Responses of Birds and Bats to differences in stand management in the Rushmore Estate Woods

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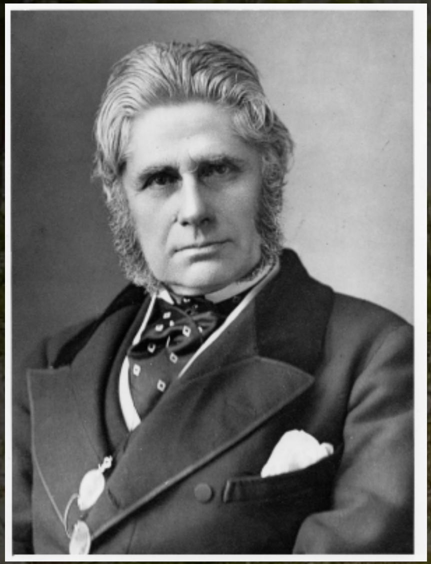
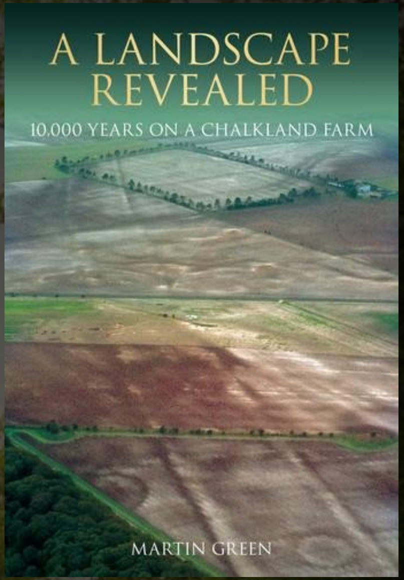




‘Preliminary results suggest that woodland development in the earlier Holocene appears to have been more patchy than the presumed model of full climax deciduous woodland’

French et al 2003 Archaeological and Palaeo-environmental Investigations of the Upper Allen Valley, Cranborne Chase, Dorset (1998–2000): a New Model of Earlier Holocene Landscape Development. Proceedings of the Prehistoric Society (Vol. 69, pp. 201-234). Cambridge University Press.

Background

In the coming decades, a wider continuum of woodland structures is likely to emerge because of the need to adapt woodland management to the constraints created by tree diseases and climate change.

A more complete knowledge is needed of how variants of forest management affect woodland structures and the resources they provide for biodiversity.

Figure 3a: Populations of woodland birds in the UK, 1970-2013

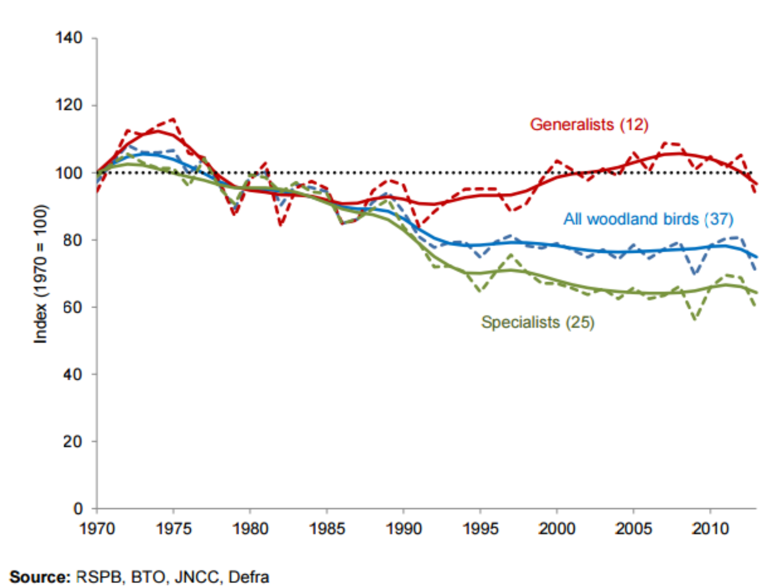
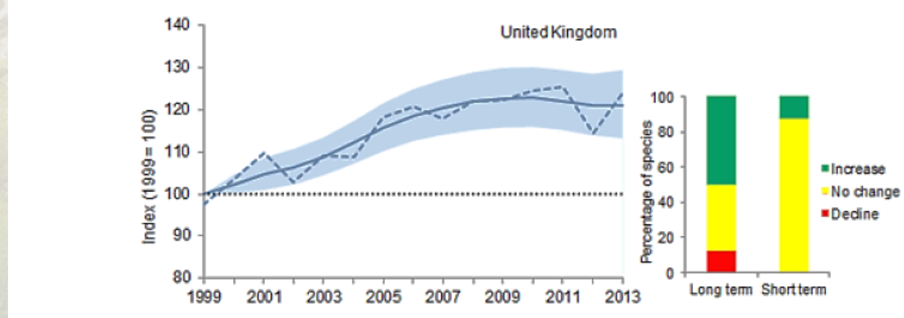


Figure C8i. Trends in bat populations, 1999 to 2013.



Russo, D., Billington, G., Bontadina, F., Dekker, J., Dietz, M., Gazaryan, S., ... & Ruczyński, I. (2016). Identifying key research objectives to make European forests greener for bats. *Frontiers in Ecology and Evolution*, *4*, 87.

Kirby, K. J., Buckley, G. P., & Mills, J. (2017). Biodiversity implications of coppice decline, transformations to high forest and coppice restoration in British woodland. *Folia Geobotanica*, 1-9.

Fuller, R. J. (2013). FORUM: Searching for biodiversity gains through woodfuel and forest management. Journal of Applied Ecology, 50(6), 1295-1300.

