

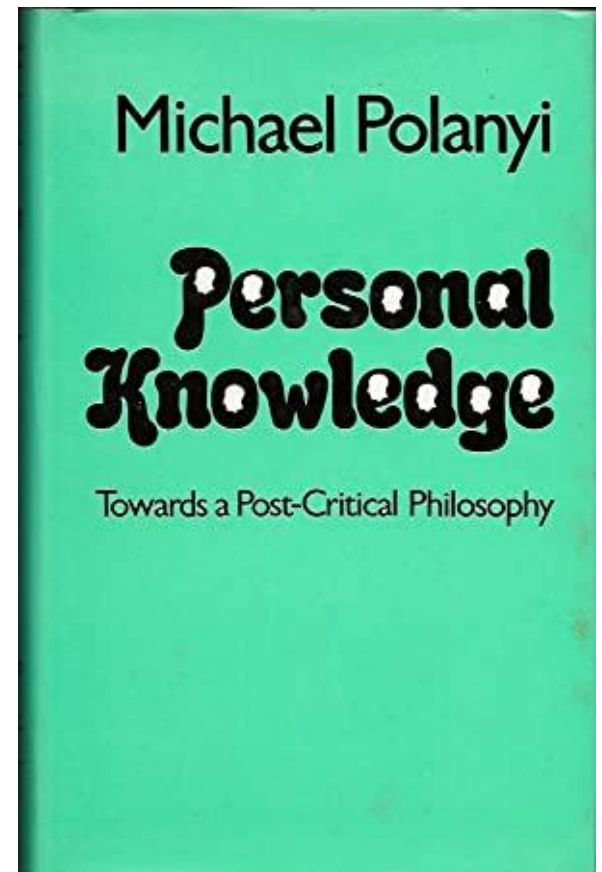
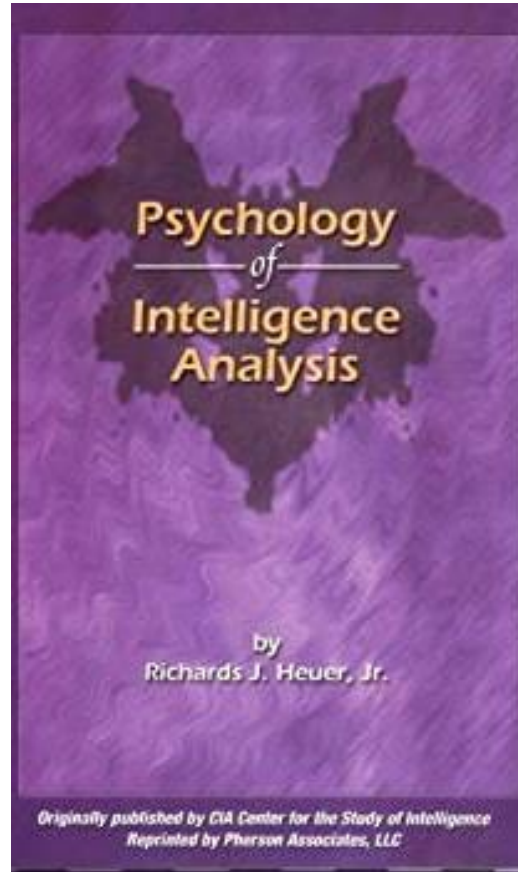
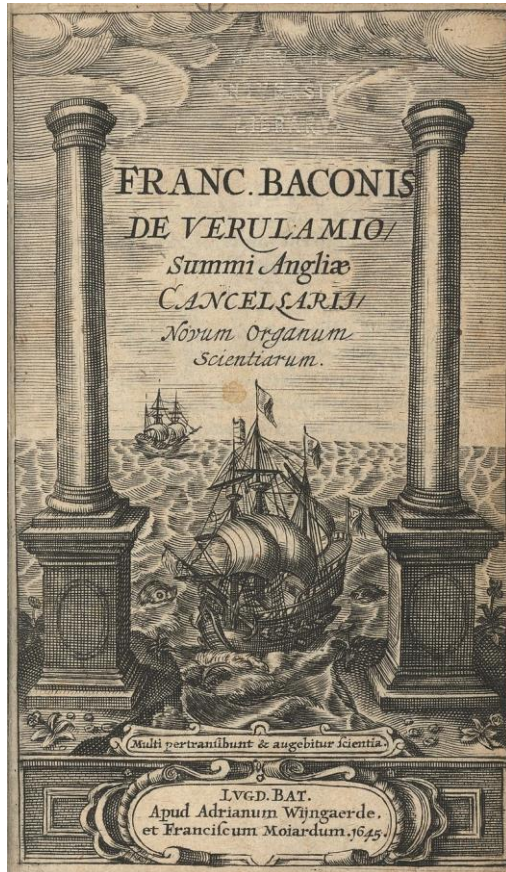


The beginning...

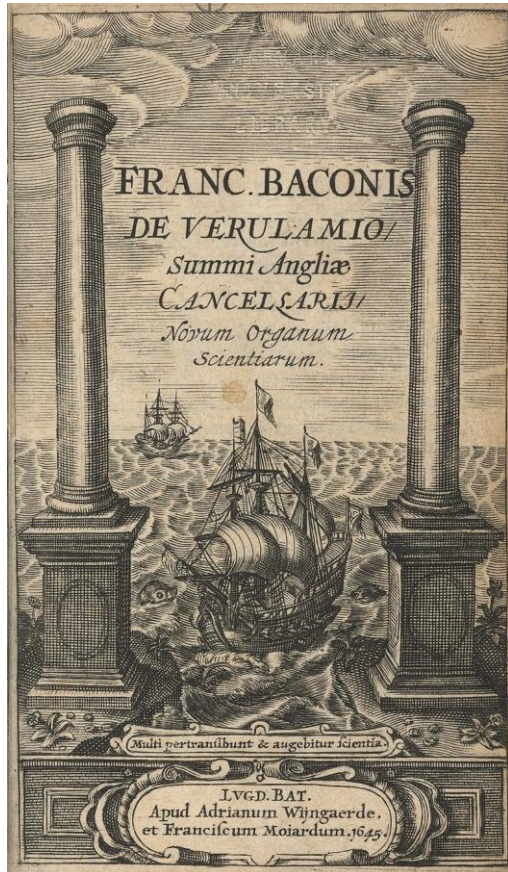
The middle...

The End.

When began... 2008



When  began... 2008

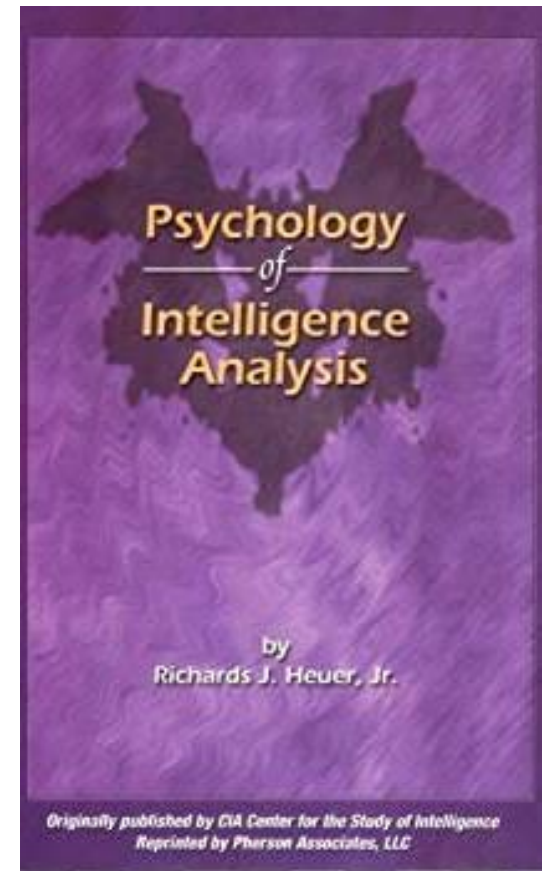


*Nature is only to be
commanded by
obeying her...*

When  began... 2008

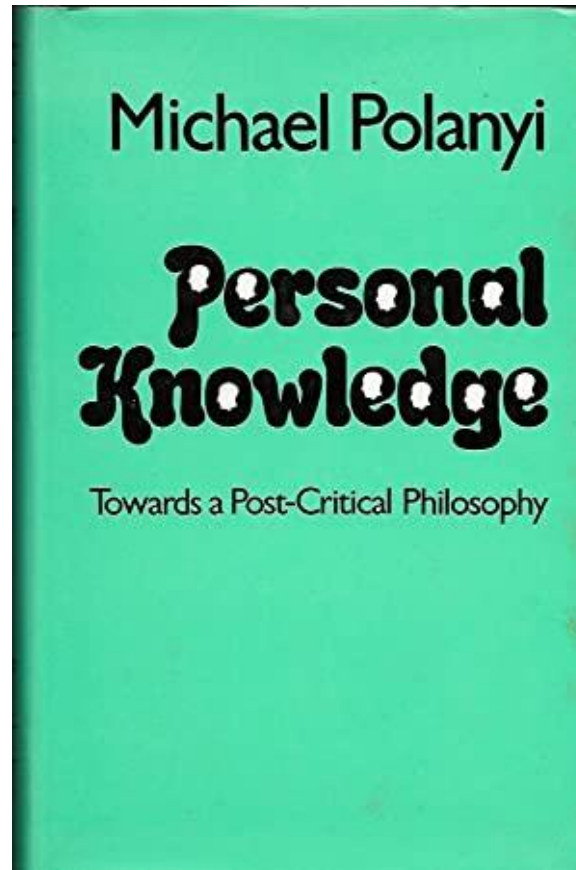
Data - Good

Concept - Bad



When  began... **2008**

*A theory is a contrivance for recording
events and computing their future
course...*





How has evolved...



SURVC11WOODLAND BATS

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SURVEY METHOD

SURVEY METHOD

SURVEY METHOD

KARL R. POPPER

Objective Knowledge

An Evolutionary Approach

Species	
Dead/alive	
Stem/branch	
Height	
Primary	
Secondary	
Name	

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 (eds) 2008. MAMMALS OF THE BRITISH
 ...
 ... James A. 2003. The Bats of Britain and Ireland

PEAKS

CYLINDERS

CREVICES

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C9

C13

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How has evolved...



