DEVELOPING SURVEYING AND MONITORING PROTOCOLS FOR WOODLAND BATS

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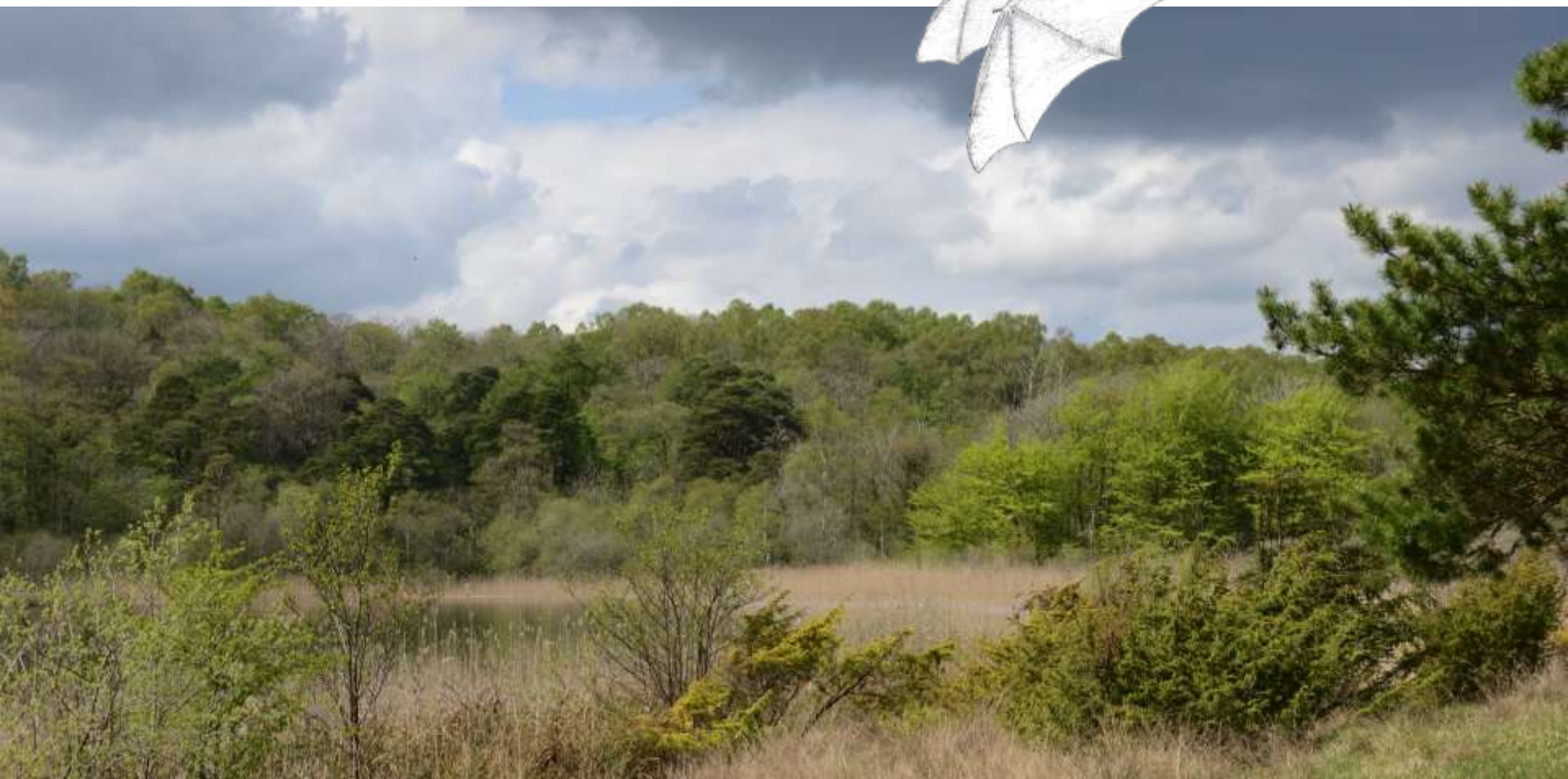

Our rarest bats are all woodland species

Reflects the loss, fragmentation and degradation of our woodland

Protecting them will take management on a landscape scale

To do this we need reliable survey and monitoring methods

Defra commissioned a research project to develop such methods:

1. National scale - addition to NBMP
2. Suitable for volunteers
3. Simple and reproducible protocols
4. Time and cost effective
5. Capable of monitoring all species
6. Have the power to detect population changes

A big ask!

Best approach?

Catching? Acoustic? Both?

Catching:

Advantages

Identification in the hand
Other information

Disadvantages

Labour intensive
Potential bias
Low numbers, weak statistical power
Training and licencing
Disturbance

Lure use: unknown bias, disturbance

Acoustic survey

Advantages

No licencing
Rapid training
Can cover large areas
Sufficient data for analysis

Disadvantages

Bias – quiet species are under-represented

Woodland is the worst environment for acoustic surveys!