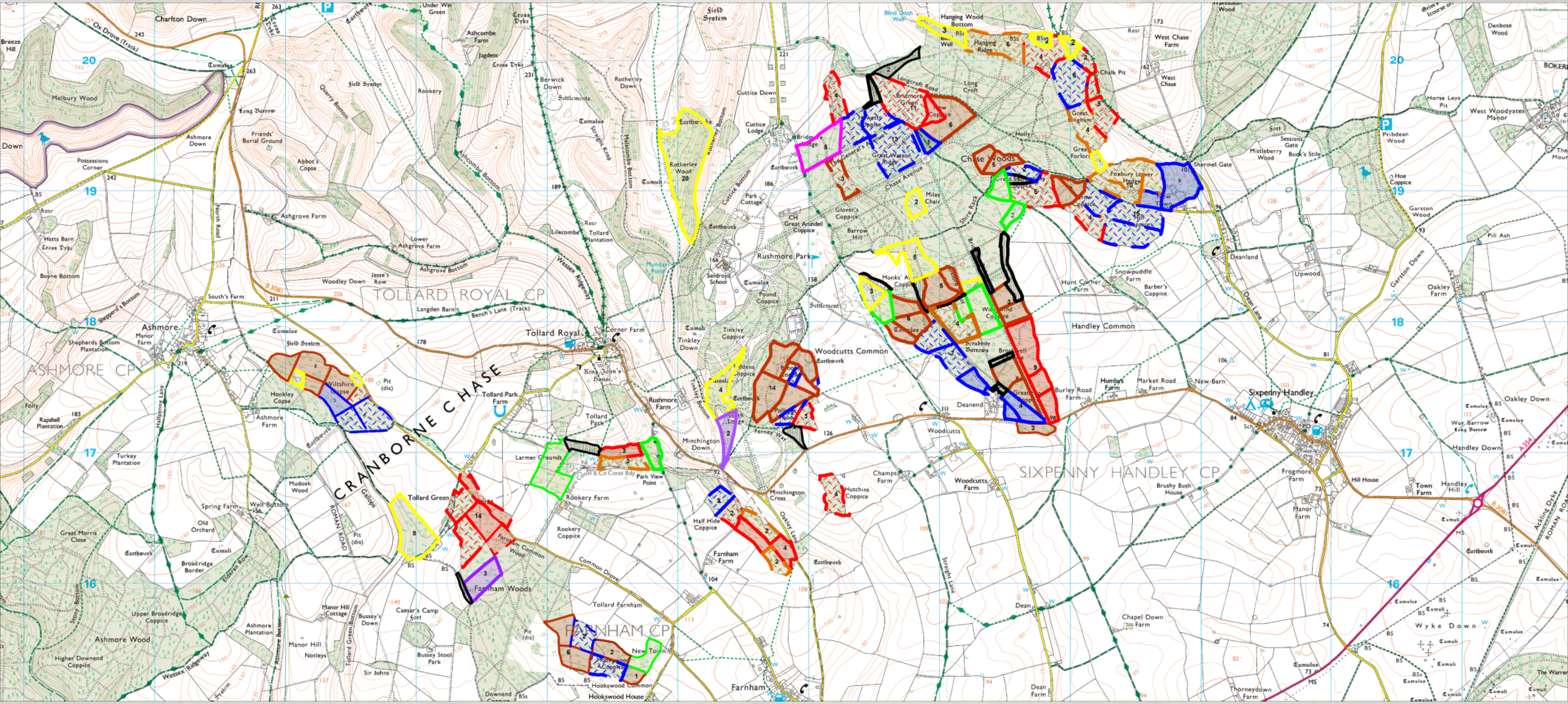
Research Aims

To understand the responses of woodland birds, bats and other taxa to different woodland management regimes within a 'working' broadleaf woodland in Cranborne Chase.

- **Birds**
- Higher Plants
- **Bats**
- Moths

- Abundances
- Differences & Similarities
- Congruence across Taxa
- Habitat gradients
- **Thresholds & Indicators**

Study Area



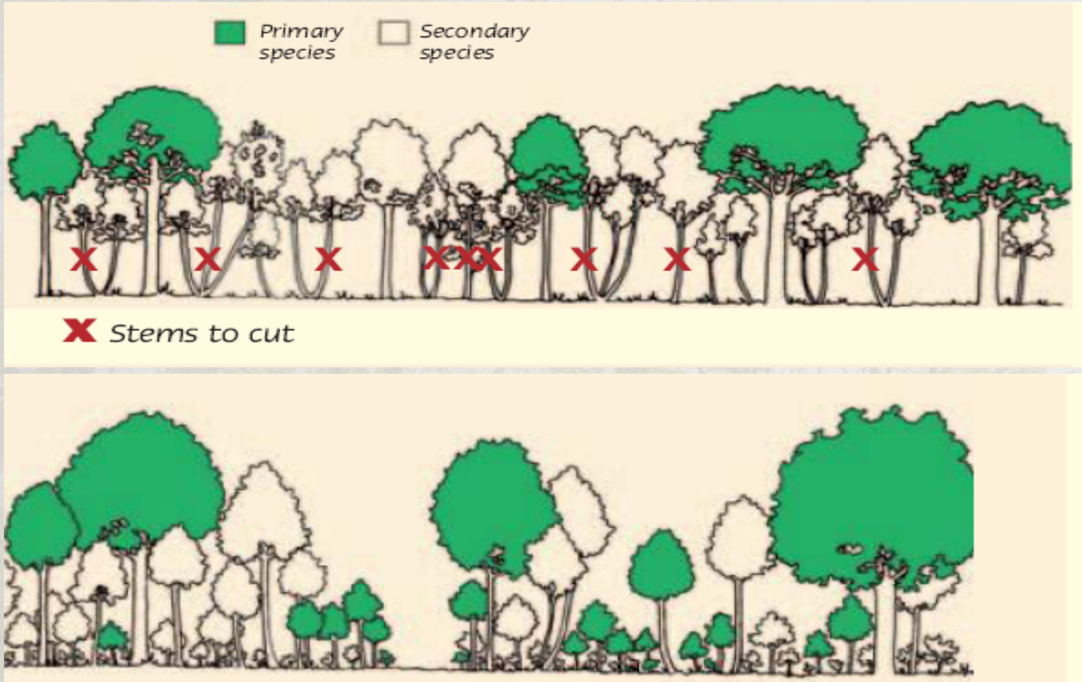
Four Stand Types

- Limited intervention - yellow
- Coppice - brown
- Irregular high forest - red
- Transitional - blue

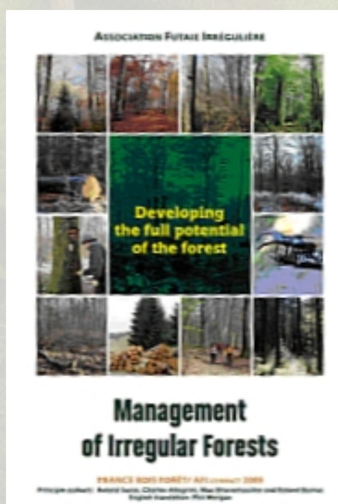
Pole-stage - Purple
Fragmented b-l stands – Black
Undergoing management - Green


Limited
Coppice
Irregular
Transitional

Stand transformation to irregular



The Association Futaie Irrégulière Research Network



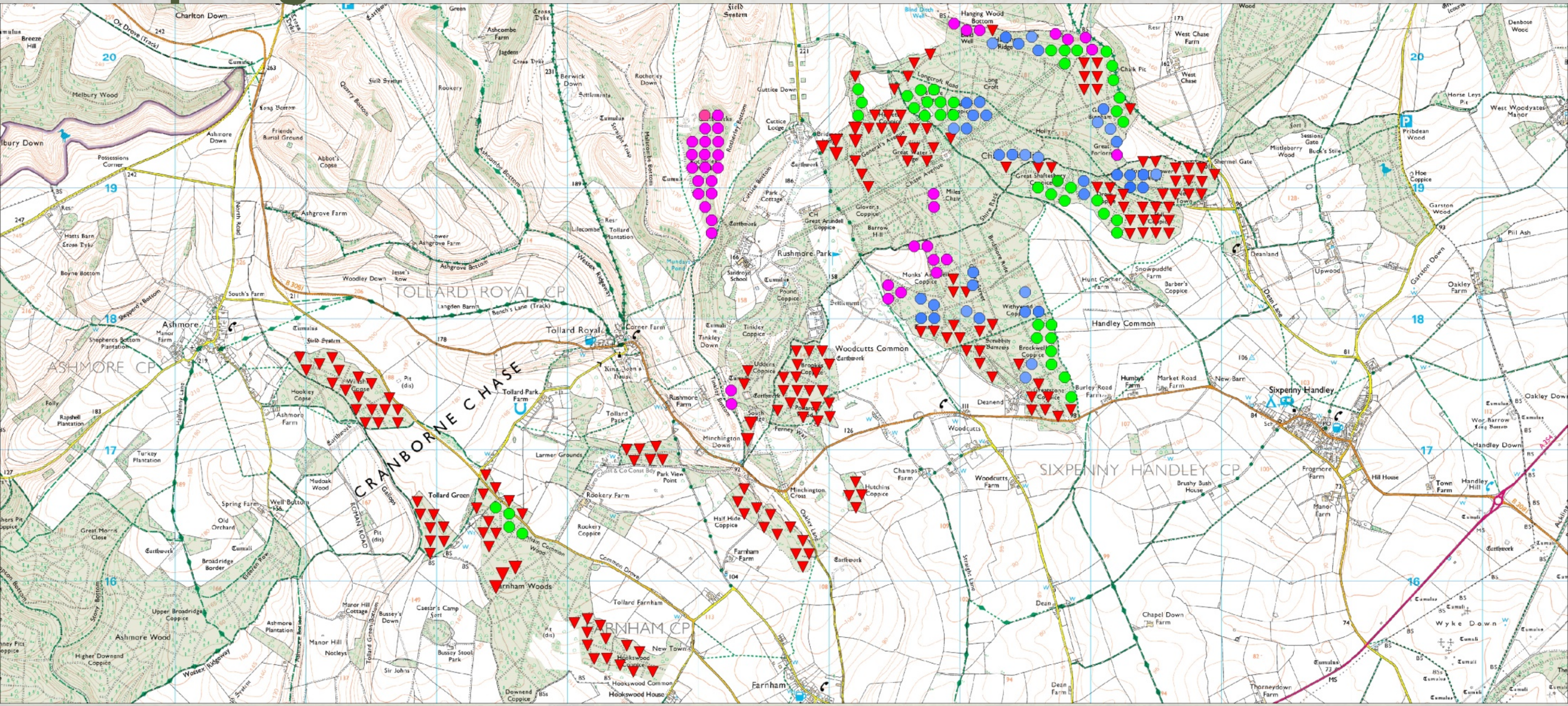
At various stages of development over the last 30 years or so in Rushmore