- 337** low clutter
336 within 60m of wood
335 tree dead
30 below lm
16 within 100m of large pond
1 within 100m of lake or large pond
- 326** high clutter
50 Over 60m from woodland
4 tree dead
3 above lm
2 slow moving river
1 slow or fast river
- 322** low clutter
321 Over 60m from wood
43 tree dead
3 below lm
2 slow river
1 slow or fast river
- 312** high clutter
148 Over 60m from wood
32 tree alive
2 within 100m of fast river
1 slow or fast river
- 303** high clutter
138 within 60m of wood
31 tree alive
30 above lm
2 100m fast river
1 slow or fast river
- 294** low clutter
283 Over 60m from woodland
31 tree dead
30 above lm
2 fast river
1 slow or fast river
- 289** low clutter
288 Over 60m from wood
30 tree alive
30 below lm
2 fast river
1 slow or fast river
- 284** low clutter
282 Within 60m from woodland
150 tree dead
30 below lm
2 fast river
1 slow or fast river
- 273** high clutter
19 Over 60m from woodland
18 tree alive
17 above lm
16 within 100m of lake
1 within 100m of lake or large pond

- 211 - 477**
40 high clutter
29 > 100m from river
28 > Over 30m but within 60m
5 Tree alive
4 Dry Woodland
3 Broadleaved woodland
2 Above lm
- 202 - 466**
30 High clutter
29 < 100m from river
28 Over 30 but within 60m
6 Over 30
5 Tree alive
4 Dry Woodland
3 Broadleaved
2 above lm
- 193 - 459**
18 High clutter
7 Over 100m from river
6 Within 30m of river
5 Tree alive
4 Dry
3 Broadleaved
2 above

- 255** low clutter
254 Over 60m from wood
100 tree dead
17 above lm
16 within 100m of lake
1 within 100m of lake or pond
- 250** low clutter
249 Over 60m from wood
94 tree alive
17 below lm
16 within 100m of lake
1 within 100m of lake or pond
- 245** low clutter
244 Within 60m of woodland
93 tree dead
17 below lm
16 within 100m of lake
1 within 100m of lake or large pond
- 234** high clutter
83 high clutter
82 within 60m of wood
81 above lm
16 within 100m of lake
1 within 100m of lake or pond
- 197** high clutter
61 high clutter
5 fast tree over 60m from wood
4 tree alive
3 above lm
2 within 100m of fast river
1 slow or fast river

- 102** low clutter
100 within 60m of wood
18 tree dead
17 above lm
16 within 100m of lake
1 lake or pond
- 96** low clutter
95 within 60m of wood
94 tree alive
17 below lm height
16 within 100m of lake
1 lake or pond
- 84** low clutter
83 within 60m of wood
82 tree alive
81 above lm
80 within 100m of lake
1 lake or pond
- 71** high clutter
6 high clutter
5 within 60m of wood
4 tree alive
3 above lm
2 slow river
1 slow or fast river
- 52** low clutter
50 within 60m of wood
4 tree dead
3 above lm
2 slow river
1 slow or fast river
- 46** low clutter
45 within 60m of wood
44 tree alive
43 below lm
3 below lm
2 slow river
1 slow or fast river
- 34** low clutter
33 within 60m of wood
32 tree alive
31 above lm
30 within 100m of lake
1 slow or fast river
- 21** low clutter
20 within 60m of wood
19 tree alive
18 above lm
16 lake
1 lake or large pond

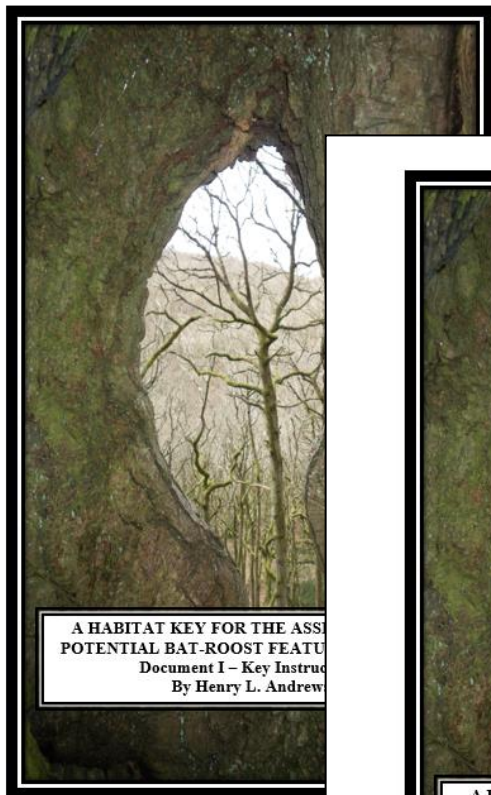
- 213 tree over 60m from woodland edge
81 tree dead
80 over lm height
16 within 100m of large pond
1 within 100m of lake or large pond
- 403** low clutter
402 Over 60m from woodland
335 tree dead
28 below lm height
16 within 100m of large pond
1 within 100m of lake or pond
- 393** high clutter
293 Over 60m from woodland
137 tree dead
31 above lm
30 within 100m of fast river
1 within 100m of lake or fast river
- 389** low clutter
388 Over 60m from woodland
282 tree dead
130 below lm
2 within 100m of fast river
1 within 100m of slow or fast river
- 379** high clutter
254 Over 60m from woodland
18 tree dead
17 above lm
16 within 100m of lake
1 within 100m of lake or large pond
- 365** low clutter
224 Over 60m from woodland
82 tree dead
81 tree alive
80 above lm
16 within 100m of large pond
1 within 100m of lake or large pond
- 356** high clutter
214 Over 60m from woodland
213 tree dead
81 tree alive
80 over lm height
16 within 100m of large pond
1 within 100m of lake or large pond
- 347** low clutter
346 Over 60m from woodland
213 tree dead
81 tree alive
80 over lm height
16 within 100m of large pond
1 within 100m of lake or large pond
- 342** low clutter
341 Over 60m from woodland
206 tree dead
80 below lm height
16 within 100m of large pond
1 within 100m of lake or large pond

- 72 - 338**
71 low clutter
70 over 30m from river
59 Over 30m from river
5 host dead
4 dry woodland
3 broadleaved
2 above lm
- 61 - 327**
60 low clutter
59 Within 100m of wood
5 host dead
4 dry woodland
3 broadleaved
2 above lm
- 50 - 316**
28 over 100m from river
6 Over 30m from river
5 host alive
4 dry woodland
3 broadleaved
2 above lm
- 41 - 307**
40 low clutter
29 over 100m from river
28 over 30 but within 100m
6 Over 30 from edge
5 tree alive
4 dry woodland
3 broadleaved
2 above lm

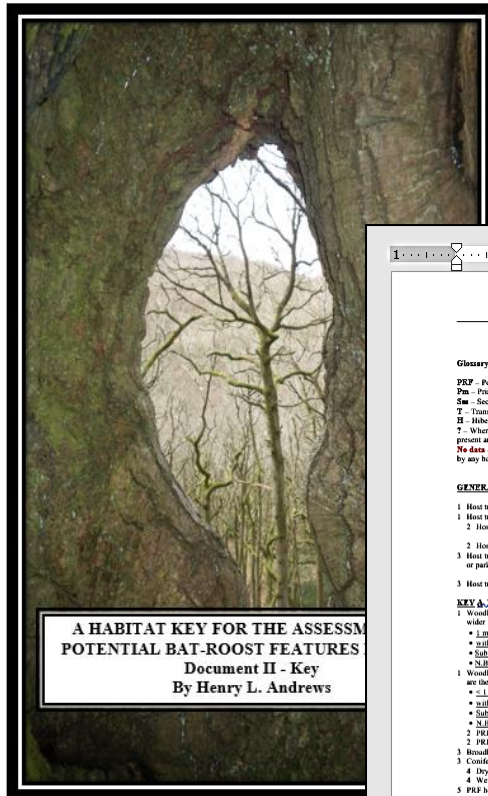
- 149** low clutter
148 Over 60m from wood
147 tree dead
3 above lm
2 slow moving river
1 slow or fast river
- 139** low clutter
138 Over 60m from wood
137 tree dead
81 tree alive
30 above lm
2 100m fast river
1 slow or fast river
- 121** high clutter
120 Over 60m from wood
119 tree dead
18 tree alive
17 above lm
16 lake
1 lake or pond
- 112** low clutter
111 Over 60m from wood
109 tree dead
108 tree alive
107 above lm
106 within 100m of lake
1 lake or large pond

- 259 - 525**
258 High clutter
155 > 100m from river etc
109 > 30m from woodland edge
108 host tree alive
3 Confirmed woodland
1m
- 250 - 516**
249 low clutter
229 > 100m away from river etc
132 > 30m from woodland edge
109 High tree dead
3 Confirmed woodland
1m
- 240 - 506**
230 High clutter
229 < 100m from river etc
132 > 30m from woodland edge
109 Tree dead
3 Confirmed woodland
1m
- 230 - 497**
229 Low clutter
228 < 100m from river etc
132 > 30m from woodland edge
109 Tree dead
3 Confirmed woodland
1m
- 220 - 476**
71 High clutter
70 Over 30 but within 100m of edge
59 Over 30m from edge
5 Tree dead
4 dry woodland
3 Broadleaved woodland / above lm height

How has evolved...



