3
PD1	2019/08/05	00:36	Myotis	1
PD1	2019/08/05	00:53	Myotis	1
PD1	2019/08/05	00:53	Unknown	1
PD1	2019/08/05	01:00	Ppip	1
PD1	2019/08/05	01:04	Rhip	1
PD1	2019/08/05	01:15	Ppip	1
PD1	2019/08/05	01:18	Myotis	1
PD1	2019/08/05	01:26	Ppip	1
PD1	2019/08/05	01:29	Ppyg	1
PD1	2019/08/05	01:30	Myotis	1
PD1	2019/08/05	01:31	Mmys	1
PD1	2019/08/05	01:46	Myotis	1
PD1	2019/08/05	01:47	Mmys	2

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/05	01:47	Myotis	2
PD1	2019/08/05	01:47	Ppyg	1
PD1	2019/08/05	01:54	Myotis	1
PD1	2019/08/05	01:54	Ppip	1
PD1	2019/08/05	02:05	Myotis	1
PD1	2019/08/05	02:05	Ppyg	1
PD1	2019/08/05	02:06	Ppyg	1
PD1	2019/08/05	02:07	Myotis	2
PD1	2019/08/05	02:11	Myotis	1
PD1	2019/08/05	02:20	Mmys	2
PD1	2019/08/05	02:31	Myotis	1
PD1	2019/08/05	02:32	Myotis	1
PD1	2019/08/05	02:39	Ppyg	1
PD1	2019/08/05	02:49	Mmys	1
PD1	2019/08/05	02:51	Ppip	1
PD1	2019/08/05	03:12	Myotis	1
PD1	2019/08/05	03:14	Ppip	1
PD1	2019/08/05	03:19	Ppip	1
PD1	2019/08/05	03:25	Ppip	1
PD1	2019/08/05	03:52	Rhip	1
PD1	2019/08/05	03:57	Ppyg	1
PD1	2019/08/05	04:00	Ppip	1
PD1	2019/08/05	04:13	Ppip	2
PD1	2019/08/05	04:17	Ppip	3
PD1	2019/08/05	04:18	Ppip	1
PD1	2019/08/05	04:19	Ppip	1
PD1	2019/08/05	04:20	Ppip	1
PD1	2019/08/05	04:21	Ppip	1
PD1	2019/08/05	04:25	Ppip	1
PD1	2019/08/05	04:38	Ppip	1
PD1	2019/08/05	04:48	Ppip	1
PD1	2019/08/05	04:49	Ppip	1
PD1	2019/08/05	05:13	Ppip	2
PD1	2019/08/05	05:19	Myotis	1
PD1	2019/08/05	05:33	Unknown	1
PD1	2019/08/05	05:34	Unknown	1
PD1	2019/08/05	05:38	Ppip	1
PD1	2019/08/05	06:10	Mmys	1
PD1	2019/08/05	21:58	Ppip	1
PD1	2019/08/05	22:04	Ppip	1
PD1	2019/08/05	22:10	Ppip	3
PD1	2019/08/05	22:11	Ppip	1
PD1	2019/08/05	22:53	Myotis	1
PD1	2019/08/05	23:07	Myotis	1
PD1	2019/08/05	23:13	Ppip	1
PD1	2019/08/05	23:14	Ppip	1
PD1	2019/08/05	23:15	Ppip	1
PD1	2019/08/05	23:17	Ppip	1
PD1	2019/08/05	23:26	Myotis	1
PD1	2019/08/05	23:48	Myotis	1
PD1	2019/08/05	23:59	Myotis	3
PD1	2019/08/06	00:02	Ppip	1
PD1	2019/08/06	00:05	Ppip	1
PD1	2019/08/06	00:06	Myotis	1
PD1	2019/08/06	00:11	Myotis	1
PD1	2019/08/06	00:12	Myotis	3
PD1	2019/08/06	00:13	Myotis	1

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/06	00:22	Myotis	2
PD1	2019/08/06	00:23	Ppip	1
PD1	2019/08/06	00:26	Myotis	1
PD1	2019/08/06	00:27	Myotis	2
PD1	2019/08/06	00:28	Unknown	1
PD1	2019/08/06	00:31	Ppip	1
PD1	2019/08/06	00:32	Ppip	1
PD1	2019/08/06	00:34	Ppip	1
PD1	2019/08/06	00:34	Ppyg	1
PD1	2019/08/06	00:37	Myotis	1
PD1	2019/08/06	00:39	Myotis	3
PD1	2019/08/06	00:41	Myotis	1
PD1	2019/08/06	00:41	Ppip	1
PD1	2019/08/06	00:42	Myotis	1
PD1	2019/08/06	00:43	Ppip	1
PD1	2019/08/06	00:45	Myotis	1
PD1	2019/08/06	00:46	Myotis	1
PD1	2019/08/06	00:50	Ppip	1
PD1	2019/08/06	00:51	Myotis	3
PD1	2019/08/06	00:52	Myotis	2
PD1	2019/08/06	00:53	Ppip	1
PD1	2019/08/06	00:54	Myotis	1
PD1	2019/08/06	00:54	Ppip	1
PD1	2019/08/06	00:55	Myotis	1
PD1	2019/08/06	00:57	Pip	1
PD1	2019/08/06	00:58	Myotis	1
PD1	2019/08/06	00:58	Ppip	1
PD1	2019/08/06	00:59	Ppip	1
PD1	2019/08/06	01:00	Mn	1
PD1	2019/08/06	01:01	Ppip	1
PD1	2019/08/06	01:02	Myotis	1
PD1	2019/08/06	01:02	Ppip	1
PD1	2019/08/06	01:05	Myotis	3
PD1	2019/08/06	01:06	Myotis	3
PD1	2019/08/06	01:07	Myotis	3
PD1	2019/08/06	01:10	Myotis	2
PD1	2019/08/06	01:12	Ppip	1
PD1	2019/08/06	01:13	Myotis	1
PD1	2019/08/06	01:13	Ppip	1
PD1	2019/08/06	01:14	Ppip	1
PD1	2019/08/06	01:17	Myotis	1
PD1	2019/08/06	01:36	Myotis	1
PD1	2019/08/06	01:36	Ppip	1
PD1	2019/08/06	01:43	Myotis	3
PD1	2019/08/06	01:46	Myotis	1
PD1	2019/08/06	01:47	Myotis	2
PD1	2019/08/06	01:49	Ppip	1
PD1	2019/08/06	01:53	Myotis	1
PD1	2019/08/06	01:54	Myotis	4
PD1	2019/08/06	01:54	Ppip	1
PD1	2019/08/06	01:59	Myotis	1
PD1	2019/08/06	02:00	Myotis	2
PD1	2019/08/06	02:03	Myotis	3
PD1	2019/08/06	02:04	Myotis	1
PD1	2019/08/06	02:05	Myotis	1
PD1	2019/08/06	02:06	Md	1
PD1	2019/08/06	02:06	Myotis	2