Study Area

Woodland type	Stand Type	Area (ha)	% Broadleaf Wood	Number of Sample plots
Semi-Natural Broadleaved Woodland	Irregular High Forest	137.1	31	73
	Transitional High Forest	97.4	22	75
	Limited intervention	102	23	61
	Coppice	106.1*	24	101
Total		442.6	100	310

- 84.3 ha of Hazel Dominated & 21.9 ha of Birch Dominated Coppice
- Coppice rotations: Birch 4-5 yrs & 15-20yrs, Hazel 7-10 yrs

Sampling



PHASE ONE 310 Plots Bird Community, Habitat Measures

Limited intervention 61

Coppice 101

Irregular high forest 73

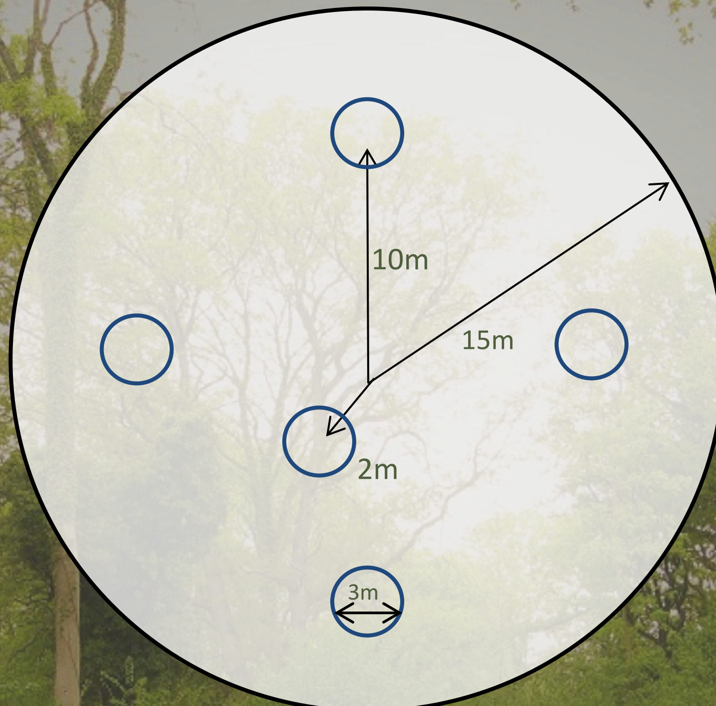
Transitional 75

PHASE TWO 120 Plots Bats, Moths, Higher Plants & Birds

40 each of the ‘best’ examples of coppice, irregular, limited intervention

Plot layout

Vegetation measurements taken within a 30m diameter plot and five smaller 3m diameter sub-plots



Variation in the woodland bird community and habitat characteristics across stand types

<u>**Data collection**</u>

310 plots during 2014-15

Vegetation – stem densities per plot in five diameter classes, frequency deadwood snags >20cm diameter, basal area m^2, canopy openness & understorey density

Birds – Morning Point counts 5 minutes at each plot
Across two seasons
Spring count x2 : April - May and May – June 2014

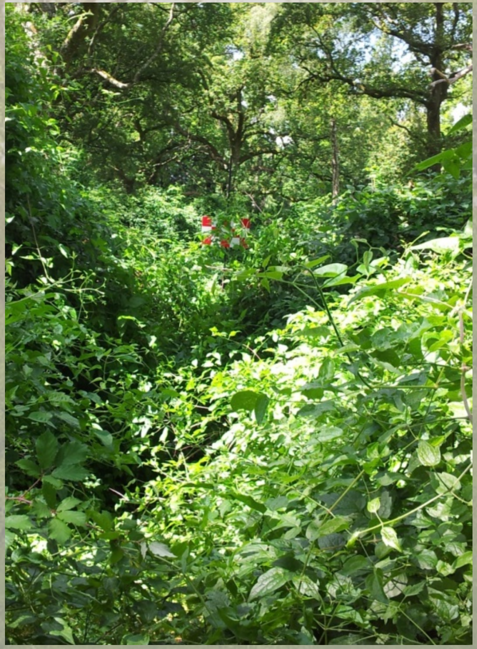
Late Winter x1 : February-early March 2015
Birds registered within 50m counted

<u>**Analyses**</u>

DISTANCE Software to produce bird densities n/km^2 stratified for each stand management type, adding understorey density as a covariate.*

PCA ordination to relate the seasonal positions of birds alongside the vegetation structural measures.

Kruskal-Wallis with *post-hoc* pairwise test for vegetation/structure between stand types.



* Marques, T. A., Thomas, L., Fancy, S. G., & Buckland, S. T. (2007). Improving estimates of bird density using multiple- covariate distance sampling. The Auk, 124(4), 1229-1243.

Results

Birds

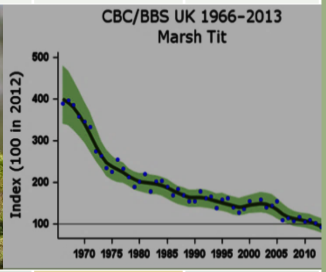
(Alder, Fuller & Marsden in prep.)

Summary of count data.