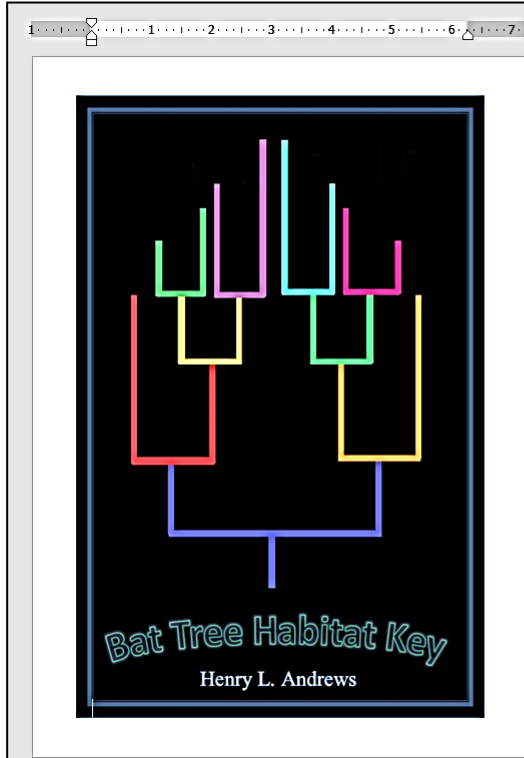
A HABITAT KEY FOR THE ASSESSMENT OF
POTENTIAL BAT-ROOST FEATURES
Document I – Key Instructions
By Henry L. Andrews



A HABITAT KEY FOR THE ASSESSMENT OF
POTENTIAL BAT-ROOST FEATURES
Document II – Key
By Henry L. Andrews

1 2 3 4 5 6 7	
A habitat key for the assessment of potential bat roost features in trees: Document II – Key. 1	
HABITAT KEY TO BAT ROOSTS IN TREES Glossary PRP – Potential roost feature. Pm – Primary maternity: roost feature preferentially selected by maternity colonies of a particular species. Sm – Secondary maternity: roost feature occasionally occupied by maternity colonies of a particular species. T – Transition roost: roost feature occupied by low numbers of bats (mixed sex) or individual males of a particular species. B – Bibernation roost. ? – Where literature review found generalisation and/or suggestion (in grey literature alone) the potential species present are set out in italics preceded with a question-mark. No data – Where literature review found no published account indicating usage or avoidance of a particular PRF by any bat species. GENERAL KEY 1 Host tree located within woodland Key A (Page 1) 2 Host tree not located in woodland 2 3 Host tree located on the bank or within 10 m of the bank of a river, lake or large pond Key B (Page 12) 4 Host tree greater than 10 m from a river, lake or large pond 3 5 Host tree located on or within 10 m of a hedgerow, tree-line or other linear feature such as a terrace of houses, or parkland trees between which a line can be navigated which is never less than 10 m from canopy Key C (Page 50) 6 Host tree isolated within the landscape Key D (Page 69) KEY A – Woodland trees: Broadleaved or coniferous tree in woodland or on woodland edge. 1 Woodland ≥ 2 ha in surface area and/or smaller woodlands which are connected to woodland in the wider landscape via a network of well-structured hedgerows which are themselves: • ≥ 1 m tall; • with gaps > 20 m in length; and • subject to negligible or no artificial lighting. 2 N.B. Typically, woodlands in an unshaded natural setting 2 3 Woodlands ≥ 2 ha which are isolated in the landscape or connected to other woodlands by hedges which are themselves: • ≤ 1 m tall; and/or • with gaps > 20 m in length; and/or • subject to significant artificial lighting. 4 N.B. Typically, woodlands in an arable or urban setting 268 5 PRF above 1 m height 3 6 PRF below 1 m height 184 7 Broadleaved woodland 4 8 Coniferous / mixed woodland 109 9 Dry woodland – Oak, beech etc. 5 10 Wet woodland – Willow / alder carr 99 11 PRF host-tree alive (limb holding PRF may be dead) 6 12 PRF host-tree dead 29 13 PRF host-tree within 30 m of woodland edge 7 14 PRF host-tree over 30 m from the woodland edge 28 15 PRF host-tree less than 100 m away from river, canal or large pond or lake 8 16 PRF host-tree more than 100 m away from river, canal or large pond or lake 18 17 Low-clutter environment: Typically bat not exclusively woodland edge and / or trees within woodland margin (< 30 m from woodland edge) with: • widely spaced canopy more than 1 m apart; • no or few dense / shrubby layers; • no obstructing overhanging foliage; • distance between PRF and nearest obstacle beneath (branch, shrub layer etc.) > 1 m 9	
A habitat key for the assessment of potential bat roost features in trees: Document II – Key. 2	
8 High-clutter environment: Typically trees within woodland margin and wider woodland (> 30 m from woodland edge) with any one of the following: • closely grouped stems less than 3m apart; and/or • dense shrub layer; and/or • obstructing overhanging foliage; and/or • distance from the PRF to the nearest obstacle beneath < 1 m 9 PRF on stem 165 10 PRF on branch 14 11 PRF a woodpecker-bellow on stem 14 12 PRF a rot-bellow, transverse crack, longitudinal split, crevice, loose bark or ivy on stem 11 13 PRF a rot-bellow on stem 11 14 PRF a transverse crack, longitudinal split, crevice, loose bark or ivy on stem 12 15 PRF a transverse crack, longitudinal split or crevice on stem 12 16 PRF a transverse crack, longitudinal split or crevice on stem 12 17 PRF a transverse crack, longitudinal split or crevice on stem 12 18 PRF a transverse crack, longitudinal split or crevice on stem 12 19 PRF a transverse crack, longitudinal split or crevice on stem 12 20 PRF a transverse crack, longitudinal 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a transverse crack, longitudinal split or crevice on stem 12 95 PRF a transverse crack, longitudinal split or crevice on stem 12 96 PRF a transverse crack, longitudinal split or crevice on stem 12 97 PRF a transverse crack, longitudinal split or crevice on stem 12 98 PRF a transverse crack, longitudinal split or crevice on stem 12 99 PRF a transverse crack, longitudinal split or crevice on stem 12 100 PRF a transverse crack, longitudinal split or crevice on stem 12	
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How has evolved...



BAT TREE HABITAT KEY

Please Reference as: Andrews H. et al. 2013. *Bat Tree Habitat Key*. AEcol, Bridgwater.

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BAT TREE HABITAT KEY

Section A. TREES
Chapter A3 - Trees - Decay & Defence

Once infection has occurred, the speed the infection spreads depends on the fungus and the host tree. Different species of tree have different compartmentalisation ability; birch *Betula* spp., poplar *Populus* spp. and willow *Salix* spp. are weak; whereas oak (*Quercus* spp.), lina *Tilia* spp. and (perhaps surprisingly) beech *Fagus* spp. are strong compartmentalisers (Schwarze *et al.* 2000). Ultimately, all the tree's defences do is slow the progress of the fungi, they rarely stop it completely and they can't kill the infection, so sooner or later the rot will spread.



Figure A3.13. Wall 4 is breached and decay enters, only to be slowed by Walls 2 & 3.

We already know that Wall 1's are the weakest walls, and Wall 2 and 3's aren't much better. So even if the tree manages to close the gap with Wall 4, the decay may continue to do its damage, working up the stem (eating away the successively narrower columns of infected heartwood) and down the stem (eating away the successively wider diameter heartwood), into the centre and all the way around the rays (see Figure A3.14).



Figure A3.14. Decay has penetrated Wall 4 at some point in the distant past. From here it has breached Wall 1, and is heading into and around Walls 2 and 3. However, Wall 4 has held, put on new growth and is now trying to close the gap, hence the elliptical hole.

If Wall 4 closes the entrance, then the bats are waiting for a kindly woodpecker to open one up (see Figure A3.15: left). If not, then you get a rot-hole (see Figure A3.15: right) which, hopefully, extends up into a nice tall, darkened, dry, spire (see Photos A3.1 & A3.2) and hey-presto - a fantastic PRF.

BAT TREE HABITAT KEY

Section A. TREES
Chapter A3 - Trees - Decay & Defence



Figure A3.15. Left: Wall 1 has failed, but Walls 2 and 3 have slowed the rot but may yet be overcome, and Wall 4 has sealed the gap (top of picture). Right: Walls 1, 2 and 5 have failed and 4 haven't sealed the gap. Both are ash *Fraxinus excelsior* stems.



Photo A3.1. A crack willow *Salix fragilis* limb that had split. You can see the back of a great-spotted woodpecker *Dendrocopos major* hole on the left, but look to the right; you can clearly see the Wall 4 going up in a 50 cm high spire, the rotten wood yellowish against the white of the healthy wood. Had this remained and the soft-wood degenerated, this would have been a beautiful PRF.

How has evolved...



How has evolved...



BCT Feature

Is there a bat in that tree?

Botanist Henry Andrews explains his tips to spotting the likely roost sites for bats in trees – the key finding spaces in nature that replicate the parts of buildings we know bats love.

Can you look at a house and make a reasoned judgement as to whether it holds bats? A lot of ecologists can. But doing the same thing with trees is trickier. Until recently I couldn't, and it really irritated me that I couldn't.

"The reputed rarity of a species is probably nothing more than an ignorance of its habitat". Ramsbottom (1953)

Some days after I first read this quote and while in a brown long-eared bat (bleb) roost, I thought 'these bats are widespread and use trees; why don't I find them?' Suddenly, it dawned on me: 'bleb favour the ridge-beam; what tree-feature replicates that?'

Looking for a 'roof' in nature

I found a description of 'hazard-beams' (a beam which has a longitudinal split passing right through it), which appeared to fit: 'the apex is peaked with callus ridges superficially similar to rafters'. A call to a friend rewarded me with the location of a hazard-beam so off I went and found two blebs! Having spotted another from the road I went to the tree; two more blebs, and I found another soon afterwards and was rewarded with ten furry little faces!

All this made me think about 'shapes'. I wondered if, where bat species occupy houses and trees, the same roost-shapes occupied in buildings are occupied in trees?

Peaks, Cylinders and Crevices

So I studied the internal characteristics of roost-features in houses and in trees, and I came across three shapes: Peaks, Cylinders and Crevices.

Peaks occur in houses in one common situation: Ridge-beams. These are favoured by bleb, a species that regularly roosts in trees. So why don't we find them? Perhaps because peaks only occur in trees in one situation: hazard-beams, where the stem/limb is at an angle of 60° or above.