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/06	02:06	Ppip	1
PD1	2019/08/06	02:07	Md	2
PD1	2019/08/06	02:07	Myotis	1
PD1	2019/08/06	02:10	Myotis	1
PD1	2019/08/06	02:11	Myotis	1
PD1	2019/08/06	02:16	Myotis	1
PD1	2019/08/06	02:17	Myotis	1
PD1	2019/08/06	02:21	Myotis	3
PD1	2019/08/06	02:22	Myotis	1
PD1	2019/08/06	02:24	Myotis	1
PD1	2019/08/06	02:24	Ppip	1
PD1	2019/08/06	02:26	Ppip	1
PD1	2019/08/06	02:40	Ppip	1
PD1	2019/08/06	02:43	Ppip	1
PD1	2019/08/06	02:44	Ppip	1
PD1	2019/08/06	02:48	Mmys	2
PD1	2019/08/06	02:59	Unknown	1
PD1	2019/08/06	03:02	Ppip	3
PD1	2019/08/06	03:06	Ppip	3
PD1	2019/08/06	03:07	Ppip	1
PD1	2019/08/06	03:07	Unknown	1
PD1	2019/08/06	03:11	Ppip	1
PD1	2019/08/06	03:26	Ppip	1
PD1	2019/08/06	03:32	Ppip	1
PD1	2019/08/06	03:39	Ppip	1
PD1	2019/08/06	03:43	Ppip	1
PD1	2019/08/06	03:46	Ppip	1
PD1	2019/08/06	03:48	Ppip	1
PD1	2019/08/06	03:49	Ppip	1
PD1	2019/08/06	03:51	Ppip	1
PD1	2019/08/06	03:52	Ppip	1
PD1	2019/08/06	03:58	Ppip	2
PD1	2019/08/06	04:00	Ppip	1
PD1	2019/08/06	04:04	Ppip	1
PD1	2019/08/06	04:08	Ppip	1
PD1	2019/08/06	04:11	Ppip	2
PD1	2019/08/06	04:36	Ppip	1
PD1	2019/08/06	04:37	Ppip	1
PD1	2019/08/06	04:38	Ppip	1
PD1	2019/08/06	04:40	Ppip	2
PD1	2019/08/06	04:41	Ppip	3
PD1	2019/08/06	04:45	Ppip	1
PD1	2019/08/06	04:49	Ppip	1
PD1	2019/08/06	04:50	Ppip	1
PD1	2019/08/06	04:51	Ppip	1
PD1	2019/08/06	04:52	Ppip	1
PD1	2019/08/06	05:24	Ppip	2
PD1	2019/08/06	05:31	Unknown	1
PD1	2019/08/06	05:34	Ppip	1
PD1	2019/08/06	05:35	Ppip	1
PD1	2019/08/06	05:49	Ppip	1
PD1	2019/08/06	06:14	Unknown	1
PD1	2019/08/06	21:16	Ppip	1
PD1	2019/08/06	21:22	Ppyg	1
PD1	2019/08/06	21:33	Ppyg	1
PD1	2019/08/06	22:09	Myotis	1
PD1	2019/08/06	22:13	Myotis	1