Species identification

Large data files to process

Acoustic survey

Advantages

No licencing
Minimal training
Covers large areas
Sufficient data for analysis

Disadvantages

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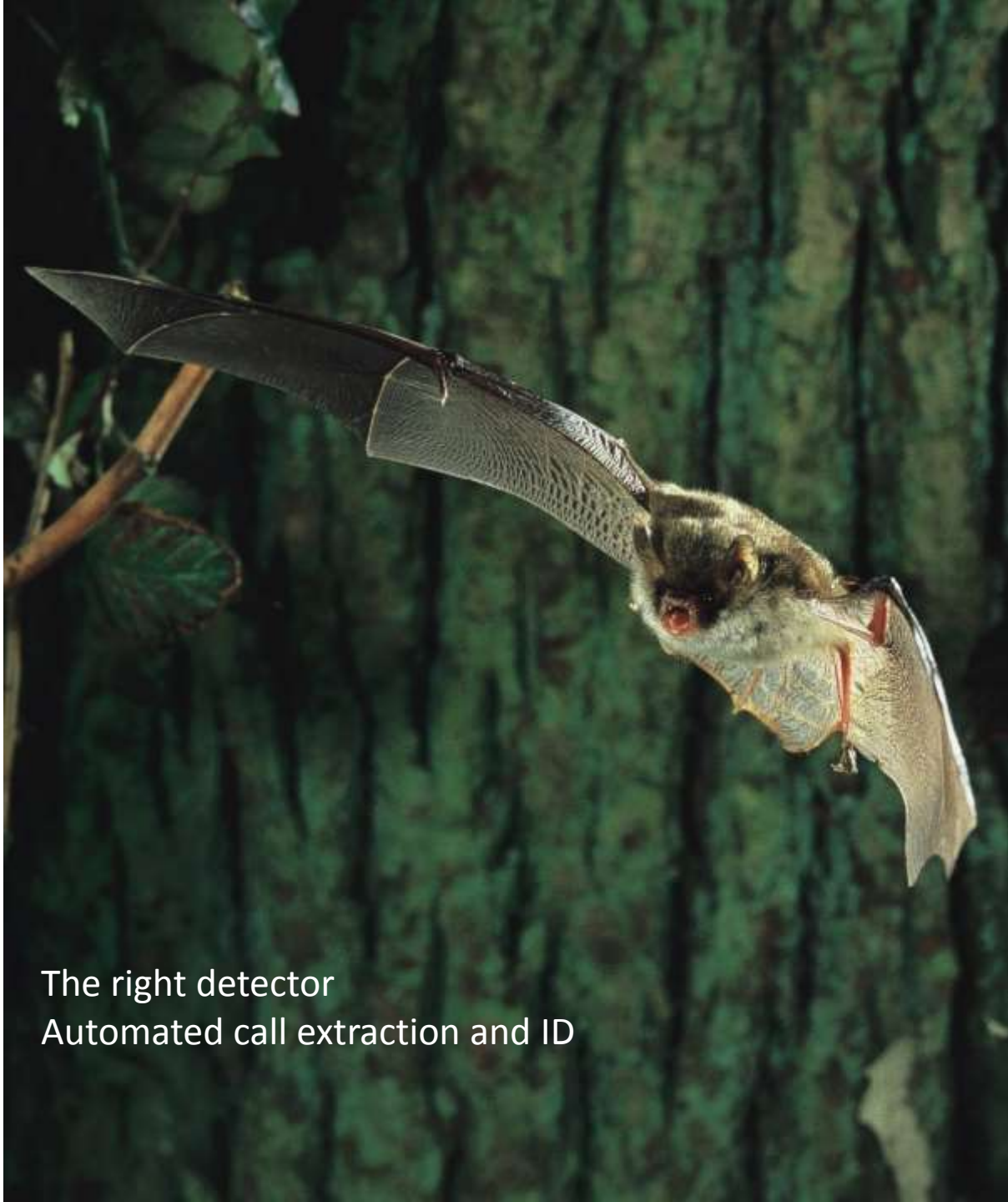
Species identification

Large data files to process



The right detector
Automated call extraction and ID

What detector?

Reliable identification is not easy
Preserve all the call content you can

Direct sampling

Preserves content and record continuously

Time-expansion

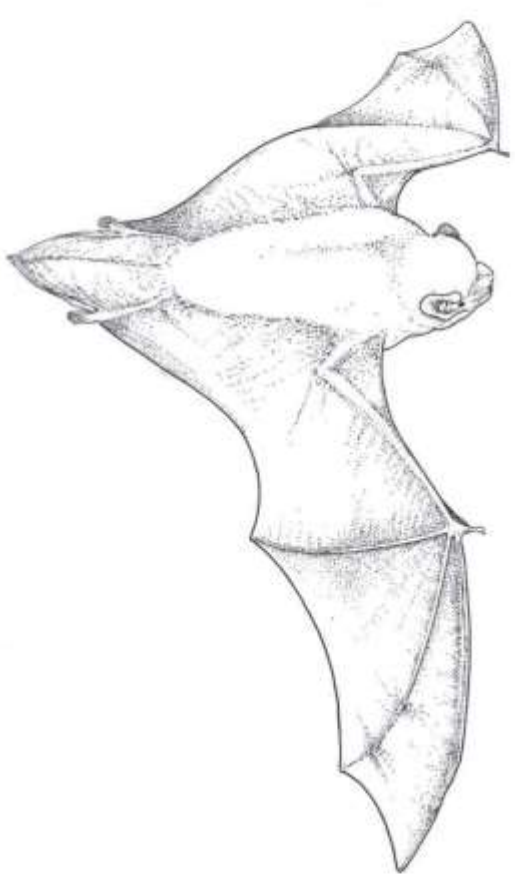
Preserves content
but only samples
10% of the time

Complete loggers

Microphones for phones and tablets

Frequency division/heterodyne

Preserve too little content



BatClassify

https://bitbucket.org/chrisscott/batclassify

Developed software for use with Pettersson detectors (D240x/D500x)

Because that's what we use

What it does:

Detects calls from background noise and isolates them

Determines a wide range of spectral and temporal parameters from the calls

Based on these features, uses 'extremely randomised trees' to classify calls to species with a given probability

For each sound file it produces a simple output giving the probability of presence (from 0-1) of each species in the file (with optional sonograms)

Process large batches of files rapidly

The user sets an acceptable threshold probability (e.g. 0.9) for acceptance of ID

How good is the software?