Cylinders occur in built structures only as chimneys, lime-kiln vents and pipe-work. The situation is, however, very different in trees, where cylinders occur in a wide variety of forms comprising woodpecker-holes, knot-holes, flash-cuts (where the heartwood has rotted away), tear-outs, double leaders, wounds & cankers, frost-cracks and butt-roots.



This canker is hiding two Daubenton's bats

Narrowing it down

Although woodpecker-holes represent suitable potential feature and are used by several bat species, competition and they hold birds and squirrels more commonly than bats. Furthermore, knot-holes rarely into suitable roost-features as typically result in discontinuous rather than rot-columns, and tend to be very large with read for predators such as weasels. But that does leave four: tear double-leaders, wounds & frost-cracks which often develop suitable roost-features where relatively competitor free areas they can access very small entry and climb up to roost facing down.

Crevice occur on and in structures in many situations: under slate tiles, behind barge-boards, in mortise-joints and cavity-walls. All lead to darkened, secure areas. In trees crevices comprise: beams, flash-cuts and butt-ends (where Heartwood remains); frost-cracks; helical-split lightning-strikes; impact-shatters; desiccation-fissures; lit bark unions; and ivy.

Of these, helical-split, lightning strikes and desiccation-fissures, are accessed from the side and around, rather than from the bottom up. They're often neither darkened nor secure. Furthermore, from my observation, many act as rain-gutters, even in light showers. Impact-shatters and unions may be unstable in windy conditions, and bats would risk being crushed. Finally, although barbastelles have been tracked into ivy-clad trees, they have been in secluded situations at heights ranging from 4 to 18 metres! So, finding them is very serious work for specialists.

Not so hazard-beams which are stable and sheltering. Dr. Billington has found barbastelles hibernating in them. Dr. Billington has found barbastelles hibernating in them. Dr. Billington has found barbastelles hibernating in them.

So hazard-beams, tear-outs, double-leaders, wounds & frost-cracks and lifting-bark are the features that are always trees with bats!

Henry Andrews MSc MIBEM is a botanist and specialist survey for protected species and works as an Ecological Consultant. [Link: www.eco.co.uk](http://www.eco.co.uk)

The Young Batworker

A magazine for the young bat enthusiast

Issue 87 Summer 2013

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What's inside?

- Make a brown long-eared bat mask
- Bats in bird boxes
- Looking for tree roosts
- Bat things to do
- Bats and fig trees
- plus lots more bat facts AND a pull-out teacher feature on Bat maths

The Young Batworker is free to members of the Young Batworkers Club, the junior wing of the Bat Conservation Trust, and to BCT family members.

LOOKING OUT for bats 9

Looking for tree roosts

We are gradually learning more about different bat species, especially those found using buildings, because of course, those are the bats that people most often come across. But in the UK most bats are naturally tree dwelling animals, and just as different species use different parts of a house to roost, the same is true of trees.

Henry Andrews thought about how and where bats roost in houses and realised that three main shapes are used, peaks, such as the ridge beams, cylinders like chimneys, and crevices under tiles, behind barge boards, under loose bark and other tight spaces. Then he looked for similar shapes in trees.

As brown long-eared bats usually choose to roost along the ridge in houses, Henry looked for 'hazard beams' in trees; the apex is ridged rather similar to rafters in a loft. Sure enough, there at the top of the first he looked in were two long-eared bats! Look carefully at the photos on this page. Can you work out which of the three shapes each roost fits?



Henry also has a special licence to use an instrument called an endoscope, with which he can see what's going on inside a hole or crack in the tree.



So when you're in the woods, if you see cracks or lifting bark, it's worth a look. But be very quiet so you don't disturb the bats, and never touch or shine your torch on them.

Ten brown long-eared bats were seen roosting in this hazard beam



A common pipistrelle roosted in a frost crack in this tiny tree



Forty-one noctule bats flew out of this flash-cut



High in the canopy 19 rare barbastelles are sheltering behind lifting bark



A canker held two Daubenton's bats

An article by Henry Andrews with more details of his search methods appears in the current issue of Bat News, the magazine for adult members of the Bat Conservation Trust. For information on membership of the Bat Conservation Trust and The Young Batworkers Club visit www.bats.org.uk

How has evolved...



How has evolved...



How has evolved...

Feature Article: Surveying Trees for Bat Roosts:
Encounter Probability v. Survey Effort



Sechser's bat maternity roost in an upwardly developed knothole in the crown of a pedunculate oak

Surveying Trees for Bat Roosts: Encounter Probability v. Survey Effort

Henry Andrews Ecological
Bat Tree Habitat Key (funded by AECOL)

Mark Gardener
DataAnalytics

Keywords: Bat Tree
modelling, median
bat survey effort

Monitoring and measuring mitigation success frequently relies upon accurate survey, particularly of protected species such as bats. An evidence-base has been lacking in respect of recommendations regarding survey intervals and intensity in relation to bat roost surveys of trees.

This article presents a descriptive summary of evidence in support of survey intervals, and includes an encounter probability model for survey intensities during the maternity season. Although the method is primarily for assessing the status of Potential Roost Features in trees, it is likely that it would be effective for assessing the

Issue 68 | June 2015

Background
This article was written for the Tree Habitat Key, a dichotomous key includes an evidence of how Potential Roost Features form in trees and when, where and document can be found at www.aecol.co.uk/Pages/Tree-Habitat-Key.aspx. The project has provided an evidence recommendation.