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/06	22:45	Ppip	1
PD1	2019/08/06	22:48	Ppip	3
PD1	2019/08/06	22:50	Ppip	1
PD1	2019/08/06	22:52	Myotis	1
PD1	2019/08/06	22:55	Ppip	1
PD1	2019/08/06	23:00	Ppyg	1
PD1	2019/08/06	23:01	Ppip	3
PD1	2019/08/06	23:02	Ppip	1
PD1	2019/08/06	23:07	Ppip	1
PD1	2019/08/06	23:08	Ppip	4
PD1	2019/08/06	23:09	Ppip	1
PD1	2019/08/06	23:11	Myotis	1
PD1	2019/08/06	23:11	Ppyg	1
PD1	2019/08/06	23:12	Ppyg	1
PD1	2019/08/06	23:22	Ppyg	1
PD1	2019/08/06	23:34	Ppip	2
PD1	2019/08/06	23:48	Md	2
PD1	2019/08/06	23:48	Myotis	1
PD1	2019/08/06	23:49	Md	1
PD1	2019/08/06	23:51	Ppip	1
PD1	2019/08/07	00:01	Ppip	1
PD1	2019/08/07	00:10	Ppip	1
PD1	2019/08/07	00:20	Myotis	3
PD1	2019/08/07	00:21	Myotis	2
PD1	2019/08/07	00:22	Myotis	1
PD1	2019/08/07	00:27	Ppyg	1
PD1	2019/08/07	00:34	Myotis	1
PD1	2019/08/07	00:35	Myotis	2
PD1	2019/08/07	00:36	Myotis	1
PD1	2019/08/07	00:47	Myotis	2
PD1	2019/08/07	00:48	Myotis	1
PD1	2019/08/07	00:49	Myotis	1
PD1	2019/08/07	00:50	Myotis	1
PD1	2019/08/07	00:54	Mn	1
PD1	2019/08/07	01:03	Mmys	1
PD1	2019/08/07	01:04	Ppip	1
PD1	2019/08/07	01:05	Ppip	3
PD1	2019/08/07	01:06	Ppip	2
PD1	2019/08/07	01:07	Ppip	1
PD1	2019/08/07	01:16	Mmys	1
PD1	2019/08/07	01:19	Unknown	1
PD1	2019/08/07	01:22	Ppip	2
PD1	2019/08/07	01:23	Ppip	1
PD1	2019/08/07	01:26	Myotis	1
PD1	2019/08/07	01:27	Ppip	1
PD1	2019/08/07	01:28	Mbr	1
PD1	2019/08/07	01:28	Mn	1
PD1	2019/08/07	01:29	Ppip	3
PD1	2019/08/07	01:34	Mmys	1
PD1	2019/08/07	01:36	Ppip	1
PD1	2019/08/07	01:38	Ppip	1
PD1	2019/08/07	01:40	Myotis	1
PD1	2019/08/07	01:41	Ppip	1
PD1	2019/08/07	01:43	Ppip	2
PD1	2019/08/07	01:44	Ppip	2
PD1	2019/08/07	01:46	Mn	1
PD1	2019/08/07	01:57	Ppip	1

Vantage point	Date	Time	Species	Number of passes
PD1	2019/08/07	02:03	Ppip	1
PD1	2019/08/07	02:04	Mmys	2
PD1	2019/08/07	02:04	Ppip	2
PD1	2019/08/07	02:05	Ppip	1
PD1	2019/08/07	02:06	Ppip	1
PD1	2019/08/07	02:10	Ppip	1
PD1	2019/08/07	02:12	Mn	1
PD1	2019/08/07	02:13	Myotis	1
PD1	2019/08/07	02:15	Myotis	1
PD1	2019/08/07	02:17	Myotis	2
PD1	2019/08/07	02:18	Myotis	1
PD1	2019/08/07	02:20	Myotis	1
PD1	2019/08/07	02:25	Myotis	1
PD1	2019/08/07	02:41	Ppip	1
PD1	2019/08/07	02:45	Unknown	1
PD1	2019/08/07	02:51	Mn	1
PD1	2019/08/07	02:51	Myotis	1
PD1	2019/08/07	02:51	Ppip	1
PD1	2019/08/07	02:57	Myotis	1
PD1	2019/08/07	03:03	Ppip	1
PD1	2019/08/07	03:06	Ppip	2
PD1	2019/08/07	03:07	Ppip	1
PD1	2019/08/07	03:08	Unknown	1
PD1	2019/08/07	03:21	Ppip	3
PD1	2019/08/07	03:22	Ppip	1
PD1	2019/08/07	03:27	Rhip	1
PD1	2019/08/07	03:28	Ppip	2
PD1	2019/08/07	03:29	Ppip	1
PD1	2019/08/07	03:31	Ppip	1
PD1	2019/08/07	03:32	Ppyg	1
PD1	2019/08/07	03:55	Mmys	1
PD1	2019/08/07	04:10	Ppip	1
PD1	2019/08/07	04:15	Myotis	1
PD1	2019/08/07	04:15	WBA	1
PD1	2019/08/07	04:17	Ppip	3
PD1	2019/08/07	04:18	Ppip	1
PD1	2019/08/07	04:19	Ppip	1
PD1	2019/08/07	04:20	Ppip	1
PD1	2019/08/07	04:23	Ppip	1
PD1	2019/08/07	04:25	Ppip	1
PD1	2019/08/07	04:26	Ppip	1
PD1	2019/08/07	04:27	Ppip	1
PD1	2019/08/07	04:34	Myotis	1
PD1	2019/08/07	04:42	Ppip	1
PD1	2019/08/07	04:42	Ppyg	1
PD1	2019/08/07	04:48	Plec	1
PD1	2019/08/07	04:54	Myotis	1
PD1	2019/08/07	04:54	Ppip	1
PD1	2019/08/07	04:55	Myotis	1
PD1	2019/08/07	05:04	Ppip	2
PD1	2019/08/07	05:08	Mmys	1
PD1	2019/08/07	05:34	Mmys	1