Number of bats

Proportion of those bats identified to a species that are done so correctly

Proportion of bats of a given species present that are retrieved

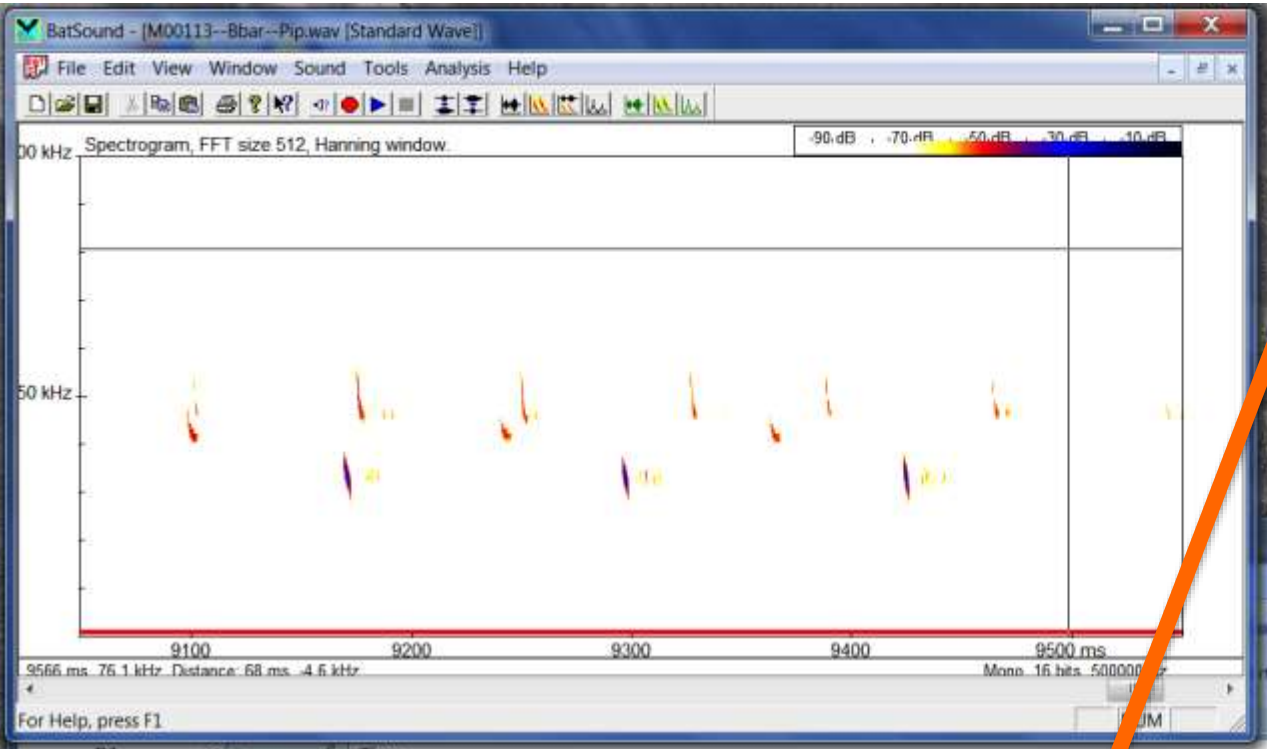
Species	N	F1	Precision	Recall
Barbastella barbastellus	243	0.95	0.96	0.91
Myotis alcathoe	23	0.85	0.83	0.87
Myotis bechsteinii	16	0.77	1.00	0.63
Myotis daubentonii	212	0.92	0.99	0.87
Myotis mystacinus / brandtii	237	0.90	0.86	0.95
Myotis nattereri	131	0.97	0.98	0.96
Noctule, Serotine, Leisler's	391	0.99	0.99	0.99
Pipistrellus pipistrellus	510	0.99	0.99	0.98
Pipistrellus pygmaeus	308	0.97	0.96	0.97
Plecotus auritus	198	0.93	0.98	0.88
Rhinolophus ferrumequinum	79	1.00	1.00	1.00
Rhinolophus hipposideros	353	1.00	1.00	1.00

Software finds and identifies most bats correctly

Less good at detecting Bechstein's, but those it does identify are done so correctly

More training data for Alcathoe and Bechstein's will improve accuracy

NOTE:
Even at 95% accuracy, on average 1 in 20 identifications will be incorrect, so….
Software handles noisy recordings well, but there is a limit!



Output file

- Sound files in rows
- Probability of species presence in columns
- Filename, date & time

D1 Time

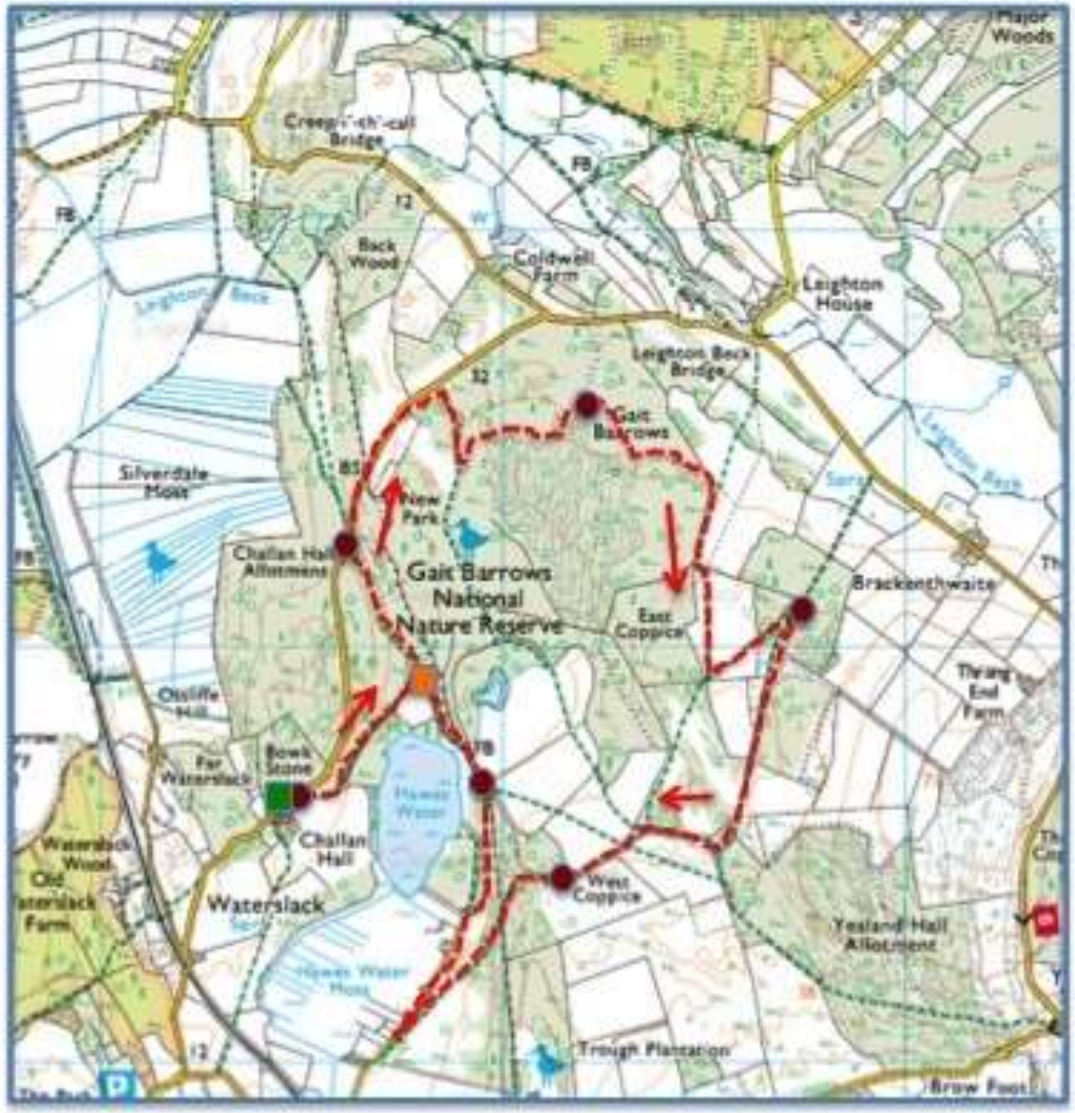
	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	FileName	Date	Time	Bbar	Malc	Mbec	MbraMmy	Mdau	Mnat	NSL	Paur	Ppip	Ppyg	Rfer	Rhip
2	M00000--Mbec	NA	NA	0	0.11	0.88	0.56	0.03	0.[illegible]	0	0	0.1	0.05	0	0
3	M00009--Rfer--Rhip	09/07/2012	21:57:02	0.01	0	0	0	0	0	0.25	0	0.12	0.01	0.96	1
4	M00010--Rfer	09/07/2012	21:57:24	0.05	0.01	0.01	0.05	0.01	0.12	0.09	0	0.35	0.01	0.97	0.03
5	M00036--Mdau	08/08/2010	21:43:00	0	0.11	0.11	0.78	0.95	0.13	0.01	0.05	0.26	0.05	0	0
6	M00096--Paur	22/05/2014	23:13:21	[illegible]	0	0	0.01	0	0.01	0.03	0.81	[illegible]	0	0	0
7	M00113--Bbar--Pip	10/06/2013	22:02:40	0.99	0	0	0	0	0	0.09	0.01	0.98	0.03	0	0
8	M00161--Paur--Pip	11/06/2013	23:38:02	[illegible]	0.01	0	0.03	0	0.01	0.01	0.9	[illegible]	0.97	0	0.01
9	M00179--Rhip	21/05/2014	23:15:17	0.02	0.02	0.03	0.1	0.02	0.01	0.06	0.01	0	0.01	0.01	1
10	M00206--Mnat	24/06/2013	22:26:36	0	0.2	0.16	0.6	0.18	0.98	0.02	0.05	0.14	0.11	0	0
11	M00257--NSL--Pip	01/07/2010	01:55:18	0	0	0	0	0	0	1	0	0.04	0.95	0.01	0
12	M00284--MbraMmys	30/07/2013	22:09:53	0	0.03	0.21	0.89	0.37	0.09	0.01	0	0.18	0.02	0	0
13															