October 2016

A REVIEW OF EMPIRICAL DATA IN RESPECT OF EMERGENCE AND RETURN TIMES REPORTED FOR THE UK'S 17 NATIVE BAT SPECIES

~~~~~

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ECOLOGICAL**

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v.1 – December 2016

## REVIEW OF TRANSECT EFFICACY & RELEVANCE IN COMPARISON TO AUTOMATED SPOT-COUNT SAMPLING

*Le Rhinolophe* (2000) 14: 37-68

Chauves-souris arboricoles en Bretagne (France): typologie de 60  
arbres-gîtes et éléments de l'écologie des espèces observées

*Tree-dwelling bats in Brittany (France): 60 roost trees and ecology of the species observed elements*

Philippe PÉNICAUD, 5 rue du Strickell, 22300 Lannion, France

**Abstract.** Tree-dwelling bats in Brittany (France): typology of 60 tree roosts, and fragments of the ecology of the observed species. From 1992 to 1999, prospecting in woodlands in the North-west of Brittany has allowed the discovery of 60 natural roosts for tree-dwelling bats. Various kinds of occupied hollows have been found inside trees, but those created by the partial healing of narrow cracks, mainly resulting of storm and/or frost (especially in oaks), appear so particularly sought out by bats, that systematic inspection inside these kind of hollows (with ladders, a light and small mirrors), quickly turned out to be a really "productive" method, for discovering bats: (with) at least 58% of the suitable narrow crevices are used by bats (results needing an average of 2.2 visits per crevice). Five bat species have been recorded: brown long-eared bat *Plecotus auritus*; Natterer's bat *Myotis nattereri*; Daubenton's bat *Myotis daubentonii*; whiskered bat *Myotis mystacinus*; and pipistrelle *Pipistrellus* sp. The tree roosts can be occupied all through the year; reproduction and hibernation included. Besides, it has been noticed that tree-dwelling bats often move around, from one roosting site to another, probably following a similar pattern of movement every year. The observed numbers (bats inside trees, or flying off) go from 1 up to 26 individuals, and several nursery roosts were recorded. Some protective measures for suitable trees are now being taken in a few National Forests.

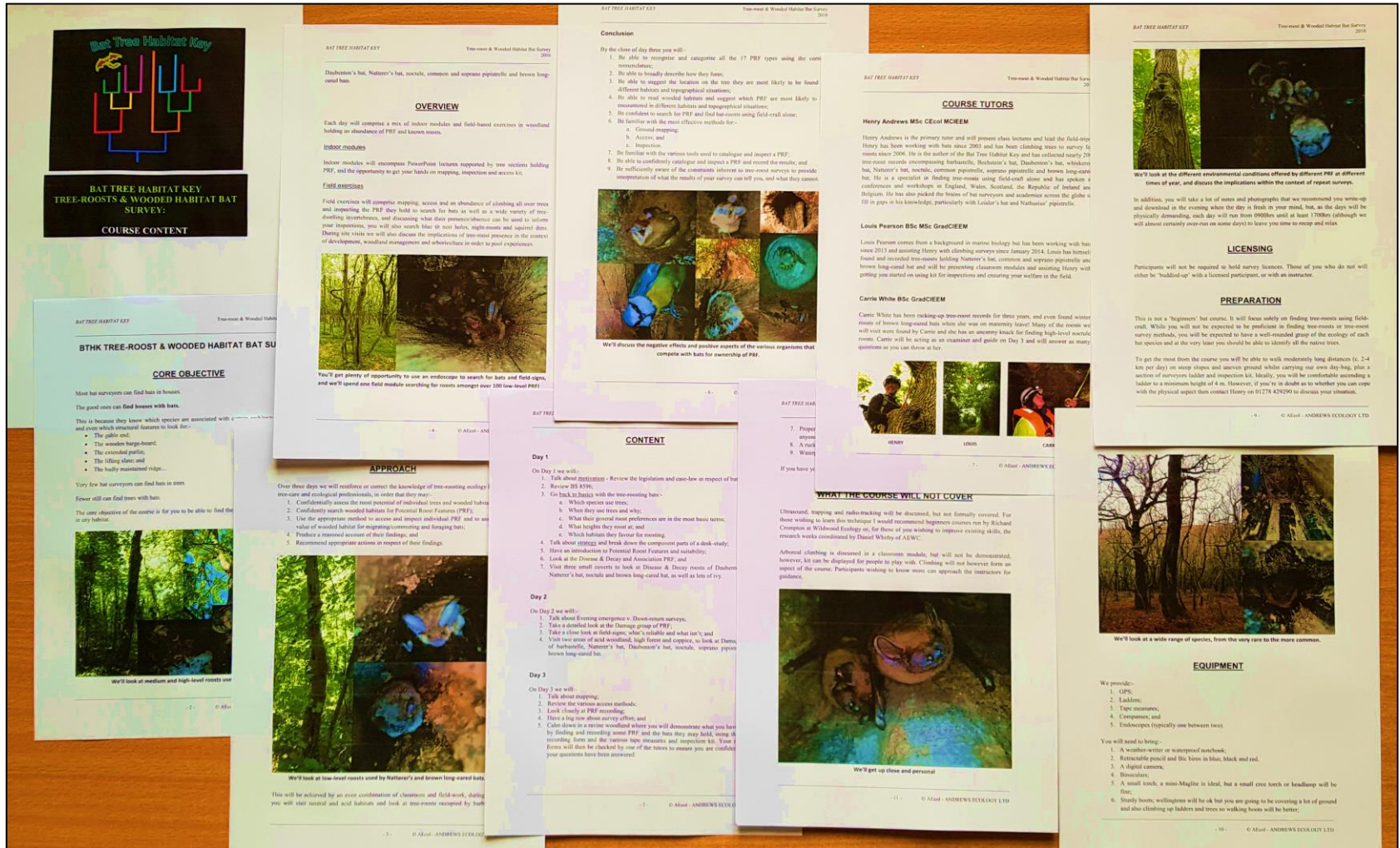
**Keywords:** typology of bat tree roosts, narrow crevices, 5 bat species, fragments of ecology, Brittany, preservation of suitable trees, France.

### INTRODUCTION

As in other French regions, most of the research on bats in Brittany has been directed, so far, to "traditional sites", such as underground hibernacula (old mines and slate quarries, bunkers, pipes etc.) and the built environment in breeding colonies (churches, castles, public and private buildings etc.) (Nicolas 1988).

Today we are making good progress in the knowledge of these types of roosts in the region, although we continue to discover interesting summer colonies (Boireau *pers. comm.*) and new underground cavities harbouring substantial numbers of hibernating bats, such as sea caves (Ros *pers. comm.*), and old slate quarries, for example in the

# How has evolved...



# How has evolved...



ELSEVIER

Biological Conservation 88 (1999) 261–276

BIOLOGICAL  
CONSERVATION

## Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests

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Received 2 November 1997; received in revised form 27 May 1998; accepted 3 June 1998

### Abstract

Roost selection by the threatened New Zealand long-tailed bat (*Chalinolobus tuberculatus*) was examined in temperate beech (*Nothofagus*) rainforest in New Zealand. Seventy-three bats were radio-tracked during the summers of 1993–1997 to 304 roost cavities in 291 different trees. Roost tree and site characteristics were compared with those of 593 randomly selected trees. Bats selected roosts on the basis of topography, forest composition and tree characteristics. Ninety-five percent of roost trees were in mature, open-structured lowland forest on the relatively flat valley floor within 500 m of the forest edge. Four tree species (including dead trees) were used as day roosts. *C. tuberculatus* did not discriminate between tree species per se, but selected roost trees on the

Journal of Mammalogy, 86(5):921–930, 2005

## ROOST CAVITY SELECTION BY *NYCTALUS NOCTULA* AND *N. LEISLERI* (VESPERTILIONIDAE, CHIROPTERA) IN BIAŁOWIEŻA PRIMEVAL FOREST, EASTERN POLAND

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The selection of roost cavities by *Nyctalus noctula* and *N. leisleri*, 2 widespread species of mainly Eurasian distribution, was examined in Białowieża Primeval Forest in eastern Poland from May to August in 1998–2002. Because *N. noctula* is one of the most common forest-dwelling bats in Europe, whereas the smaller *N. leisleri* is relatively rare across its range (except in Ireland) and more limited to ancient forests, we hypothesized that these 2 taxa may differ significantly in their tree-cavity selection. Twenty-five *N. noctula* and 26 *N. leisleri* were radiotracked to 52 and 50 roost trees, respectively. For each accessible cavity roost occupied by *N. noctula* ( $n = 28$ ) and *N. leisleri* ( $n = 39$ ), 16 features were measured and compared with potentially available cavities ( $n = 72$ ). Both species were selective in roost choice, and preferred cavities located higher (averaging 19 m above the ground), in more open surroundings, with smaller entrances, and with greater safety distance (from martens) than available cavities. Nearly all roosts occupied by bats were dry inside. Both species slightly more frequently

1<sup>st</sup> recorder:  
(climber/inspector)

2<sup>nd</sup> Recorder:  
(groundsman/scribe)

|                                                                                                                           |                                                                                     |           |                                     |                |            |  |
|---------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------|-------------------------------------|----------------|------------|--|
| GROUNDSMAN                                                                                                                | SITE NAME                                                                           |           |                                     |                |            |  |
|                                                                                                                           | DATE                                                                                |           |                                     |                |            |  |
|                                                                                                                           | HABITAT (Phase 1)                                                                   |           |                                     |                |            |  |
|                                                                                                                           | GRID REFERENCE (O.S. not lat/lon)                                                   |           |                                     |                |            |  |
|                                                                                                                           | Tag number                                                                          |           |                                     |                |            |  |
|                                                                                                                           | TREE SPECIES                                                                        |           |                                     |                |            |  |
|                                                                                                                           | TREE ALIVE/DEAD                                                                     |           |                                     |                |            |  |
|                                                                                                                           | DBH (Diameter at Breast Height)                                                     |           |                                     |                |            |  |
|                                                                                                                           | TREE HEIGHT                                                                         |           |                                     |                |            |  |
|                                                                                                                           | PRF on STEM/LIMB                                                                    |           |                                     |                |            |  |
| PRF TYPE                                                                                                                  |                                                                                     |           |                                     |                |            |  |
| DIRECTION PRF FACES                                                                                                       |                                                                                     |           |                                     |                |            |  |
| MEASUREMENTS                                                                                                              | PRF HEIGHT                                                                          |           |                                     |                |            |  |
|                                                                                                                           | DPH (Diameter at PRF Height)                                                        |           |                                     |                |            |  |
|                                                                                                                           | ENTRANCE                                                                            | Height    |                                     |                |            |  |
|                                                                                                                           |                                                                                     | Width     |                                     |                |            |  |
| INTERNAL                                                                                                                  |                                                                                     | Height    |                                     |                |            |  |
|                                                                                                                           |                                                                                     | Width     |                                     |                |            |  |
|                                                                                                                           |                                                                                     | Depth     |                                     |                |            |  |
| ROOSTING EVIDENCE                                                                                                         |  |           | Droppings (look in base)            |                |            |  |
|                                                                                                                           |                                                                                     |           | Species                             |                |            |  |
|                                                                                                                           |                                                                                     |           | Number of bats                      |                |            |  |
|                                                                                                                           |                                                                                     |           | Above, below or to side of entrance |                |            |  |
|                                                                                                                           |                                                                                     |           | Distance from entrance (cm)         |                |            |  |