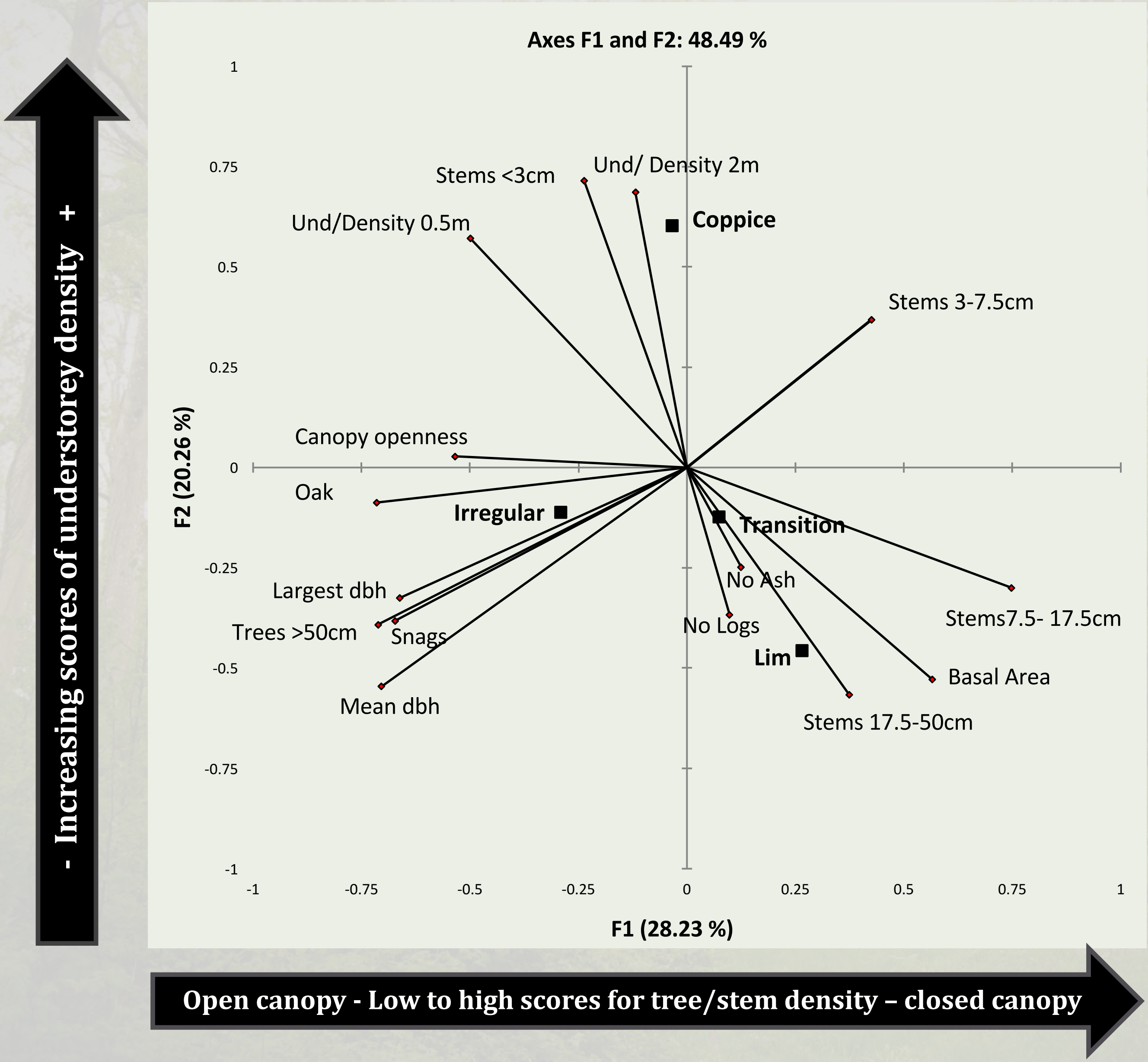
4994 individual bird registrations
38 Species
14 Specialists
10 Generalists
14 Non-woodland
5 UK Priority Species
5 Red listed BoCC
4 Amber listed BoCC

Photo Scyrene

	Spring				ANOVA	Winter				ANOVA
	Coppice	Irregular	Limited	Transition		Coppice	Irregular	Limited	Transition	
Woodpigeon	60.1 ± 10	32.4 ± 17	74.2 ± 12 I	66.0 ± 11	p < 0.05	17.0 ± 35	20.0 ± 33	38.1 ± 22	47.2 ± 21 C	p < 0.05
Great Spotted Woodpecker	10.4 ± 27	12.7 ± 31	7.1 ± 47	9.2 ± 34	n/s	5.4 ± 50	19.0 ± 34	22.8 ± 30	16.2 ± 36	n/s
Goldcrest	25.9 ± 27	27.2 ± 29	27.7 ± 32	60.1 ± 19 CI	p < 0.05	48.8 ± 28	68.8 ± 30	93.3 ± 27	47.9 ± 30	n/s
Blue Tit	124.7 ± 12	135.1 ± 13	129.4 ± 15	120.5 ± 14	n/s	173.3 ± 10	244.5 ± 9	197.7 ± 13	200.5 ± 11	n/s
Great Tit	92.4 ± 22	115.2 ± 24	128.9 ± 24	86.4 ± 25	n/s	155.9 ± 19	182.1 ± 20	236.0 ± 19	194.2 ± 22	n/s
Coal Tit	22.5 ± 24	27.0 ± 24	9.2 ± 45	17.1 ± 30	n/s	17.3 ± 43	59.3 ± 25	62.6 ± 26	66.1 ± 24 C	p < 0.05
Marsh Tit	65.1 ± 21	122.8 ± 19 CLT	53.8 ± 27	34.9 ± 29	p < 0.05	63.1 ± 22	76.4 ± 24	86.3 ± 27	68.4 ± 23	n/s
Long-tailed Tit	66.0 ± 36 L	56.5 ± 46 L	0	33.5 ± 50 L	p < 0.05	77.7 ± 37	65.7 ± 45	78.7 ± 44	41.6 ± 53	n/s
Chiffchaff	98.4 ± 11 LT	82.5 ± 14	34.9 ± 23	35.0 ± 21	p< 0.005					
Willow Warbler	19.3 ± 62 L	5.4 ± 89 L	0	3.0 ± 113 L	p< 0.05					
Blackcap	101.1 ± 12	120.2 ± 13 LT	50.4 ± 21	49.3 ± 19	P < 0.05					
Garden Warbler	30.3 ± 20 LT	18.9 ± 28 L	0	7.4 ± 38 L	P < 0.05					
Nuthatch	24.4 ± 32	31.4 ± 35	27.9 ± 37	29.7 ± 33	n/s	20.8 ± 23	29.4 ± 24	37.3 ± 21	29.6 ± 23	n/s
Treecreeper	9.4 ± 32	30.2 ± 21 C	25.6 ± 25	21.1 ± 24	p < 0.05	20.4 ± 31	48.9 ± 22	34.4 ± 33	24.6 ± 32	n/s
Wren	108.6 ± 8	221.6 ± 6 C L	148.0 ± 8	180.1 ± 8	P < 0.005	77.9 ± 15	163.5 ± 13 C L	88.7 ± 19	106.6 ± 18	p < 0.05
Blackbird	56.2 ± 10	53.6 ± 12	46.9 ± 14	63.2 ± 11	n/s	60.1 ± 16	82.4 ± 19 L	31.0 ± 28	49.2 ± 21	p < 0.05
SongThrush	29.2 ± 15 L	24.0 ± 19	11.0 ± 36	24.6 ± 18	p < 0.05	24.3 ± 24	21.7 ± 27	19.5 ± 31	27.4 ± 23	n/s
Robin	134.0 ± 9	87.9 ± 13	132.6 ± 12	150.3 ± 10 I	p < 0.05	80.9 ± 13	76.1± 15	96.1 ± 14	104.2 ± 11	n/s
Dunnock	51.8 ± 20	61.9 ± 22	20.9 ± 40	26.3 ± 29	n/s	67.3 ± 23	107.6 ± 20 L	15.1 ± 50	57.0 ± 27	p < 0.05
Chaffinch	16.1 ± 20	29.8 ± 17	25.3 ± 22	19.7 ± 21	n/s	26.7 ± 23	25.2 ± 24	23.7 ± 31	35.8 ± 22	n/s