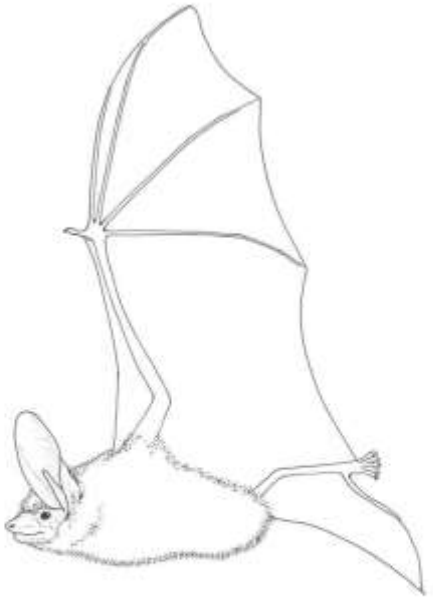
Results Sheet1

Ready

The best acoustic survey protocol?

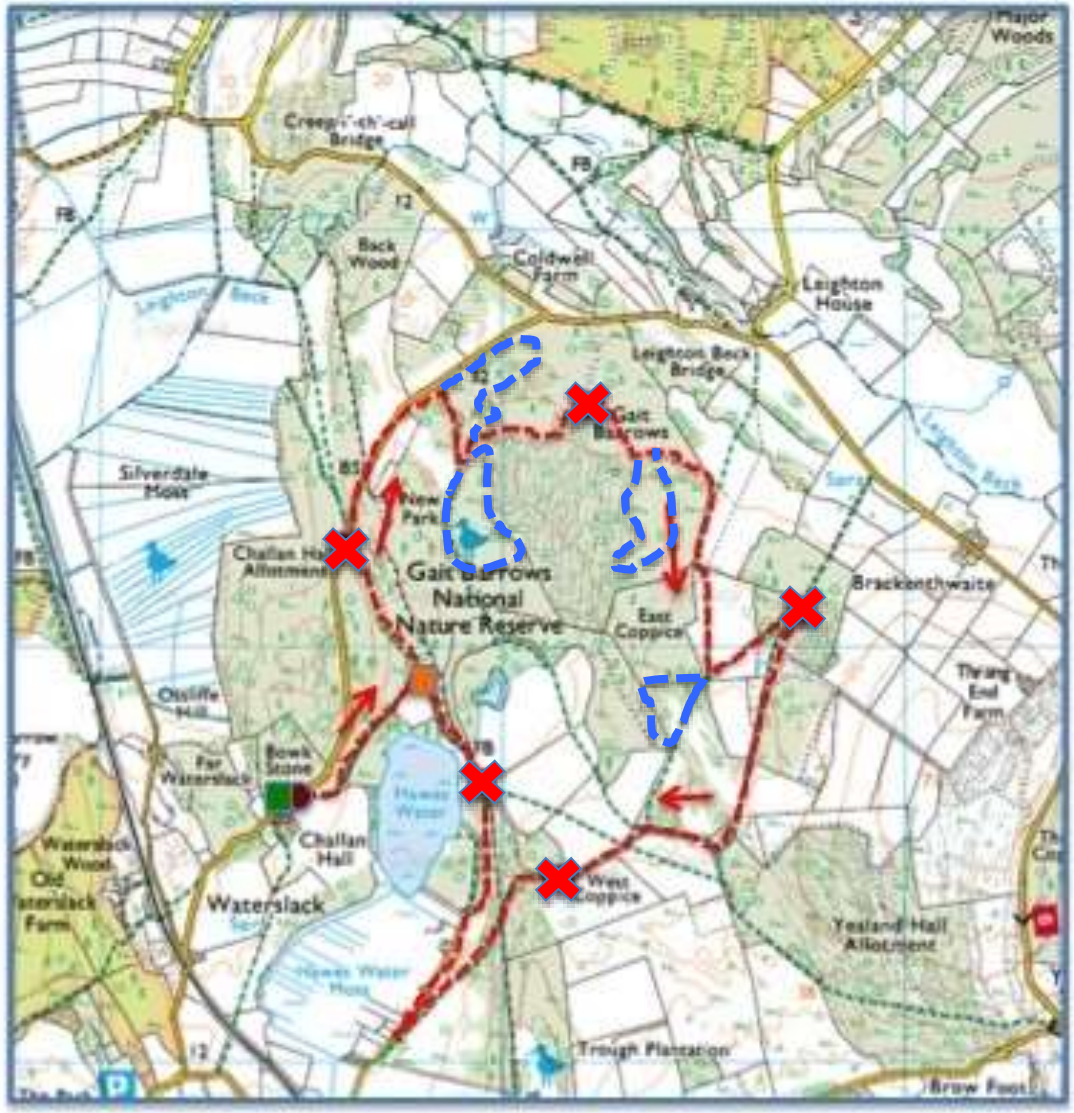
Transects with spot checks – generate continuous sound recordings over 90 min





The best acoustic survey protocol?