| Awake or torpid                                                                                                           |                                                                                     |           |                                     |                |            |  |
| INTERNAL CONDITIONS:<br>Tick as many of the following as are applicable.<br>Where a field is negative please put a cross. | SMELL                                                                               | None      | Pleasant                            | Not unpleasant | Unpleasant |  |
|                                                                                                                           |                                                                                     |           |                                     |                |            |  |
|                                                                                                                           | SUBSTRATE                                                                           | Smooth    | Bobbly                              | Bumpy          | Rough      |  |
|                                                                                                                           |                                                                                     | Clean     | Waxy                                | Blackened      | Polished   |  |
|                                                                                                                           |                                                                                     | Messy     | Dusty                               | Debris         | Sludgy     |  |
|                                                                                                                           |                                                                                     |           |                                     |                |            |  |
|                                                                                                                           | HUMIDITY                                                                            | Dry       | Damp                                | Wet            |            |  |
|                                                                                                                           | APEX SHAPE                                                                          | Dome      | Spire                               | Peak/wedge     | Flat       |  |
|                                                                                                                           |                                                                                     | Chambered | tube                                |                |            |  |
|                                                                                                                           | COMPETITORS<br>(invertebrates, birds, mammals?)                                     |           |                                     |                |            |  |
| COMMENTS                                                                                                                  | Don't forget the photographs!                                                       |           |                                     |                |            |  |

# How has evolved...



## BAT TREE HABITAT KEY

DATABASE REPORT 2016



Reference as:

Andrews H & Gardener M 2016. *Bat Tree Habitat Key – Database Report 2016*. AECOL, Bridgwater



## Höhlenbäume im urbanen Raum

### Teil 2 Leitfaden



Entwicklung eines Leitfadens  
zum Erhalt eines wertvollen Lebensraumes  
in Parks und Stadtwäldern  
unter Berücksichtigung der Verkehrssicherung



Note: This English translation was primarily interpreted using Google Translate and may therefore not be fully accurate.

## Cavity trees in urban areas

### Part 2 Guide



Development of guidelines for obtaining a  
valuable habitat in parks and urban forests,  
taking into account the public safety



2  
Municipality of the City of Frankfurt am Main, Environmental Office  
Institute of Animal Ecology and Nature Education



## BAT TREE HABITAT KEY

3<sup>rd</sup> EDITION 2016



Reference as:

Andrews H et al. 2016. *Bat Tree Habitat Key (3<sup>rd</sup> Edition)*. AECOL, Bridgwater

# How has evolved...

## BAT ROOSTS IN TREES

A GUIDE TO IDENTIFICATION AND ASSESSMENT  
FOR TREE-CARE AND ECOLOGY PROFESSIONALS



WY PELAGIC  
PUBLISHING



BAT TREE  
HABITAT KEY

### Bat Roosts in Trees

1. The maximum number of bat species that might potentially roost in a tree and their individual months

|                            | WINTER |     | SPRING-FLUX |     | PREGNANCY |     | NURSERY |     |
|----------------------------|--------|-----|-------------|-----|-----------|-----|---------|-----|
| Month                      | Jan    | Feb | Mar         | Apr | May       | Jun | Jul     | Aug |
| Number of species roosting |        |     |             | 13  | 12        | 13  | 11      | 11  |
|                            | 8      | 8   | 9           |     |           |     |         |     |

present, as the populations of these species are significant. There are fewer bats present overall, and those that are present are less likely to be present because they are grouping together. Therefore, the proportion of bats present is lower.

### Activity

The proportion of discovering a tree-roost, activity relates to whether the bat is in a state of sleeping and waking, or are following a cycle of torpor interspersed with irregular periods of waking. While scientific, it is rational to suppose that the more torpid the bat is, the more likely it will move, and therefore the longer each duration of occurrence. Figure 11.1 illustrates the proportion of encounters with bats of all species in each month in records held on the BTHK Database.

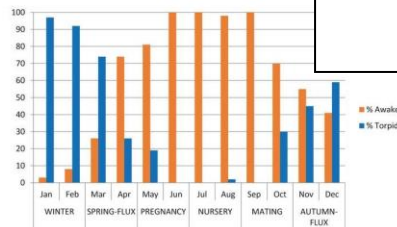


Figure 11.1 The proportion of bats that were awake and torpid in each period in records held on the BTHK Database.



Lightning-strikes: Top to bottom: barbastelles; Natterer's and brown long-eared bats; and brown long-eared bats.

Close-Inspection 157

Table 8.14 Noctule *Nyctalus noctula*: associated dimensions (cm)

| ENTRANCE HEIGHT | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
|-----------------|--------------------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------|----------------------------------|------------------------------------------------------|
| Total range     | 0-169                                            | 5.5-227                                    | 4.5-145                                                                                | 1.2-15                      | 7-227                            | 6.5-201                                              |
| sonable lihood  | 8.8-94                                           | 8.7-111.2                                  | 7-10.6                                                                                 | 5.8-11.2                    | 11.05-169.2                      | 9.5-117.5                                            |
| lian            | 29.5                                             | 22.5                                       | 8                                                                                      | 7                           | 84.5                             | 22.5                                                 |
| FRANCE PTH      | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
| al range        | 1.8-20                                           | 1.8-20                                     | 4.6-8.9                                                                                | 6-11                        | 2.5-5.5                          | 1.6-20                                               |
| sonable lihood  | 2.5-6.2                                          | 5-7.3                                      | 5.5-6.5                                                                                | 6.3-9.1                     | 4.6-5.5                          | 2-6.3                                                |
| lian            | 5.8                                              | 5.8                                        | 6.3                                                                                    | 7.2                         | 5                                | 3                                                    |
| ERNAL GHT       | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
| al range        | 21-180                                           | 6-180                                      | 0-88.1                                                                                 | 0-90                        | 20-115                           | 22-180                                               |
| sonable lihood  | 24.3-59                                          | 21.5-67                                    | 19.4-40                                                                                | 0-85.7                      | 31.2-56                          | 39.2-100.7                                           |
| lian            | 36.5                                             | 31.7                                       | 21                                                                                     | 44                          | 37                               | 63.7                                                 |
| ERNAL PTH       | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
| al range        | 2.1-150                                          | 4-150                                      | 8-50                                                                                   | 1.2-50                      | 4-20                             | 2-150                                                |
| sonable lihood  | 4.7-9.2                                          | 7.3-18.7                                   | 11-21                                                                                  | 19.1-41.2                   | 5.3-12.3                         | 4.6-7.7                                              |
| lian            | 6                                                | 9.5                                        | 15                                                                                     | 23.1                        | 7.5                              | 5                                                    |
| ERNAL PTH       | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
| al range        | 0-267                                            | 0-267                                      | 0-51                                                                                   | 0-50                        | 0-28.4                           | 0-267                                                |
| sonable lihood  | 0-10                                             | 0-12.7                                     | 2-19.1                                                                                 | 15.5-42                     | 0-12.2                           | 0-11.7                                               |
| lian            | 0                                                | 3                                          | 6.5                                                                                    | 23                          | 9                                | 1.2                                                  |
| ERNAL LUME      | AVERAGE LENGTH OF BAT (top of head to rump) (mm) | AVERAGE WIDTH OF BAT (wrist to wrist) (mm) | AVERAGE CONDOLO-BASAL OF BAT (nose to back of skull taken from Dietz et al. 2011) (mm) | AVERAGE VOLUME OF BAT (cm³) | TREE ROOST MATERNITY COLONY SIZE | MINIMUM VOLUME REQUIRED FOR A MATERNITY COLONY (cm³) |
|                 | 101                                              | 47                                         | 11.2                                                                                   | 52.9                        | 10-95 (BTHK Database)            | 1,059-5,025                                          |
| IX SHAPE        | Winter                                           | Spring-flux                                | Pregnancy                                                                              | Nursery                     | Mating                           | Autumn-flux                                          |
| ne              | 33.3 (4)                                         | 41.7 (5)                                   | 100 (9)                                                                                | 50 (4)                      | 12.5 (1)                         | 40 (4)                                               |
| re              | 25 (3)                                           | 16.7 (2)                                   | —                                                                                      | —                           | 25 (2)                           | 50 (5)                                               |