Habitat Variable	Coppice (n 101)		Irregular (n 73)		Limited (n 61)		Transition (n 75)		χ^2	P value
Basal Area	18.0	(11-22) L T	18.0	(15-22) L T	29.0	(24 -33) I T C	22.0	(18-27)I C L	81.2	< 0.0001
Canopy Openness	10.4	(8-19) I	21.3	(14-29) C T L	9.9	(8-14) I L	10.9	(8-21) I	37.9	<0.0001
Mean dbh	36.0	(24-49) I L	50.6	(44-56) C T	42.8	(34-53) C	39.4	(34- 50) I	36.2	<0.0001
Largest dbh	61.0	(46-79) I	71.0	(58-82) C	67.0	(52-83)ns	62.0	(51-70)ns	9.9	<0.02
Number of Oak	1.0	(0-2) L	1.0	(0-2) L	0.0	(0- 0) C I	1.0	(0-2) L	25.2	<0.0001
Number of Ash	1.0	(0-2) I L	3.0	(2-4) C	2.0	(1-3) C	2.0	(1-4)	38.3	<0.0001
Number of deadwood snags	8.0	(4-12) I	13.0	(7-17) C	8.0	(6-12)ns	8.0	(6-16)ns	12.2	<0.007
Logs (m) per plot	0.0	(0-4) L	0.0	(0-4) L	3.0	(0-8) I	1.0	(0-4) L	16.3	<0.001
Understory density at 0.5m	48.0	(25-85) T L	56.0	(19-75) T L	7.0	(3-22) I T	20.0	(11-36) I C	76.4	<0.0001
Understory density at 2m	52.5	(30-76) I T L	23.8	(8-39) C	13.8	(5-28) C	17.5	(9-28) C	73.8	<0.0001
Number stem ≤3cm dbh	9.2	(5-18) I L	2.8	(1-7) C L	0.6	(0-2) C I	5.4	(2-10) L C	104.0	<0.0001
Number stem 3 - 7.5cm dbh	3.2	(1-7) I L	0.2	(0-1) I T	0.8	(1-2) C	2.2	(0-4) I	53.4	<0.0001
Number stems 7.5 - 17.5cm dbh	9.0	(1-39) L	9.0	(1-21) L T	69.0	(43-88) C I T	21.0	(7-59) L I	78.0	<0.0001
Number stems 17.5cm - 50cm dbh	2.0	(0-4) I T L	5.0	(2-7) C L	11.0	(5-16) I C	7.0	(3-12) C	82.4	<0.0001
Number of trees ≥50cm dbh	1.0	(0-2) I	2.0	(1-3) C T L	2.0	(1-3) I	1.0	(1-2) I	16.6	<0.001



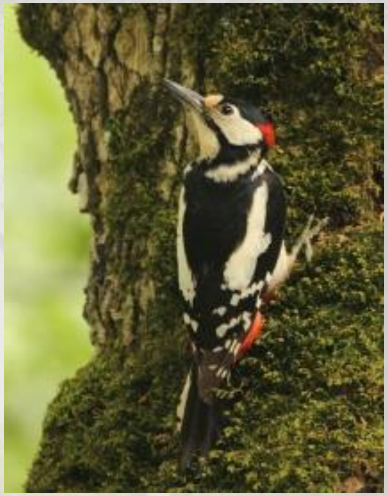


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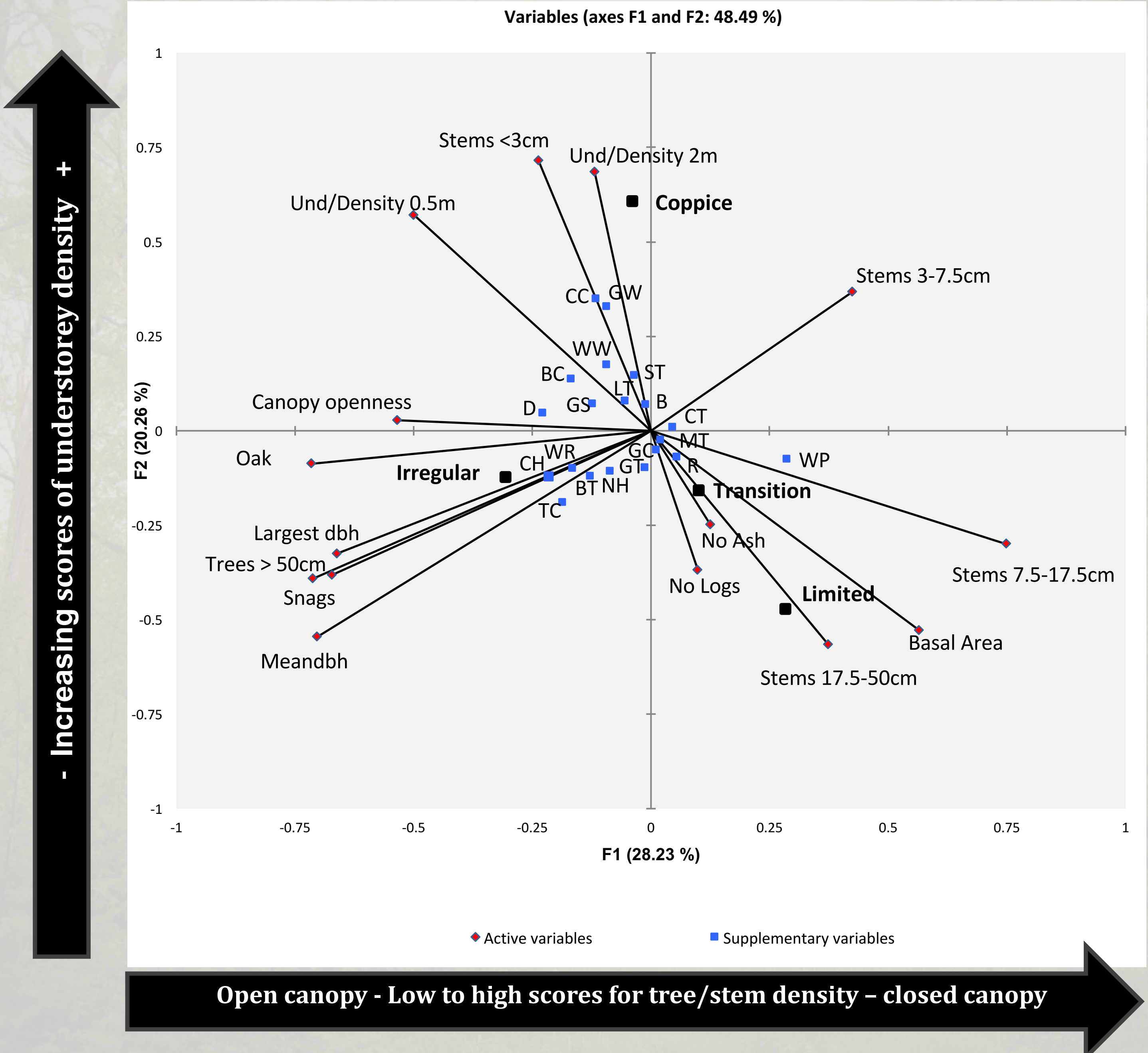
Figure 1 Ordination plot of habitat variables and mean positions of stand management types.