Appendix 3
Sample sonograms

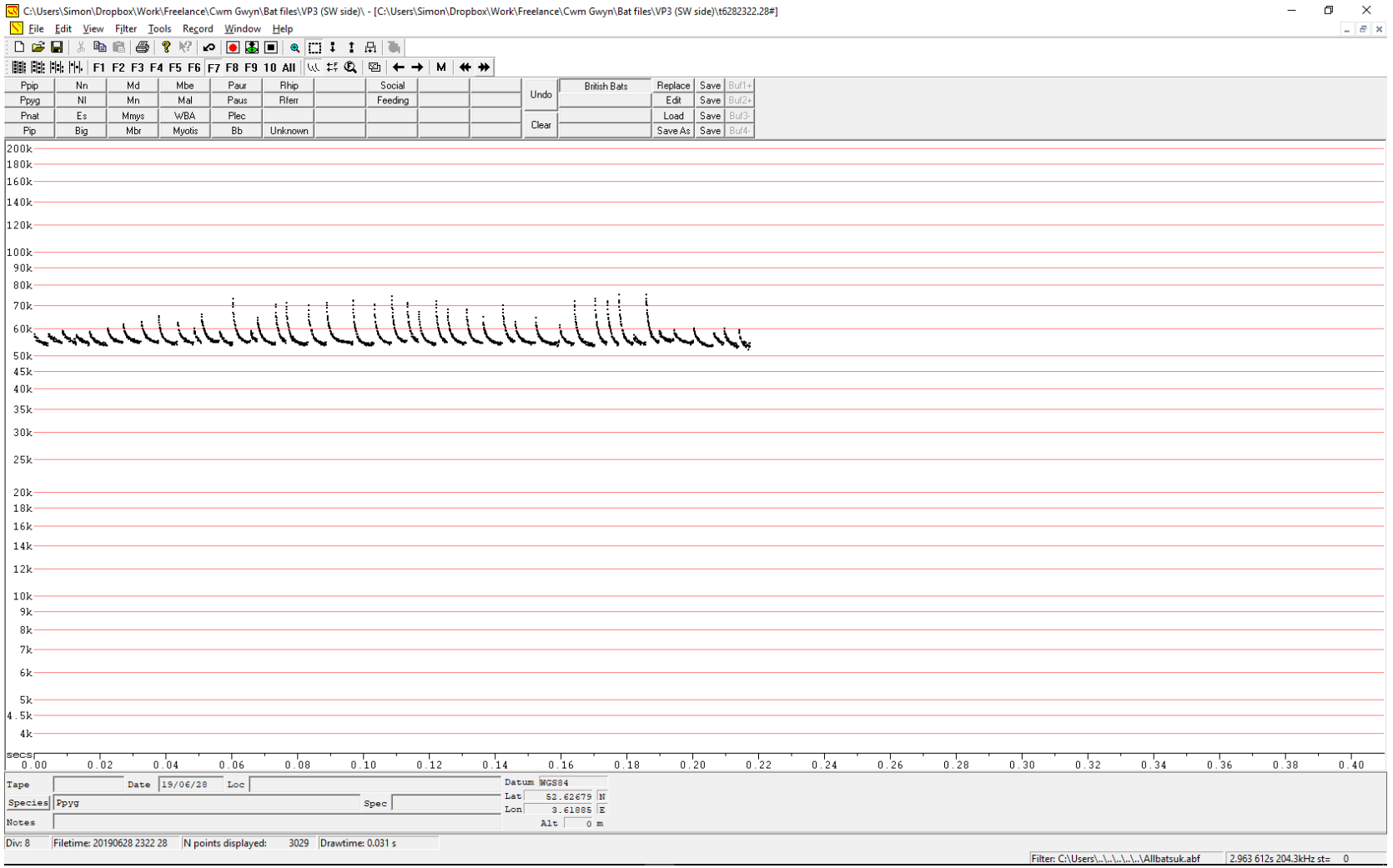


Figure 11. Screenshot of a sonogram, with frequency on the vertical axis and time along the horizontal axis. The hockey stick shaped calls are diagnostic of all pipistrelle species, and the flatter (qCF) part of the call at around 55 kHz indicates a Common Pipistrelle (expansion scale: F7, compressed to remove spaces between calls, filtered to remove non-bat noise).