| k               | 41.7 (5)                                         | 16.7 (2)                                   | —                                                                                      | 37.5 (3)                    | 25 (2)                           | 20 (2)                                               |
|                 | —                                                | 8.3 (1)                                    | —                                                                                      | 12.5 (1)                    | 12.5 (1)                         | —                                                    |
| umbered         | 16.7 (2)                                         | 8.3 (1)                                    | —                                                                                      | 12.5 (1)                    | 12.5 (1)                         | 20 (2)                                               |
| e               | —                                                | 8.3 (1)                                    | —                                                                                      | —                           | 25 (2)                           | —                                                    |



## FEATURE

# Bat Tree Habitat Key (Bats write books)

Henry Andrews has become well known in the bat world for leading the Bat Tree Habitat Key Project, a collaborative effort involving naturalists across Europe. Developed over several years the project has produced great resources for bat workers and later this year a new guide for finding tree-roosts will be published.

The objective is to provide an identical account of how each bat species exploits individual tree species as roost sites, to define effective intelligence-gathering and surveillance methods.

This is achieved by data collection, collation, review and analysis within a standardised format, as well as the collection of photographic accounts, which may be contributed to by anyone, and are made publicly available for everyone (see [www.battreehabitatkey.com](http://www.battreehabitatkey.com) and an associated Facebook page).



Henry Andrews up a tree

To date the project has produced a literature review which has been enlarged over three editions; in 2011, 2013 and 2016. This exercise has established a definition of what each Potential Roost Feature (PRF) comprises, accounts of tree-roosting ecology in an identical format for each bat species (thereby identifying what is not known, as well as what is), and culminated in the *Bat Tree Habitat Key* itself, which is a dichotomous key based on published scientific evidence and photographic accounts. This key broadly identifies:

- ◆ Which bat species might occupy a given tree feature; in
- ◆ Each habitat;
- ◆ When; and for
- ◆ What purpose.

Acquisition of scientific papers and books required to complete these reviews has been funded by tree-roost survey courses. These have also funded the first web-hosted open-access tree-roost database ([www.battreehabitatkey.com](http://www.battreehabitatkey.com)) and two annual database reports which collate the data into accounts which have a practical application.

Recording criteria have also been identified and revised to the stage that they are 'future-proof' and can be used to take the project forward.



The third edition of the literature review was therefore the last. The project is ready to move to the next stage, and it has been demonstrated that the dichotomous key is not fit for purpose. Nevertheless, the objective has been achieved in as much as the desk-study has accurately identified the known/knowns and the known/unknowns.

It is now time to focus upon the contents of the database. To date these comprise 5,829 individual biological records each encompassing a detailed account of the location, habitat, dimensions, internal environment and organisms present on individual dates PRF are inspected. New records are added every month and an updated spreadsheet is posted online.

These data are the alchemic stardust that is mixed to make the algorithm that will identify the location of a target with the minimum logistical exposure. Although biological records have many uses, this is their greatest value – predictive power.

By using biological records to define a structure-based framework, the curious naturalist can process specific habitat attributes to render the invisible hiding-place of an animal visible, not just when the target

exploits the habitat resource but is hidden within it, but also when the target is absent when the surveillance is performed.

The aim of *Bat Tree Habitat Key* is to:

1. Provide a means of predicting the probability a specific area of habitat will hold specific PRF;
2. Predict the probability a PRF will be exploited by a specific bat species at a specific point in time for a specific purpose; and
3. Even if the PRF is found but is empty on that first inspection, still be able to predict the probability that it is exploited as a roost.

It has taken nearly two years to produce the structure-based framework that can be used to assess field-data against the database to produce a probability of roost presence. In addition, it has been necessary to review the



Pipistrelles in a desiccation feature

## FEATURE

# How has evolved...

A summary of 10 nights sampling of a male noctule *Nyctalus noctula* emitting Advertisement Calls from a grey squirrel *Sciurus carolinensis* hole in a sessile oak *Quercus petraea* standard

Suggestions for a walked transect using a hand-held ultrasound recorder

Version 1 – 12<sup>th</sup> August 2020

BTNH

*Nyctalus noctula* mating roost transect

Natural Woodland known as Five Lords, in Somerset. Figure 2.1 illustrates the roost and Figure 2.2 illustrates the context.



Figure 2.1. Noctule *Nyctalus noctula* mating roost that was sampled, and the bat itself.



Figure 2.2. The context of the Five Lords noctule mating roost.

- 2 -

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BTNH

*Nyctalus noctula* mating roost transect

## 4.1 Advertisement Calls

Advertisement Calls are produced repeatedly by the male from a stationary position inside and above the entrance to the roost<sup>1</sup>. The call is low, almost constant frequency and has a Fmax of c. 11 kHz (Middleton *et al.* 2014). Figure 4.1 shows an Advertisement Call.

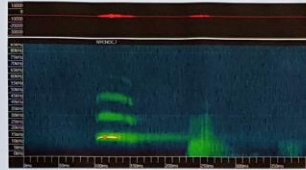


Figure 4.1. Noctule *Nyctalus noctula* Advertisement Call.

Advertisement Calls are basically individual yells given to a rather irregular pulse. They sound and, when using a detector with a screen that allows the call 'shape' to be seen in the field, look to the occasional yells heard in the general chatter that can be heard in the vicinity of roosts. To illustrate, images of chatter are provided at Figure 4.2 and 4.3.

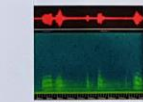


Figure 4.2. The chatter of female noctules *Nyctalus noctula*.

may not therefore be visible at the roost

BTNH

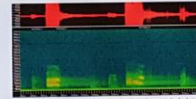


Figure 4.3. The chatter of female noctules *Nyctalus noctula* during a

Reference to Figures 4.1 through 4.3 show that the Advertisement Call is in view. Another aspect is that (to Henry Andrews) it is not heard without the detector, where chatter is clearly as

There other differences, inasmuch as: a) whether female bats roost, b) the chatter may not be constant throughout the day, and, c) even where chatter is typical for the situation, it may differ in amplitude from day to day. As a result, finding maternity roosts using the chatter can be frustrating. In contrast, mating calls are emitted at night, when bird song is over and the surveyor is unlikely to be confused by familiar goldcrest *Regulus regularis* (although this latter variation can be settled by using an ultrasound detector as, although (to Henry Andrews at least) the noctule chatter and the goldcrest sound similar, the call shape is different.

As Advertisement Calls are produced repeatedly and over a long period, night-after-night, from a stationary position at the entrance to the mating roost (Middleton *et al.* 2014), they may be used to identify the roost site. In addition, although they are usually emitted in flight and might not be helpful in determining the exact location of a roost, Slow and Fast Trills may also be associated with mating behaviour, and might therefore lead to the general vicinity in which a mating roost tree is situated. These call types are therefore also described and illustrated.

## 4.2 Slow Trills

Slow Trills are usually emitted in flight, including in the vicinity of roosts (Middleton *et al.* 2014). The call typically produces two to five continuous dipped U shapes (Middleton *et al.* 2014). Figure 4.4 shows a Slow Trill.

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*Nyctalus noctula* mating roost transect

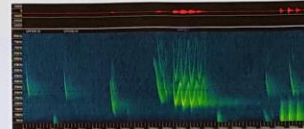


Figure 4.4. Noctule *Nyctalus noctula* Slow Trill.

## 4.3 Fast Trills

Fast Trills are produced both in the vicinity of roosts and in flight (Middleton *et al.* 2014). These calls are typically longer than Slow Trills and have a higher modulated speed (Middleton *et al.* 2014). Figure 4.5 shows a Fast Trill.

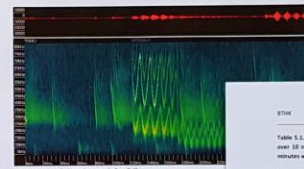


Figure 4.5. Noctule *Nyctalus noctula* Fast Trill.

## 4.4 Learning the difference

Not everyone has a detector with a screen, and that should not put a mating roost, so we have provided a series of films at [www.bath.ac.uk/bath-nature](http://www.bath.ac.uk/bath-nature) go to the reference page and look for the following:

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Table S.1. Summary of noctule *Nyctalus noctula* over 10 nights between 10<sup>th</sup> September and 19<sup>th</sup> September, minutes within each hour in which AC were

| NIGHT | 1 | 2  | 3  | 4  |
|-------|---|----|----|----|
| 1     | 0 | 46 | 6  | 14 |
| 2     | 0 | 7  | 1  | 2  |
| 3     | 0 | 22 | 26 | 10 |
| 4     | 0 | 17 | 4  | 2  |
| 5     | 0 | 41 | 20 | 7  |
| 6     | 0 | 19 | 11 | 3  |
| 7     | 0 | 2  | 12 | 5  |
| 8     | 0 | 0  | 0  | 1  |
| 9     | 0 | 20 | 1  | 7  |
| 10    | 0 | 21 | 11 | 1  |

|              |    |     |     |      |     |     |     |     |     |    |
|--------------|----|-----|-----|------|-----|-----|-----|-----|-----|----|
| Total nights | 0  | 9   | 9   | 10   | 6   | 9   | 5   | 4   | 2   | 0  |
| AC were made | 0% | 30% | 50% | 100% | 60% | 90% | 50% | 40% | 40% | 0% |

## 5.1 Key points

Whilst accepting that this is a single bat recorded over what is likely to be c. 25% or less of the overall mating season, the data might be applied as a starting point from which to direct further investigation.

>> Point 1 – Over the entire 10-night sample, no calls were recorded within an hour of sunset.

>> Point 2 – The overall range between sunset and the commencement of AC spanned 60 to 211 minutes. However, the calls began within 90 minutes of sunset on 90% of the 10 nights.

>> Point 3 – The overall nightly patterns recorded followed three broad campaigns, each two hours long but with different call intensities, as follows:

- Campaign 1 – within the 2<sup>nd</sup> and 3<sup>rd</sup> hour following sunset (i.e. 2030 hrs – 2330 hrs). This first campaign has the highest call intensity and 42% of the overall calls fell within this period.

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*Nyctalus noctula* mating roost transect

- Campaign 2 – within the 3<sup>rd</sup> and 6<sup>th</sup> hour following sunset (i.e. 0030 hrs – 0230 hrs). This middle campaign has the lowest call intensity with 27% of calls falling within this period.

And

- Campaign 3 – within the 9<sup>th</sup> and 10<sup>th</sup> hour following sunset (i.e. 0330 hrs – 0530 hrs). This last campaign at 15% sees a slight increase on campaign 2, but this is still 10% lower than the first campaign.

>> Point 4 – Although the second greatest number of calls were emitted in the 3<sup>rd</sup> campaign (in the 9<sup>th</sup> and 10<sup>th</sup> hour after sunset), our noctule only emitted AC in the 3<sup>rd</sup> campaign on four of the 10 nights sampled.

## SECTION 6

### Transect suggestion

Based on the results of this sampling, the period of the night in which a surveyor would have the greatest probability of encountering a noctule producing AC for the least effort begins 90 minutes following sunset and continues for 1.5 hours.

As sunset is around 1915hrs in mid-September, the transect would therefore commence at 2045hrs and finish at 2215hrs.

N.B. Anecdotal accounts from amateurs, academics and professional bat surveyors suggests that calling may commence at sunset and sometimes even earlier. Notwithstanding, these accounts agree with the behaviour exhibited by our bat inasmuch as the Advertisement Calls continued for typically at least three hours following sunset. This means that even if the bat begins calling earlier in the evening, unless it gets a positive response from a female almost immediately, the period we have recommended would still be effective.