No significant movements from these positions for resident birds in winter

Richard Broughton

Figure 2 Ordination of habitat variables and mean positions of birds during the breeding season.

Summary

Significant variation in vegetation measures between stand types producing different woodland characteristics. Irregular characterised by more open woodland, larger trees and an uneven mix of ages.

Spring bird densities were highest in irregular for half of the 20 species. Winter densities were closer between stands; low intervention had six species with highest abundances and irregular with five.

Low intervention woodland had the lowest or second lowest Spring densities for 14 of 20 species, particularly reflecting a negative association for understorey species especially Warblers.

Three of four Warblers had, highest densities in coppice yet had second highest in Irregular. Irregular stands appear to provide similar structural cues for these Summer migrants, including the Amber listed Willow Warbler and the relatively uncommon Garden Warbler *.

Irregular stands were favoured in Spring by six of ten woodland specialists (DEFRA 2015): Great Spotted Woodpecker, Treecreeper, Nuthatch, Blackcap, Coal Tit and Marsh Tit.

Summer density for Marsh Tit in Irregular was around twice that found in other management types and suggests potential from this stand management for this species which has declined in UK by < 70% since 1970.

* Eaton et al 2015 Birds of Conservation Concern 4: the population status of birds in the UK, Channel Islands and Isle of Man. British Birds, 108, 708-746

Richard Towell

Steve Herring

Martin Hornsby

Richard Broughton

Differential use of stands by Bats identified from static acoustic detectors

Potential to collect and analyse large volumes of acoustic data over extended periods

Provides a representative assessment of species

Efficient and reliable means of collecting data in difficult terrain

Data requires sifting using classification software and manual checking for identification

Generates measures of relative use of habitats from activity as a proxy for bat abundance

Produces reference material that can be revisited for future studies

From 120 plots equally of coppice, irregular and low intervention stands

Late June to early September 2015, coincide with moth sampling

Each plot sampled twice with 3 week minimum period between

Six Wildlife Acoustics SM3Bat detectors programmed to switch on 15minutes before sunset and off at sunrise

Recording trigger values set to switch to recording mode with a pre-roll buffer

Sampling evenly 2 units per stand type per sample night

Recordings uniquely filed by grid reference

Data transferred each morning and SD cards replaced and batteries checked /replaced as required before moving to next plot

Avoid periods of heavy rain or strong winds over Beaufort 4

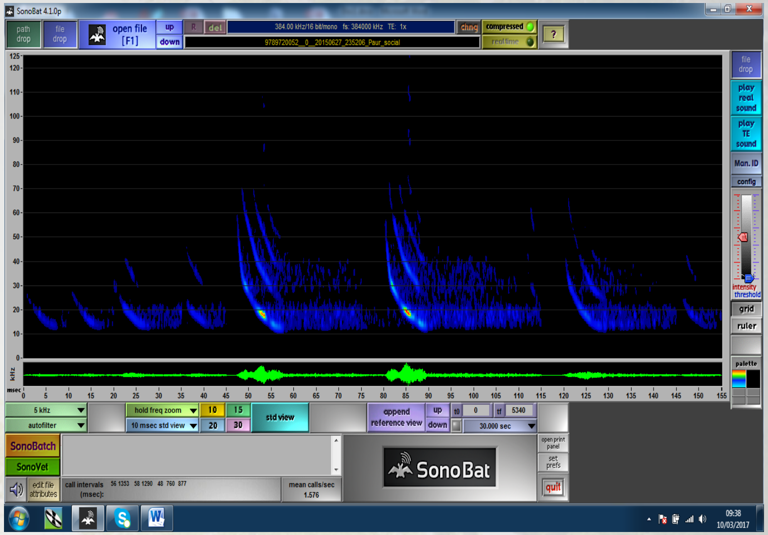
Omnidirectional mic placed at least 1m away from leafy vegetation at 5m above ground on a composite fishing pole

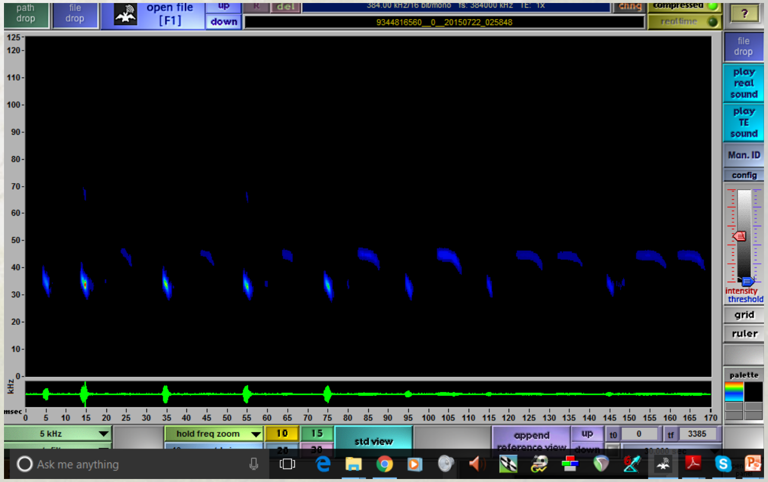
Data Preparation

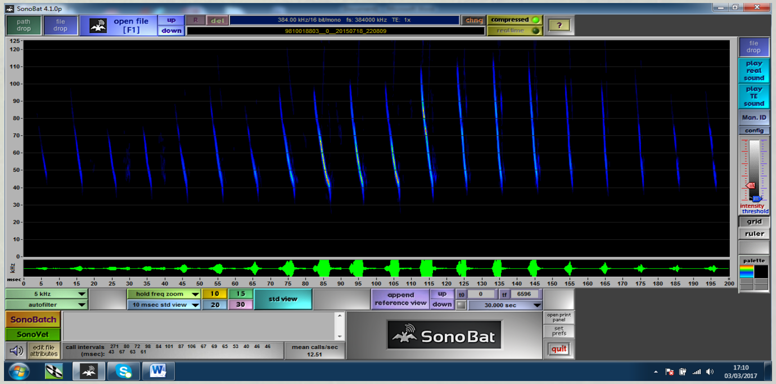
Following approach used by Newson et al (2015) to define a bat pass and two stage processing of audio.

1) Acoustic recordings were run through a call recognition analysis Tadarida (Bas et al 2017) to identify bat calls

2) Further filtered manually using Sonobat 4 to visually inspect sonograms against known characteristics of species echolocations







Newson, S. E., Evans, H. E., & Gillings, S. (2015). A novel citizen science approach for large-scale standardised monitoring of bat activity and distribution, evaluated in eastern England. *Biological Conservation*, *191*, 38-49.