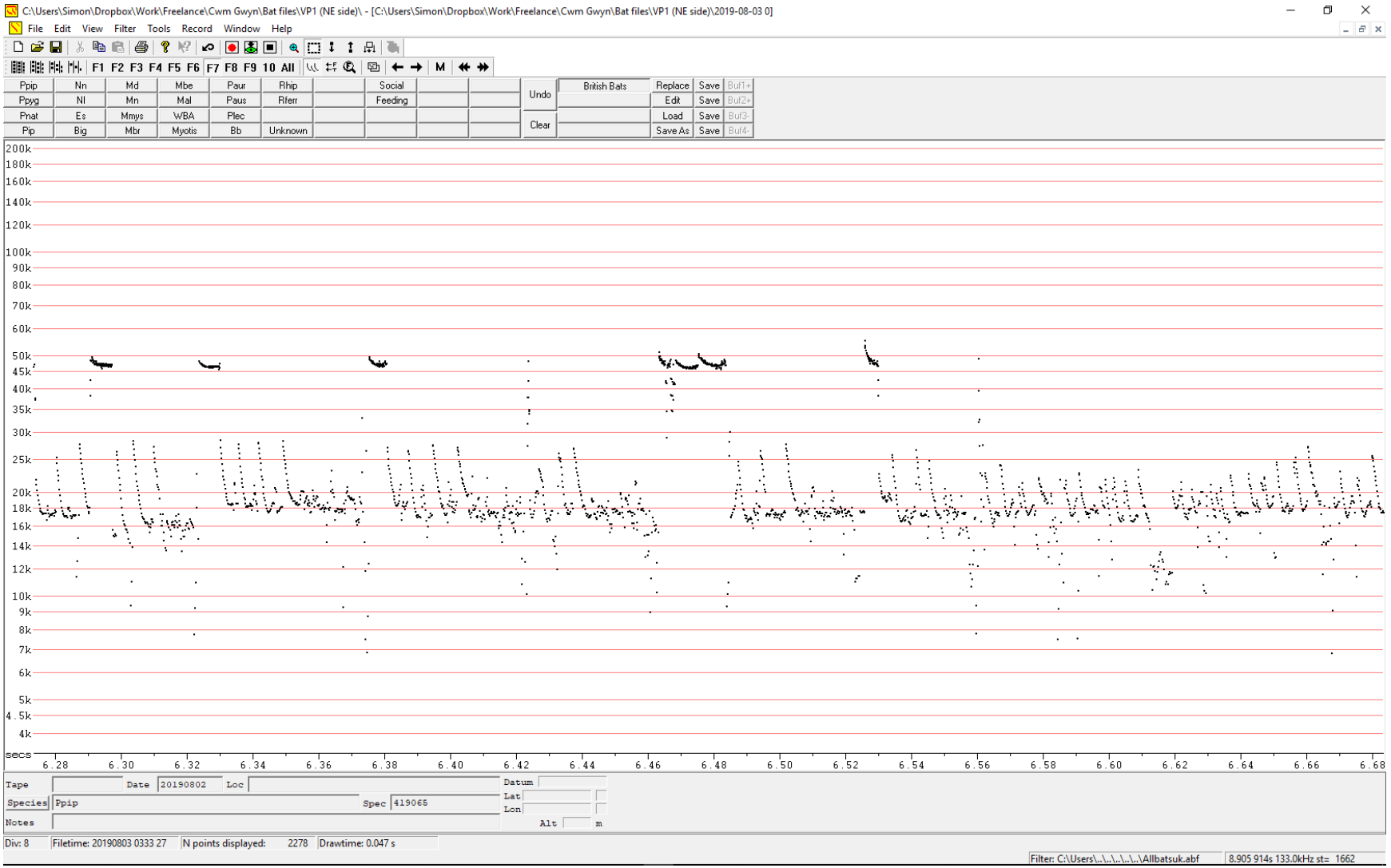


Figure 12. Sonogram of common pipistrelle, showing echolocation calls with qCF at around 45kHz. The lower frequency calls are social calls produced by the same bat (F7, compressed, filtered).

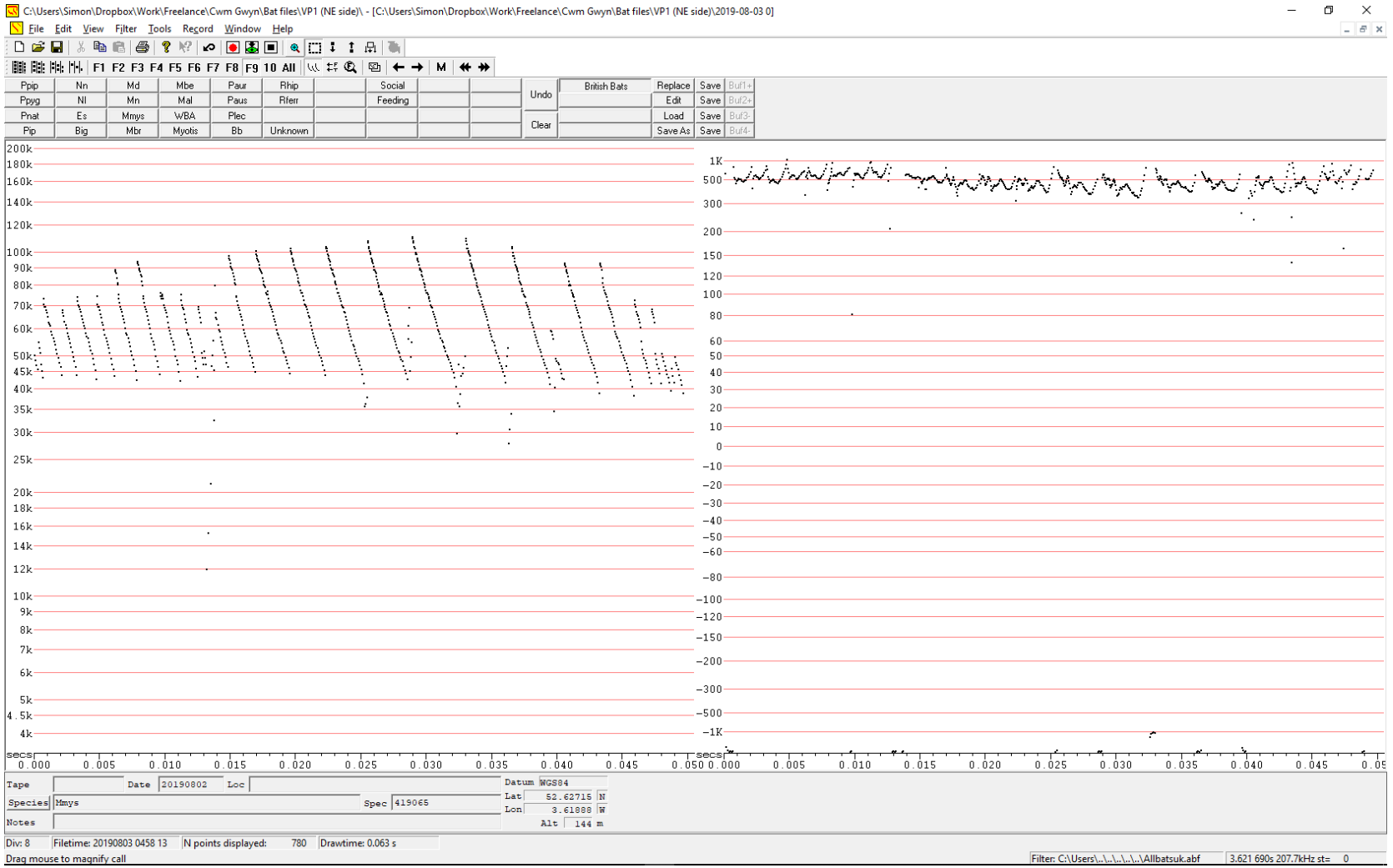


Figure 13. Sonogram of a Whiskered Bat. The near-vertical (FM) sweeps on the left-hand side are indicative of a Myotis species; the split-screen on the right-hand side is an analysis of the rate of change in frequency (slope) of the corresponding calls on the left-hand side. A slope between 500 and 1000 octaves per second with many small-scale kinks indicates the likely species. (F9, compressed, filtered).