We would however highlight that it is possible that our bat was not a particularly desirable mate and therefore continued calling because he wasn't getting any offers. A really attractive individual (i.e. Bat Pitt) might cease calling earlier because he scored earlier. This might be anticipated by either starting the transect earlier but ensuring the same trees were visited at least once every 15 minutes, or conducting repeat visits.

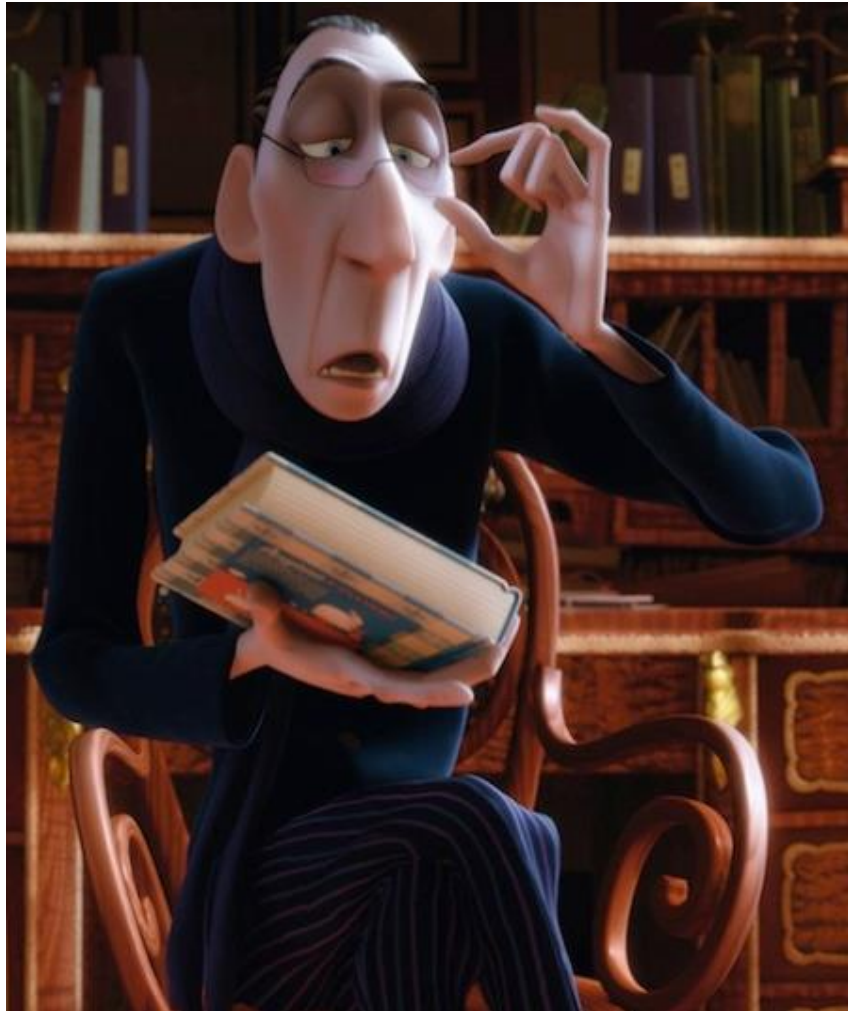
To close, at this stage at least, this is supposed to be a bit of fun - something for a bat group walk maybe? It is not supposed to be a 'consultancy recommendation', it is not 'guidance' and it is not a serious piece of science.

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# How has evolved...

| Content                                                   | 1 <sup>st</sup> Edition<br>2011 | 2 <sup>nd</sup> Edition<br>2013 | 3 <sup>rd</sup> Edition<br>2016 | 4 <sup>th</sup> Edition<br>2020 |
|-----------------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Key                                                       | ✓                               | ✓                               | ----                            | ----                            |
| Biological<br>records                                     | ----                            | ----                            | ✓                               | ✓                               |
| Photos                                                    | 30                              | 71 (+41)                        | 47 (-24)                        | 20 (-27)                        |
| Illustrations<br>and annotated<br>photographic<br>figures | 21                              | 61 (+40)                        | 154 (+93)                       | 187 (+33)                       |
| Tables                                                    | ----                            | 31 (+31)                        | 38 (+7)                         | 89 (+51)                        |
| Referenced<br>sources                                     | 21                              | 206 (+185)                      | 293 (+87)                       | 155 (-138)                      |
| Pages                                                     | 164                             | 326 (+162)                      | 385 (+59)                       | 245 (-140)                      |

# The End?



1. Ownership
2. Profiteering
3. Bias

# The End?



# The End?



# The End?

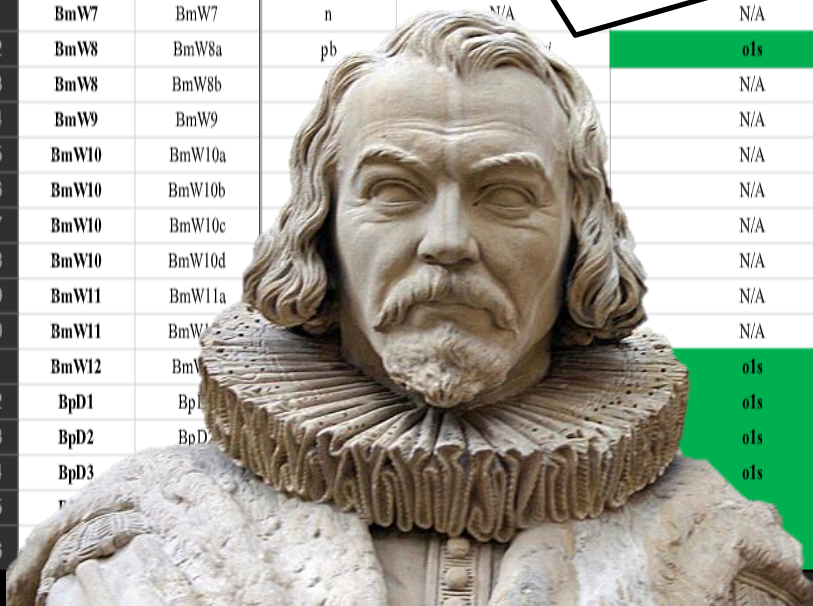


The habitat key to  
unlock nature...

No obligation, no  
agenda, just a library  
of data (mate)...



***Nature is only to be commanded  
...by obeying her***



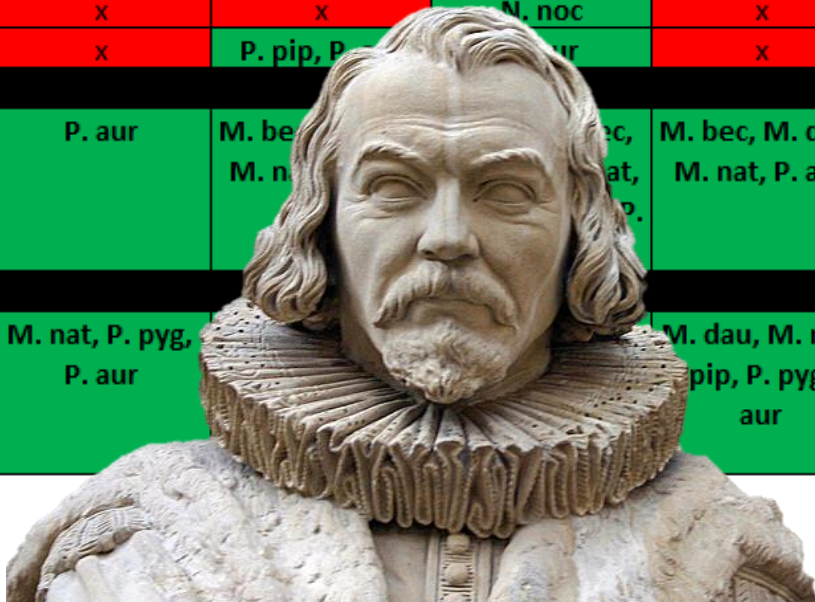
*Nature is only to be commanded  
...by obeying her*

The image is a composite. In the foreground, there is a detailed stone bust of William Shakespeare, showing his characteristic long, wavy hair and a large, ruffled collar. Behind the bust, a large, black-outlined speech bubble contains the text "Nature is only to be commanded ...by obeying her" in a black serif font. The background of the entire image is a screenshot of a spreadsheet. The spreadsheet has columns labeled A through L at the top. The first column (A) contains row numbers from 1 to 296. The second column (B) is labeled "Tree ref" and contains various codes like BmW5, BmW5d, BmW5e, BmW5f, BmW5g, BmW7, BmW8, BmW8a, BmW8b, BmW9, BmW10a, BmW10b, BmW10c, BmW10d, BmW11a, BmW11b, BmW12, BpD1, BpD2, BpD3, and BpD4. The third column (C) contains the letters "n", "pb", and "ols". The fourth column (D) contains "N/A". The fifth column (E) contains "Berkswell Marsh" and "Brake Plantation". The sixth column (F) contains "West Midlands" and "Devon". The seventh column (G) contains "England". The eighth column (H) contains numbers "25", "26", and "28". The ninth column (I) contains "5" and "9". The tenth column (J) contains "2016" and "2019". The eleventh column (K) contains "pregnancy", "mating", and "nursery". The twelfth column (L) contains "England". The spreadsheet is partially obscured by the speech bubble and the Shakespeare bust.

# The End?



| H                                                               | I                                                                    | J                                                                  | K                                                                | L                                                               | M                                                                    | N                                                                                                                       |
|-----------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| PRF type proven to be occupied in this habitat in WINTER period | PRF type proven to be occupied in this habitat in SPRING-FLUX period | PRF type proven to be occupied in this habitat in PREGNANCY period | PRF type proven to be occupied in this habitat in NURSERY period | PRF type proven to be occupied in this habitat in MATING period | PRF type proven to be occupied in this habitat in AUTUMN-FLUX period | New Ground Covert PRF ID                                                                                                |
| x                                                               | x                                                                    | M. bec, N. noc                                                     | M. dau, N. noc                                                   | x                                                               | x                                                                    | NGC2                                                                                                                    |
| x                                                               | x                                                                    | N. noc                                                             | x                                                                | x                                                               | x                                                                    | NGC3                                                                                                                    |
| P. pyg                                                          | M. dau, M. nat                                                       | M. bec, M. dau, M. nat                                             | M. bec, M. dau, M. nat, N. noc                                   | M. nat, P. aur                                                  | M. nat, P. aur                                                       | NGC12, NGC18a, NGC18b, NGC22                                                                                            |
| x                                                               | x                                                                    | N. noc                                                             | x                                                                | P. aur                                                          | x                                                                    | NGC1                                                                                                                    |
| x                                                               | P. pip, P. aur                                                       | x                                                                  | x                                                                | x                                                               | x                                                                    | NGC6                                                                                                                    |
| P. aur                                                          | M. bec, M. nat                                                       | M. bec, M. dau, M. nat, P. aur                                     | M. bec, M. dau, M. nat, P. aur                                   | M. dau, M. nat, P. aur                                          | M. nat, P. aur                                                       | NGC23, NGC24                                                                                                            |
| M. nat, P. pyg, P. aur                                          |                                                                      | M. dau, M. nat, P. pip, P. pyg, P. aur                             | B. bar, M. dau, M. nat, P. pip, P. pyg, P. aur                   | M. dau, M. nat, N. noc, P. aur                                  |                                                                      | NGC4, NGC5, NGC7, NGC11b, NGC13, NGC14, NGC15, NGC16, NGC17, NGC19, NGC20, NGC21, NGC25a, NGC25b, NGC26a, NGC26b, NGC27 |



|     | A        | B                   | C                         | D                                | E                                                                                                                                 | F             | G      | H | I | J | K | L |
|-----|----------|---------------------|---------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------|--------|---|---|---|---|---|
| 1   | Tree ref | PRF ID              | Inspection result         | Bat species                      | Roost usage: only one species (o1s), more than one species but on different days (m1dd), more than one species on same day (m1sd) |               |        |   |   |   |   |   |
| 273 | BmW4     | BmW4b               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 274 | BmW5     | BmW5a               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 275 | BmW5     | BmW5b               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 276 | BmW5     | BmW5c               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 277 | BmW5     | BmW5d               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 278 | BmW5     | BmW5e               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 279 | BmW5     | BmW5f               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 280 | BmW5     | BmW5g               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 281 | BmW7     | BmW7                | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 282 | BmW8     | BmW8a               | pb                        | <i>Myotis nattereri</i>          | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 283 | BmW8     | BmW8b               | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 284 | BmW9     | BmW9                | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 285 | BmW10    | BmW10a              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 286 | BmW10    | BmW10b              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 287 | BmW10    | BmW10c              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 288 | BmW10    | BmW10d              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 289 | BmW11    | BmW11a              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 290 | BmW11    | BmW11b              | n                         | N/A                              | N/A                                                                                                                               |               |        |   |   |   |   |   |
| 291 | BmW12    | BmW12               | pb                        | <i>Pipistrellus pipistrellus</i> | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 292 | BpD1     | BpD1                | pb                        | <i>Plecotus auritus</i>          | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 293 | BpD2     | BpD2                | pb                        | <i>Plecotus auritus</i>          | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 294 | BpD3     | BpD3                | pbd                       | <i>Pipistrellus</i> sp.          | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 295 | BpD4     | BpD4                | pb                        | <i>Myotis nattereri</i>          | o1s                                                                                                                               |               |        |   |   |   |   |   |
| 296 | BpLoR1   | BpLoR1              | pb (droppings)            | <i>Pipistrellus nathusii</i>     | o1s                                                                                                                               |               |        |   |   |   |   |   |
|     | BTHK     | Colour code look up | Inspection result look up | Country look up                  | Form look up                                                                                                                      | Smell look up | Season |   |   |   |   |   |

**The ~~End~~ Beginning**