Bas, Y., Bas, D., & Julien, J. F. (2017). Tadarida: A Toolbox for Animal Detection on Acoustic Recordings. Journal of Open Research Software, 5(1)

Results

Round 1 130GB
Round 2 316GB

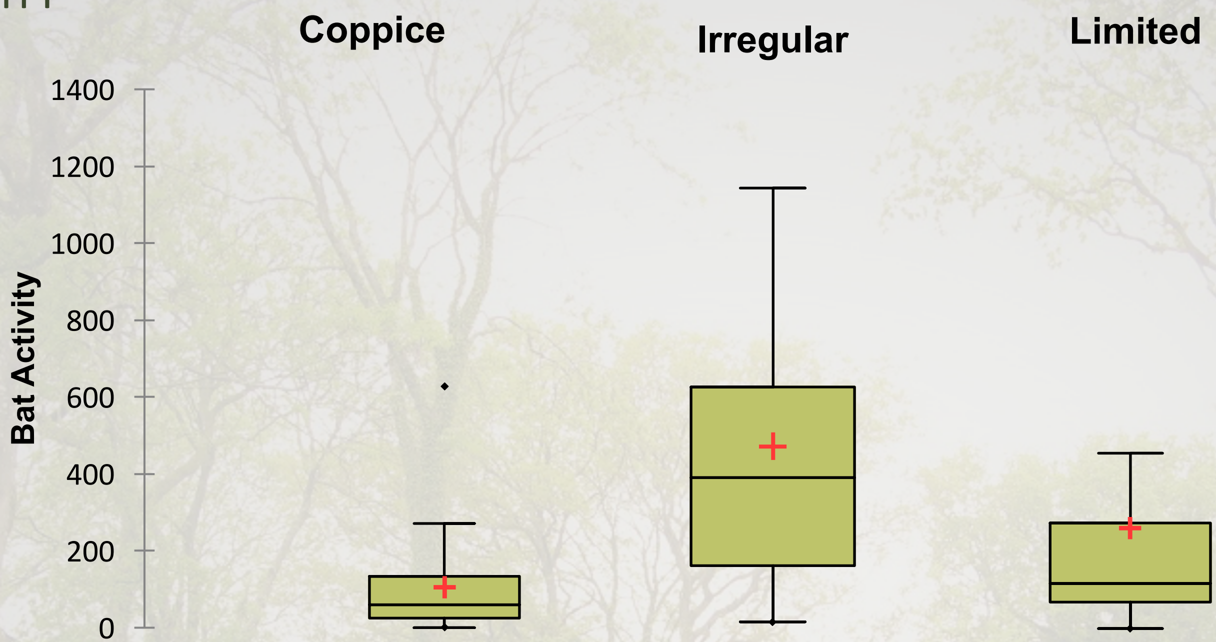
Tadarida classified 123,000 files, of which 46,000 it said were Bats.

Manually checked to produce

Bat Species Recordings (June – Sept 2015)		Freq	%	Mean	SD
Common pipistrelle	*Pipistrellus pipistrellus*	27344	78.0	227.9	310.4
Soprano pipistrelle	*P.pygmaeus*	2861	8.2	23.8	66.6
Barbastelle	*Barbastella barbastellus*	1023	2.9	8.5	26.4
Nathusius' pipistrelle	*P.nathusii*	22	0.1	0.2	1.3
Daubenton's	*Myotis daubentonii*	464	1.3	3.9	6.0
Natterer's	*Myotis nattererii*	549	1.6	4.6	7.1
Whiskered / Brandt's	*Myotis mystacinus/brandtii*	1734	4.9	14.5	29.9
Noctule	*Nyctalus noctula*	313	0.9	2.6	7.3
Serotine	*Eptesicus serotinus*	428	1.2	3.6	7.1
Leisler's	*Nyctalus leisleri*	52	0.1	0.4	0.9
Brown long-eared bat	*Plecotus auritus*	251	0.7	2.1	4.5
All Bat passes		35,041			

Bat recordings (not assigned to species) 1744 ,remainder were other taxa, a mix of *Orthoptera* (esp. dark bush crickets *Pholidoptera griseoaptera*) and small mammals; shrews, voles.