Transects with flexibility – drop the spot checks and use the time to ‘chase’ bats and explore beyond the transect. BUT – transect must still take 90 min

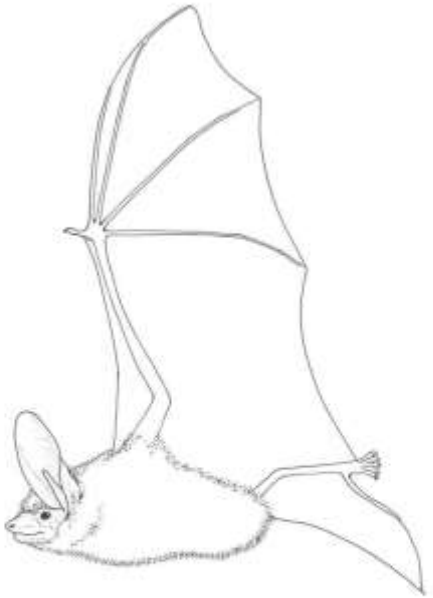


Start

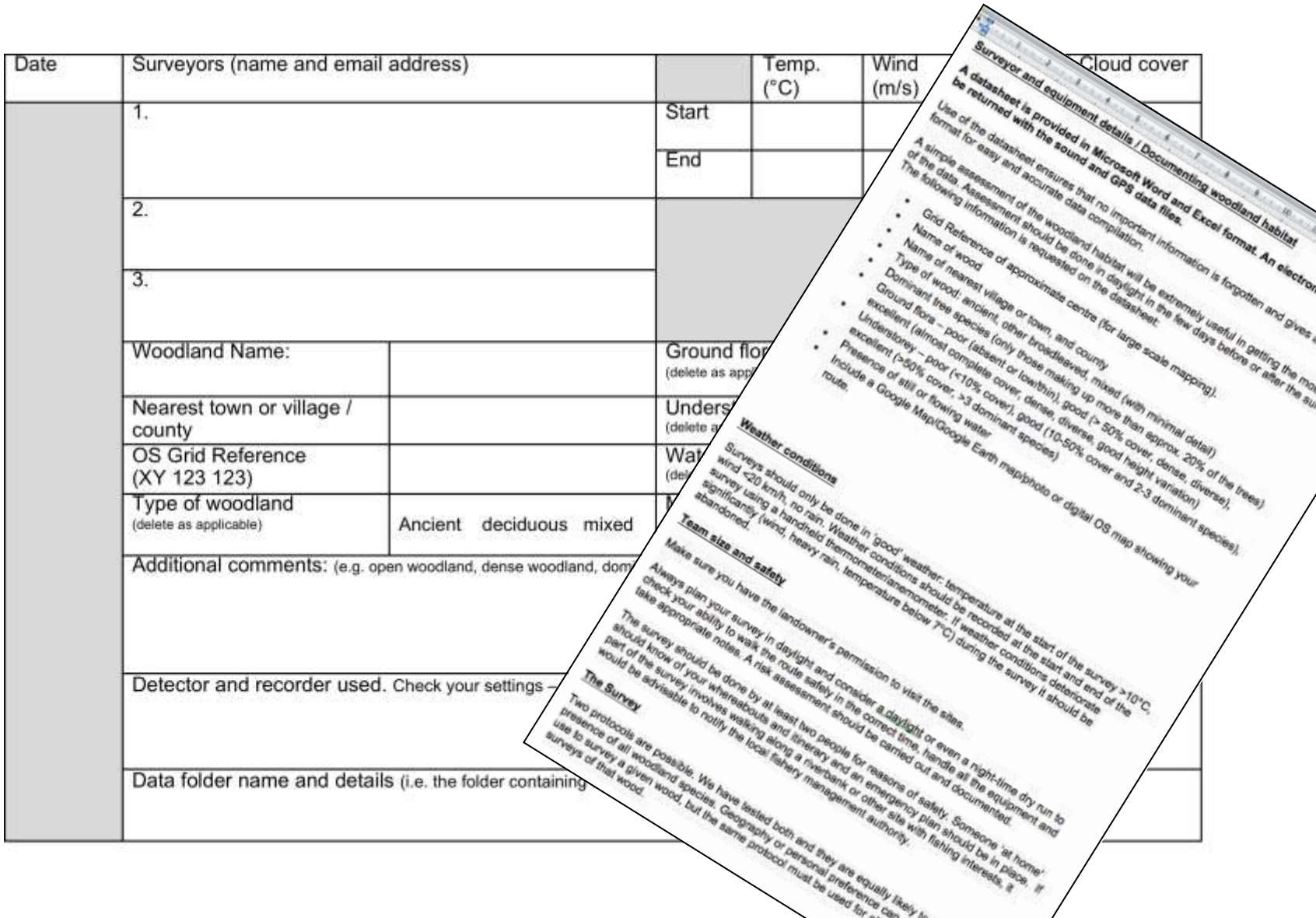
Finish

Track

Area search extensions



Metadata: site, date, surveyors, habitat data, weather, etc.



Date	Surveyors (name and email address)			Temp. (°C)	Wind (m/s)	Cloud cover
	1.		Start			
			End			
	2.					
	3.					
	Woodland Name:		Ground flor (delete as appl			
	Nearest town or village / county		Unders (delete a			
	OS Grid Reference (XY 123 123)		Wat (del			
	Type of woodland (delete as applicable)	Ancient deciduous mixed				
	Additional comments: (e.g. open woodland, dense woodland, dom					
	Detector and recorder used. Check your settings –					
	Data folder name and details (i.e. the folder containing					

Surveyor and equipment details / Documenting woodland habitat

A datasheet is provided in Microsoft Word and Excel format. An electron
be returned with the sound and GPS data files.

Use of the datasheet ensures that no important information is forgotten and gives
format for easy and accurate data compilation.

A simple assessment of the woodland habitat will be extremely useful in getting the mo
of the data. Assessment should be done in daylight in the few days before or after the su
The following information is requested on the datasheet:

- Grid Reference of approximate centre (for large scale mapping).
- Name of wood
- Name of nearest village or town, and county
- Type of wood: ancient, other broadleaved, mixed (with minimal detail)
- Dominant tree species (only those making up more than approx. 20% of the trees)
- Ground flora – poor (absent or low/thin), good (> 50% cover, dense, diverse),
excellent (almost complete cover, dense, diverse, good height variation)
- Understorey – poor (<10% cover; >3 dominant species), good (10-50% cover and 2-3 dominant species),
excellent (>50% cover)
- Presence of still or flowing water
- Include a Google Map/Google Earth map/photo or digital OS map showing your route.