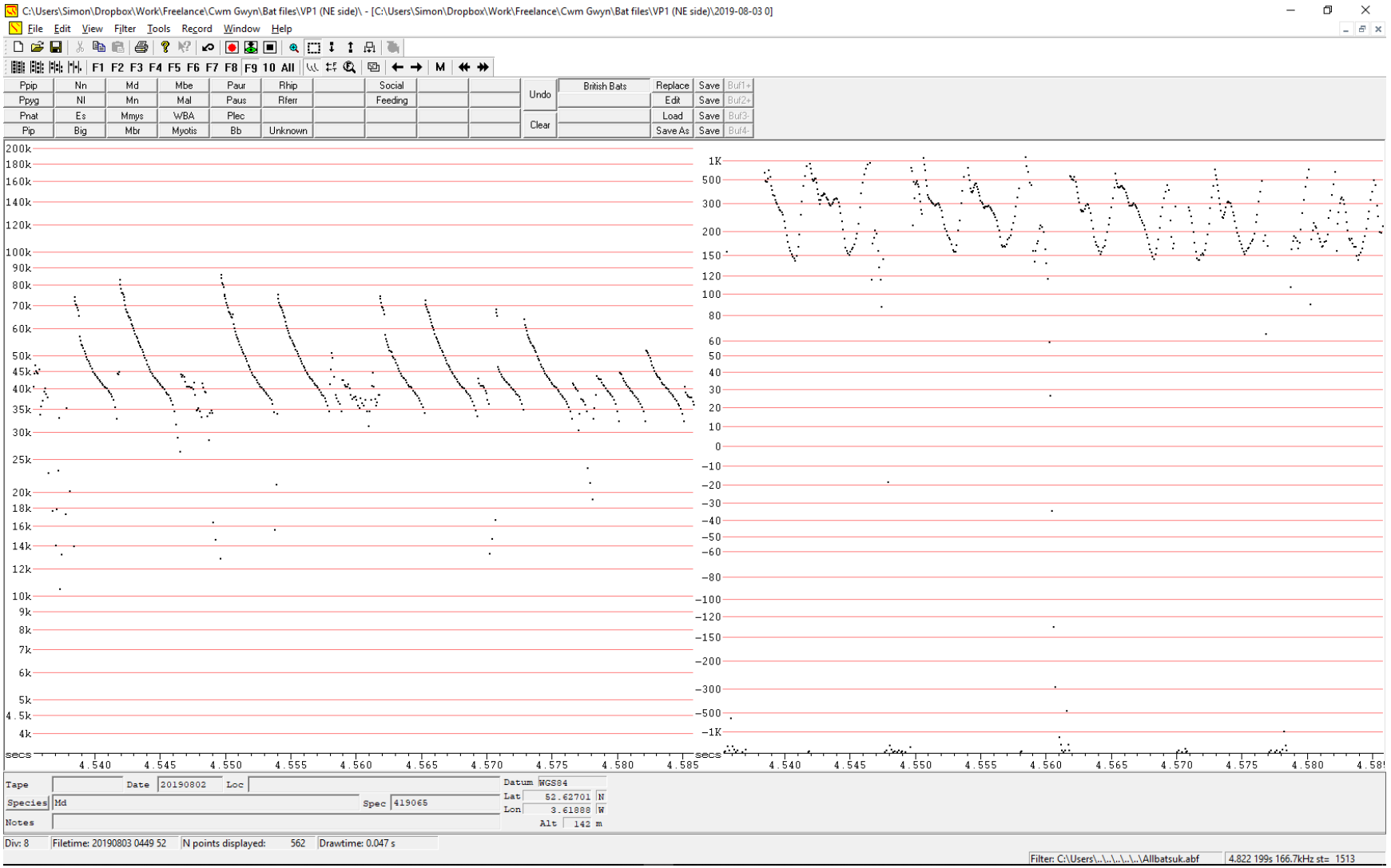


Figure 14. Sonogram of a Daubenton's Bat. The range of octaves per second (120 - 1000 OPS) coupled with the sigmoidal call shape (represented by the single large-scale V-shape of the slope line) is diagnostic of the species (F9, compressed, filtered).