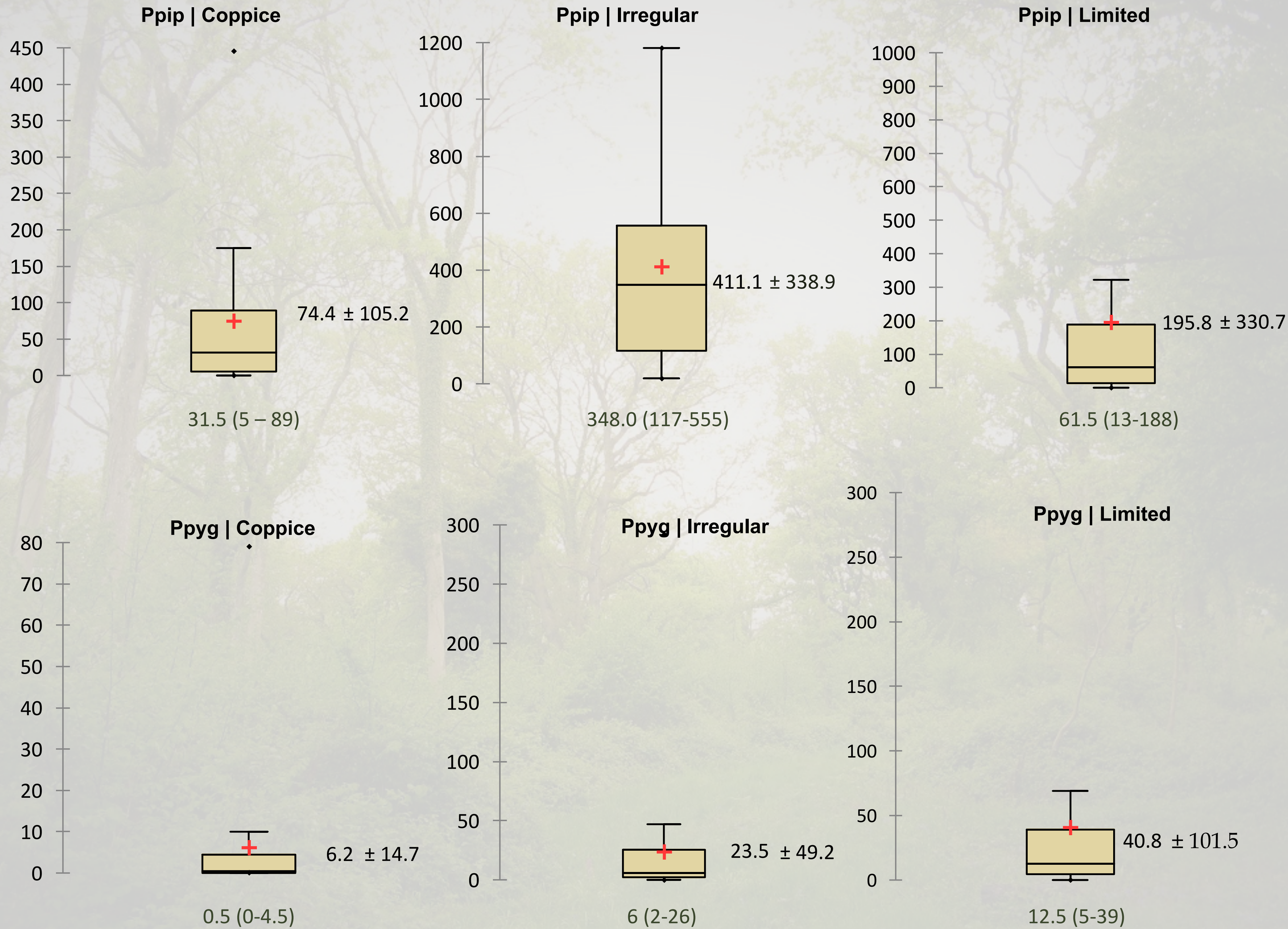
BAT ACTIVITY

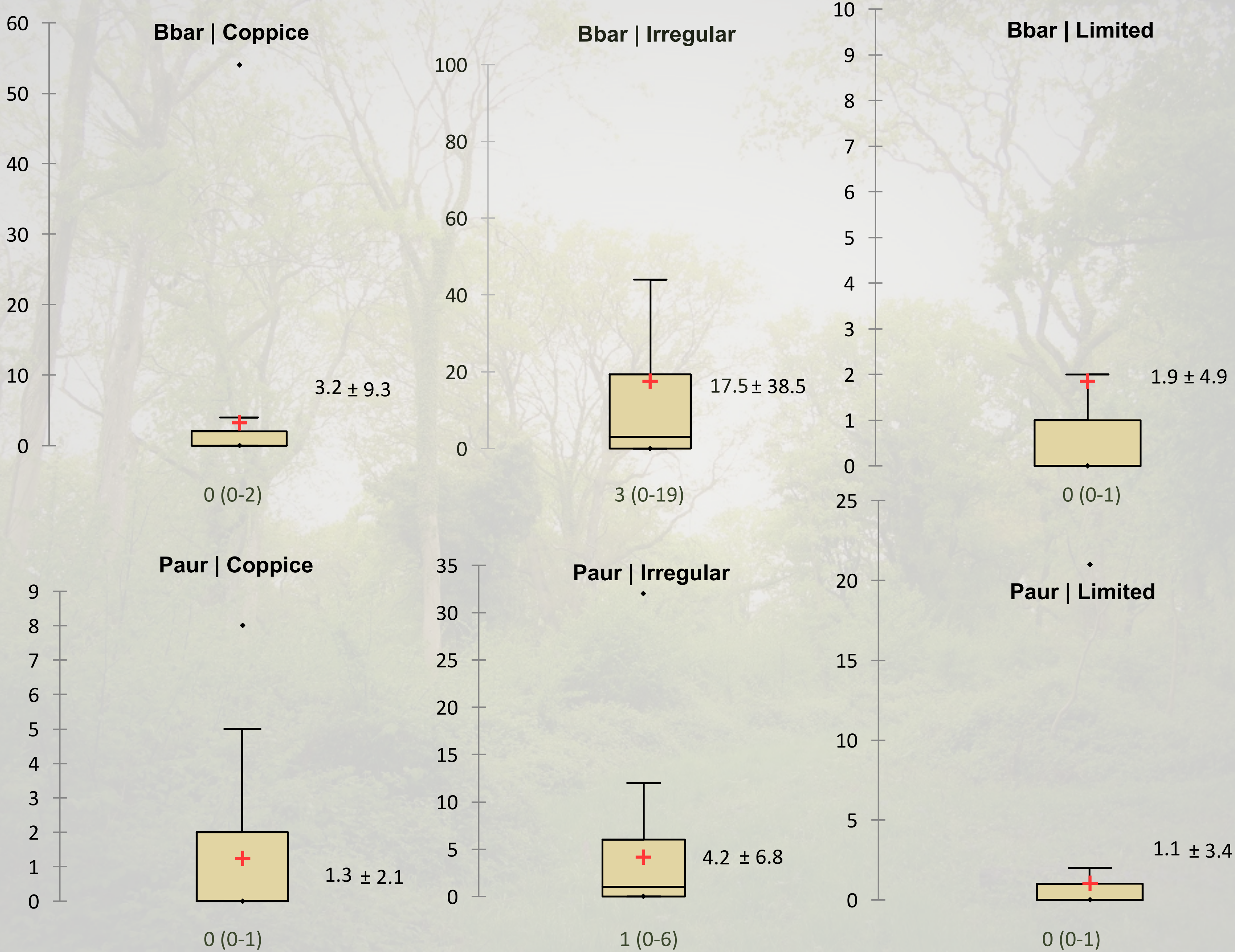


	Coppice	Irregular	Limited
Median	60.5 (25-133)	415.0 (187-651)	125.5 (77-281)
Mean	105.2 (SD ± 139.2) (n=40)	496.8 (SD ± 391.0) (n=40)	268.8 (SD ± 348.6) (n=40)

Kruskal-Wallis test All Bats - Coppice < Limited < Irregular

K (Observed value)	34.708
K (Critical value)	5.991
DF	2
p-value (Two-tailed)	< 0.0001


Ppip | Coppice
74.4 ± 105.2
31.5 (5 – 89)
Ppip | Irregular
411.1 ± 338.9
348.0 (117-555)
Ppip | Limited
195.8 ± 330.7
61.5 (13-188)
Ppyg | Coppice
6.2 ± 14.7
0.5 (0-4.5)
Ppyg | Irregular
23.5 ± 49.2
6 (2-26)
Ppyg | Limited
40.8 ± 101.5
12.5 (5-39)



Bbar | Coppice
60
50
40
30
20
10
0
3.2 ± 9.3
0 (0-2)
Bbar | Irregular
100
80
60
40
20
0
17.5 ± 38.5
3 (0-19)
Bbar | Limited
10
9
8
7
6
5
4
3
2
1
0
1.9 ± 4.9
0 (0-1)
Paur | Coppice
9
8
7
6
5
4
3
2
1
0
1.3 ± 2.1
0 (0-1)
Paur | Irregular
35
30
25
20
15
10
5
0
4.2 ± 6.8
1 (0-6)
Paur | Limited
25
20
15
10
5
0
1.1 ± 3.4
0 (0-1)

Bat Activity
Pairwise Comparisons

		Coppice n 40		Irregular n 40		Low n 40		Result	χ^2	P value
		Mean	±SD	Mean	±SD	Mean	±SD			
Common pipistrelle	*Pipistrellus pipistrellus*	74.5	± 105.2	411.1	± 338.9	195.8	± 330.7	I>C,L	34.1	**< 0.0001**
Soprano pipistrelle *	*P.pygmaeus*	6.2	± 14.7	23.6	± 49.2	40.8	± 101.5	L,I>C	25.4	**< 0.0001**
Barbastelle *	*Barbastella barbastellus*	3.2	± 9.3	17.5	± 38.5	1.9	± 4.9	I>C,L	20.6	**< 0.0001**
Nathusius' pipistrelle	*P.nathusii*	0.1	± 0.3	0.3	± 1.9	0.2	± 1.1	ns	0.5	0.793
Daubenton's	*Myotis daubentonii*	2.4	± 5.6	6.8	± 7	2.9	± 4.6	I>L,C	19.2	**< 0.0001**
Natterer's	*Myotis nattererii*	3.0	± 6	5.3	± 8.1	5.4	± 7.1	ns	5.4	0.069
Whiskered / Brandt's	*Myotis mystacinus/brandtii*	10.7	± 20.2	19.2	± 35.6	14.2	± 32.4	ns	3.5	0.172
Noctule *	*Nyctalus noctula*	1.8	± 2.9	1.0	± 1.2	4.9	± 12	ns	5.5	0.065
Serotine	*Eptesicus serotinus*	1.8	± 2.1	7.3	± 11.1	1.5	± 2.2	I>C,L	22.8	**< 0.0001**
Leisler's	*Nyctalus leisleri*	0.5	± 0.8	0.6	± 1.2	0.2	± 0.5	ns	2.9	0.230
Brown long-eared bat*	*Plecotus auritus*	1.3	± 2.1	4.2	± 6.8	1.1	± 3.4	I>C,L	14.4	**0.001**

* UK Priority Species

Stuart Newson

Further work

- Explore bat data and relate activity (including feeding ‘buzzes’) to stands, habitat measures and moths
- Analysis of ground flora, determine how plant communities vary along gradients within and across stand types and respond to different treatments
- Multivariate analyses to identify the most sensitive habitat predictors for each taxa and the congruence across them
- Fine-scale study of foraging by Marsh tits – underway

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