Weather conditions

Surveys should only be done in 'good' weather: temperature at the start of the survey >10°C, wind <20 km/h, no rain. Weather conditions should be recorded at the start and end of the survey using a handheld thermometer/anemometer. If weather conditions deteriorate significantly (wind, heavy rain, temperature below 7°C) during the survey it should be abandoned.

Team size and safety

Make sure you have the landowner's permission to visit the sites.

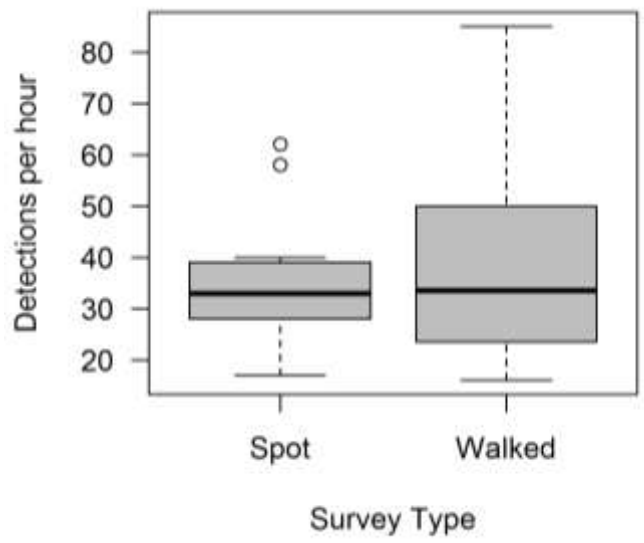
Always plan your survey in daylight and consider a daylight or even a night-time dry run to check your ability to walk the route safely in the correct time, handle all the equipment and take appropriate notes. A risk assessment should be carried out and documented.

The survey should be done by at least two people for reasons of safety. Someone 'at home' should know of your whereabouts and itinerary and an emergency plan should be in place. If part of the survey involves walking along a riverbank or other site with fishing interests, it would be advisable to notify the local fishery management authority.

The Survey

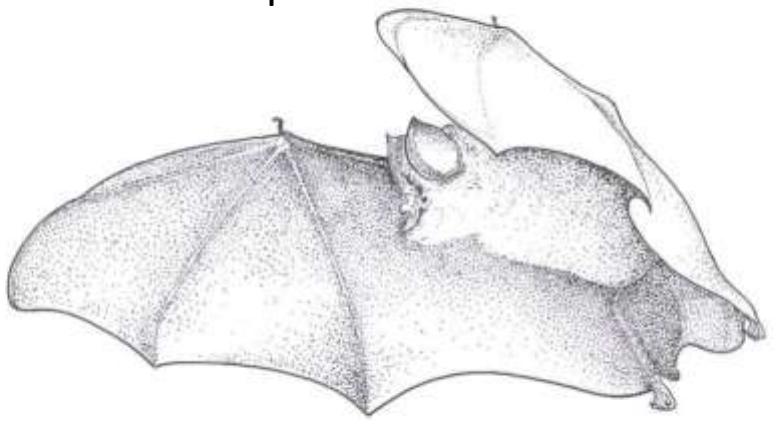
Two protocols are possible. We have tested both and they are equally likely to
presence of all woodland species. Geography or personal preference can
use to survey a given wood, but the same protocol must be used for
surveys of that wood.

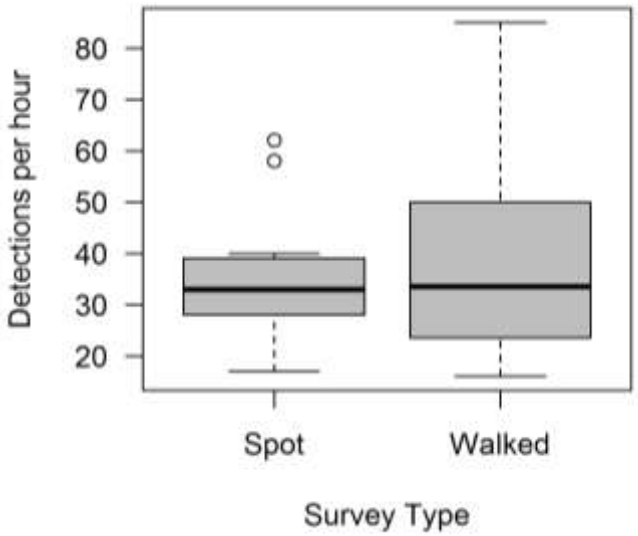
Spot check v walked



Spot checks and walked transects were comparable:

Used in combination the transect is more relaxed and you have time to think and organise in the stops





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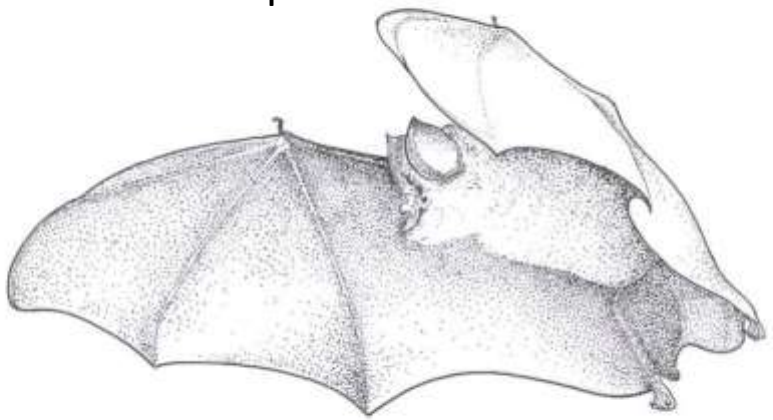
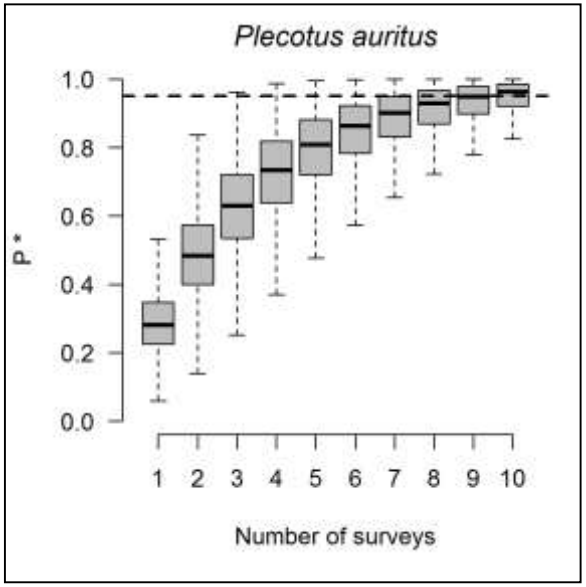
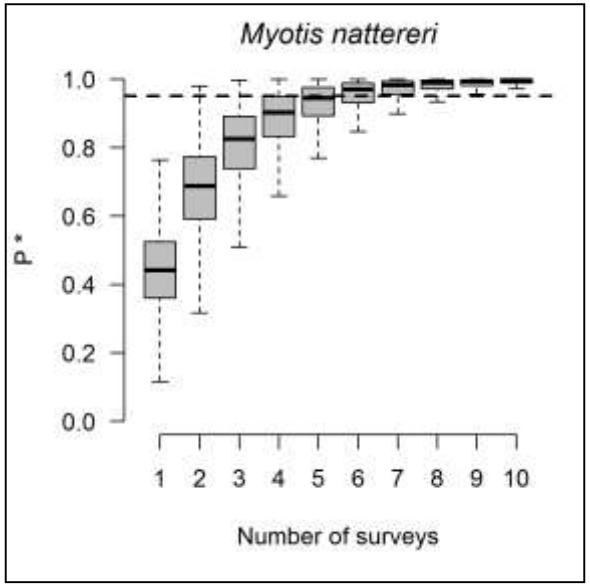