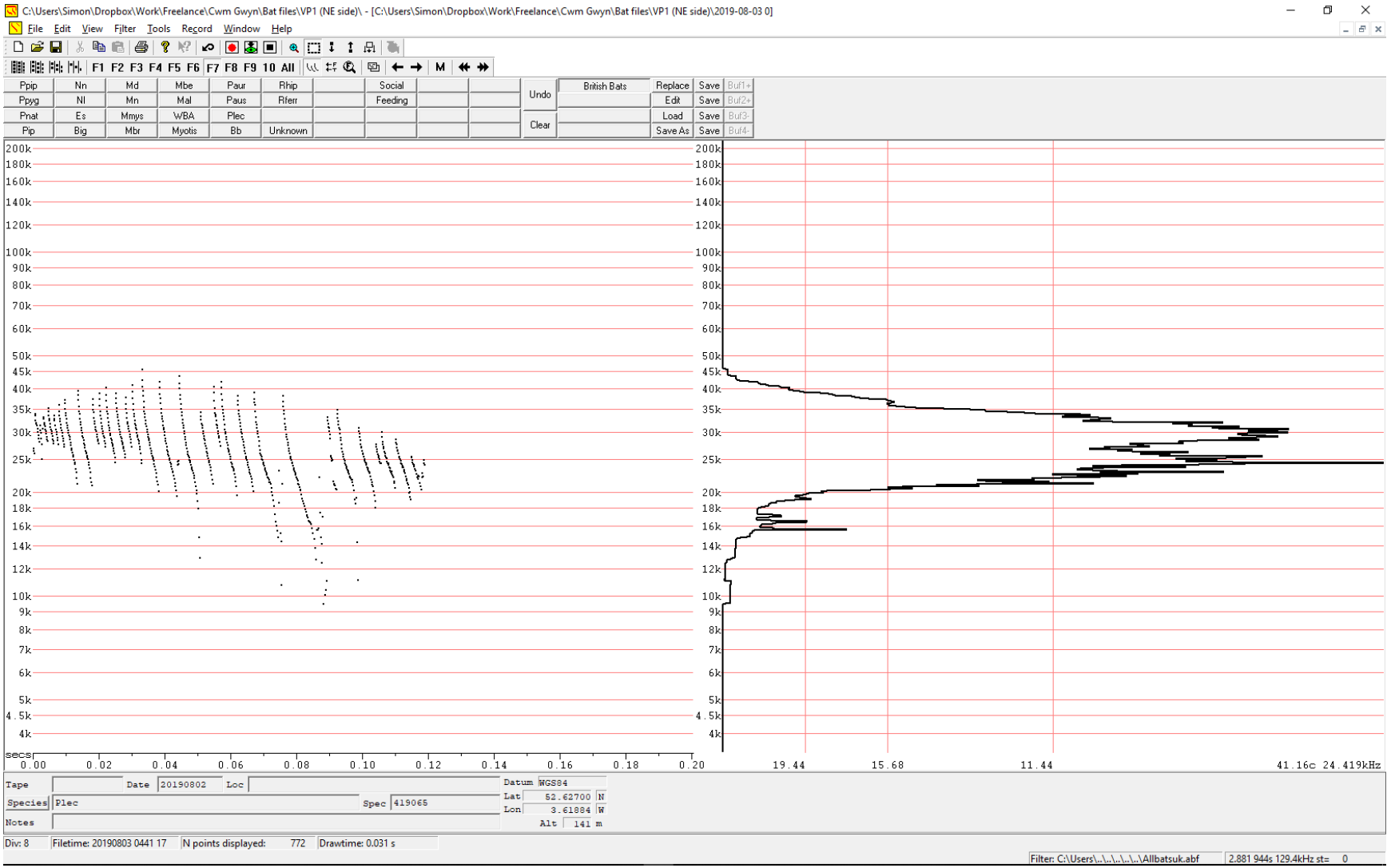


Figure 15. Sonogram of a Long-eared Bat. The calls are similar in shape to some Myotid echolocation calls in that they are entirely FM, but the peak energy (shown on the right-hand split-screen) is around 30 cycles per second, which is too low for a Myotid (F9, compressed, filtered).