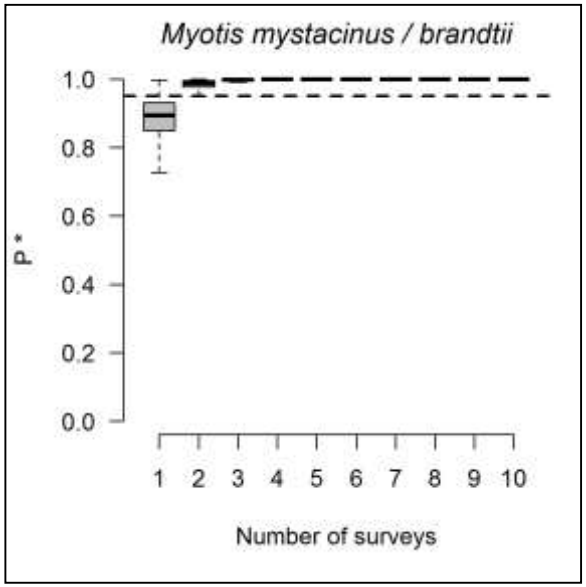
detectability

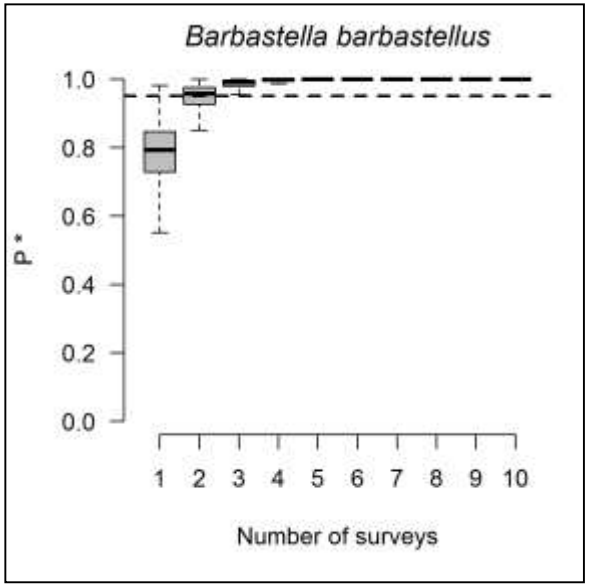
Species	Conventional Mean [95% HDI]	Area-Search Mean [95% HDI]
Barbastella barbastellus	0.78 [0.61, 0.93]	0.89 [0.75, 0.99]
Myotis mystacinus/ brandtii	0.88 [0.76, 0.98]	0.89 [0.76, 0.99]
Myotis nattereri	0.44 [0.23, 0.66]	0.36 [0.18, 0.54]
Noctule, Serotine, Leisler's	0.86 [0.73, 0.97]	0.86 [0.73, 0.97]
Pipistrellus pipistrellus	0.92 [0.83, 0.99]	0.83 [0.68, 0.96]
Pipistrellus pygmaeus	0.97 [0.91, 0.99]	0.97 [0.90, 0.99]
Plecotus auritus	0.29 [0.12, 0.46]	0.33 [0.16, 0.53]
Rhinolophus hipposideros	0.50 [0.27, 0.71]	0.61 [0.36, 0.85]

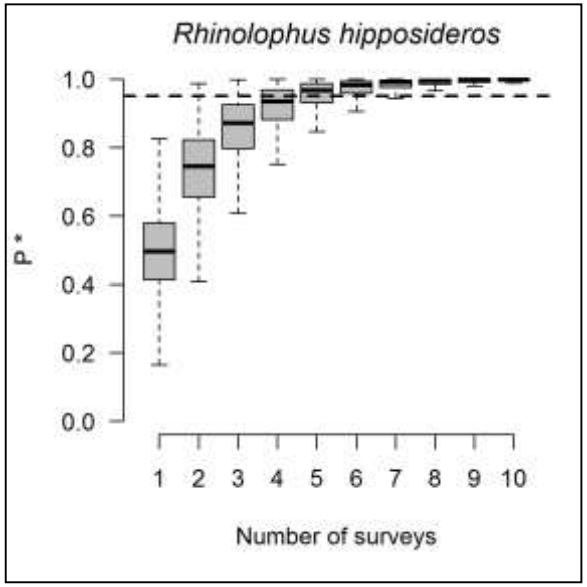
You are just as likely to detect a species with conventional transects as with the area search