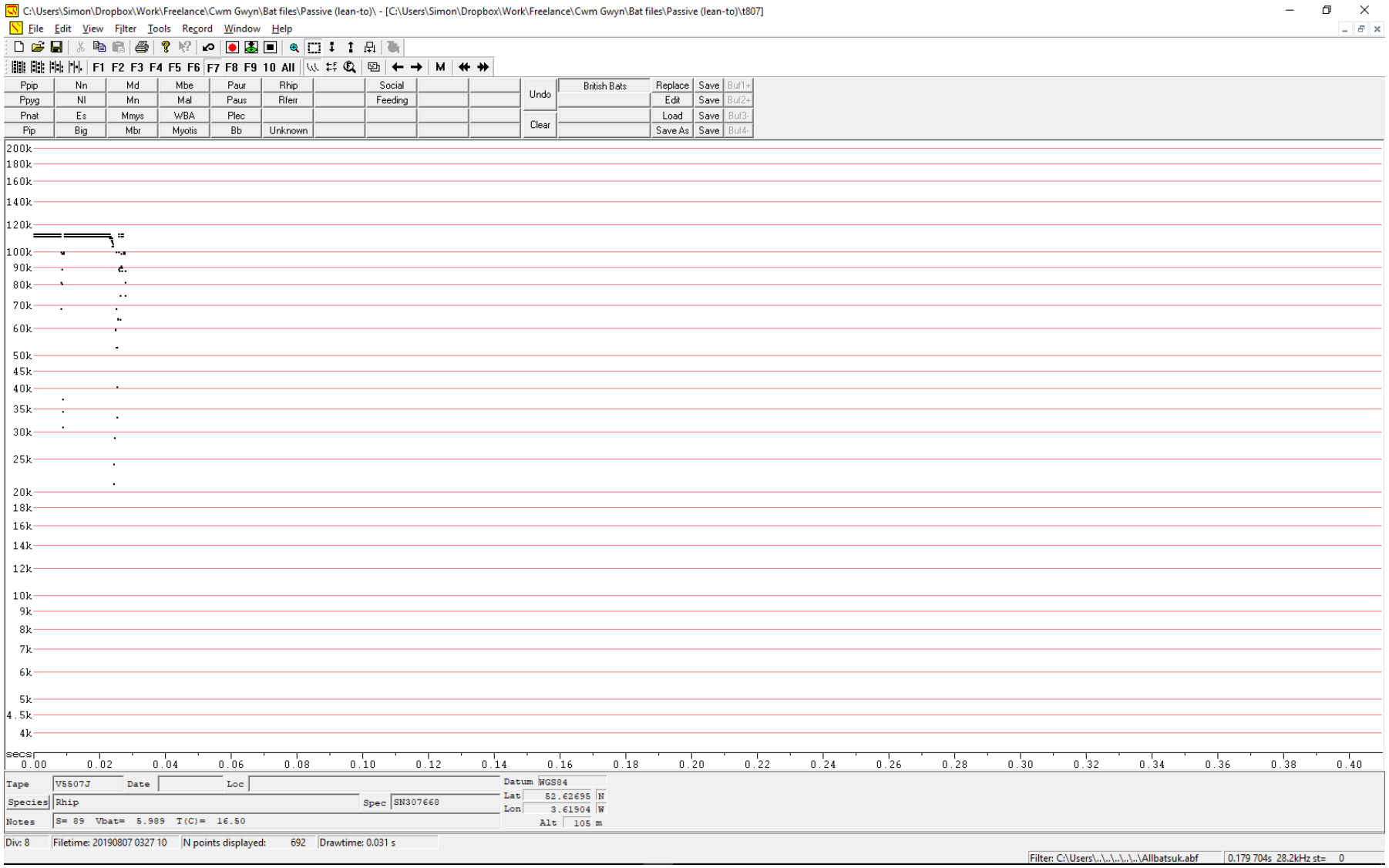


Figure 16. The unmistakeable constant frequency call of a Lesser Horseshoe Bat, with the first harmonic at around 110 kHz (F7, compressed, filtered).

Appendix 4
Construction of Kent Bat Box

The Kent bat box

Simple to construct, self-cleaning and low maintenance.

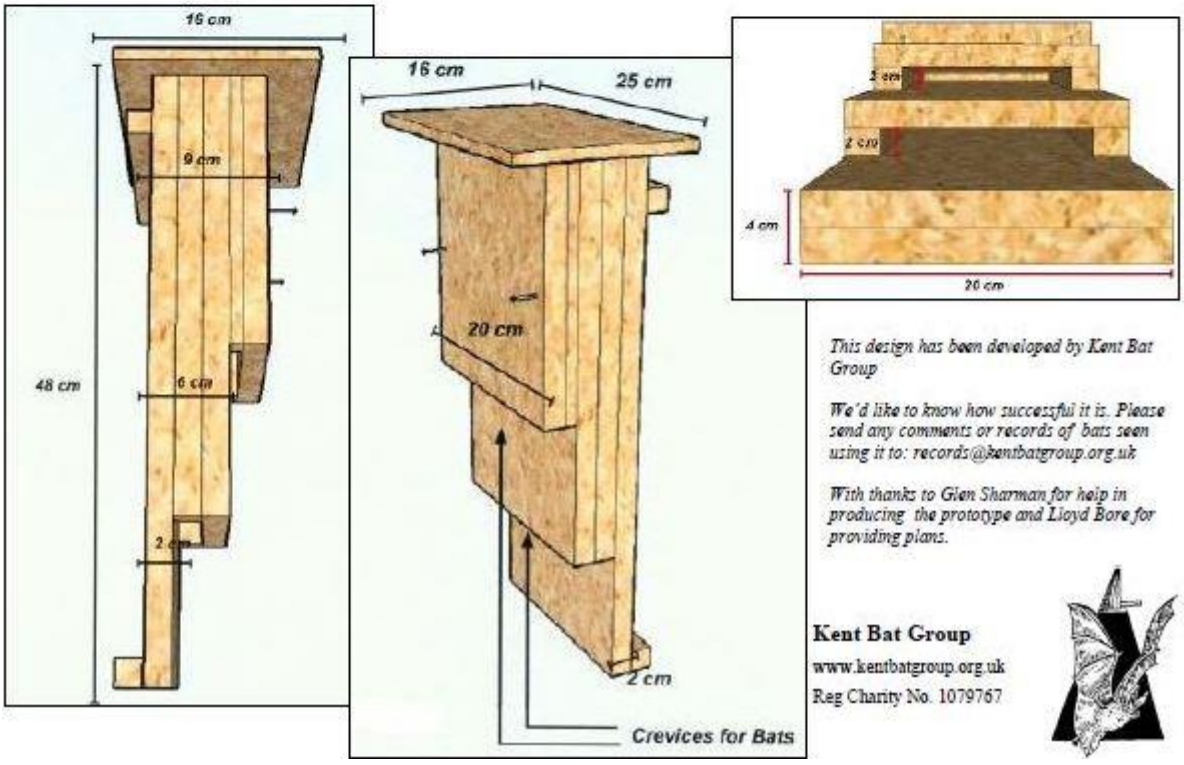
The only critical measurement is the width of the crevices—these should be no larger than suggested. Other measurements are approximate.

Materials and construction

Box to be made from untreated rough-sawn timbers
Timber should be c,20mm thick
The box should be rainproof and draught-free
Crevices can be between 15 and 25 mm wide
Fixing may be by use of brackets, durable bands or wires

Location

Boxes are best fixed as high as possible in a sheltered wind-free position, exposed to the sun for part of the day.
They can be fitted to walls, other flat surfaces or trees
A clear flight line to the entrance is important



This design has been developed by Kent Bat Group

We'd like to know how successful it is. Please send any comments or records of bats seen using it to: records@kentbatgroup.org.uk

With thanks to Glen Sharman for help in producing the prototype and Lloyd Bore for providing plans.

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