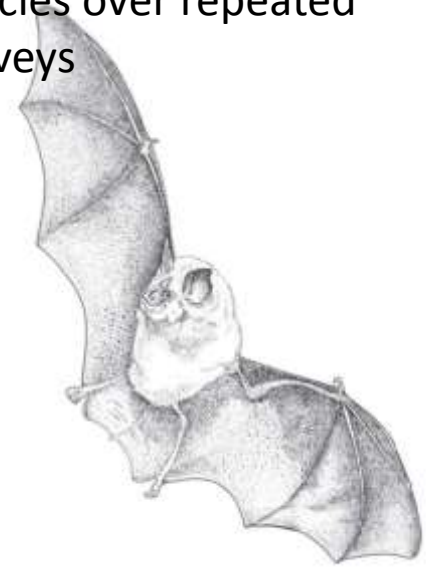


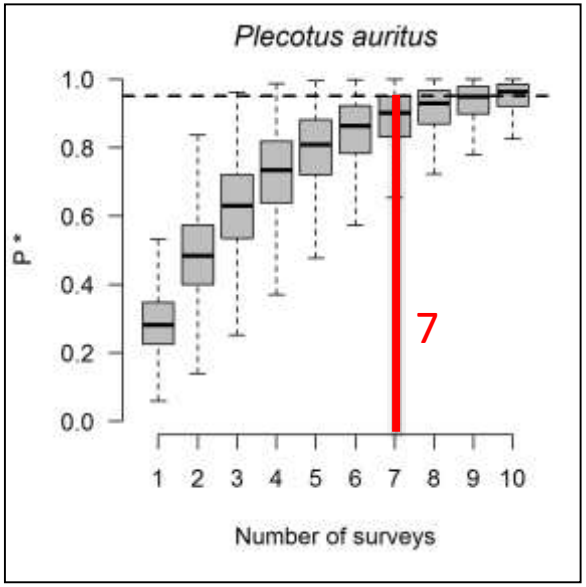


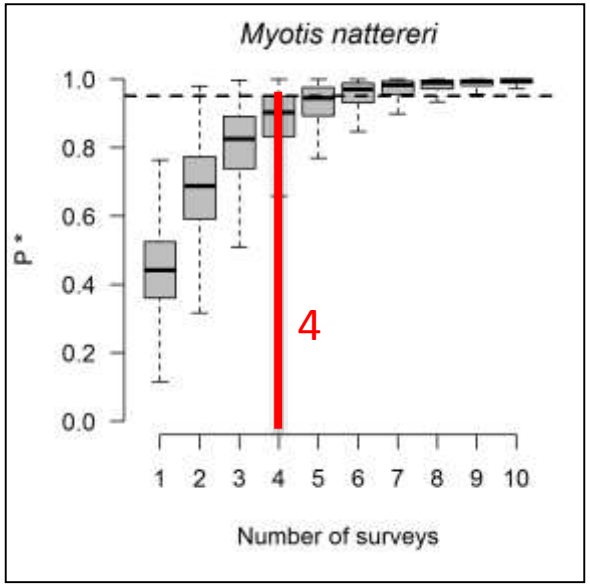


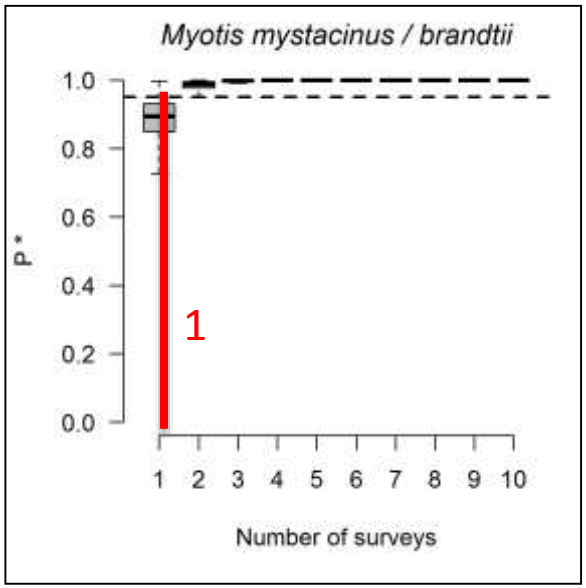


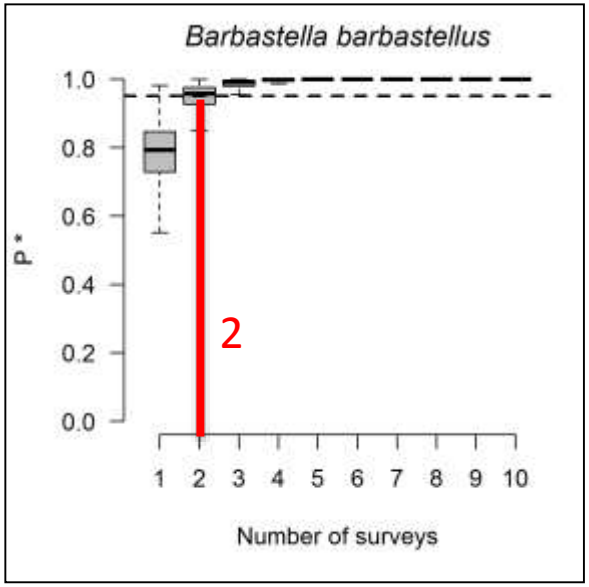
Probability of detecting a species over repeated surveys

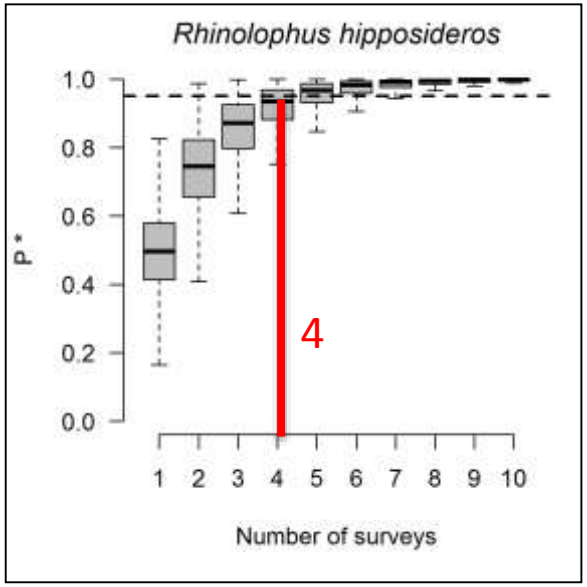






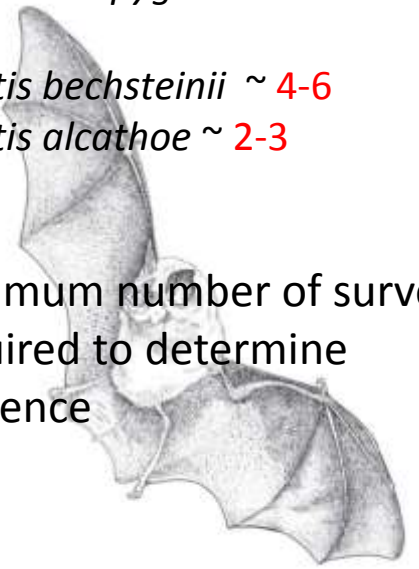






Pipistrellus pipistrellus = 1
Pipistrellus pygmaeus = 1

Myotis bechsteinii ~ 4-6
Myotis alcathoe ~ 2-3

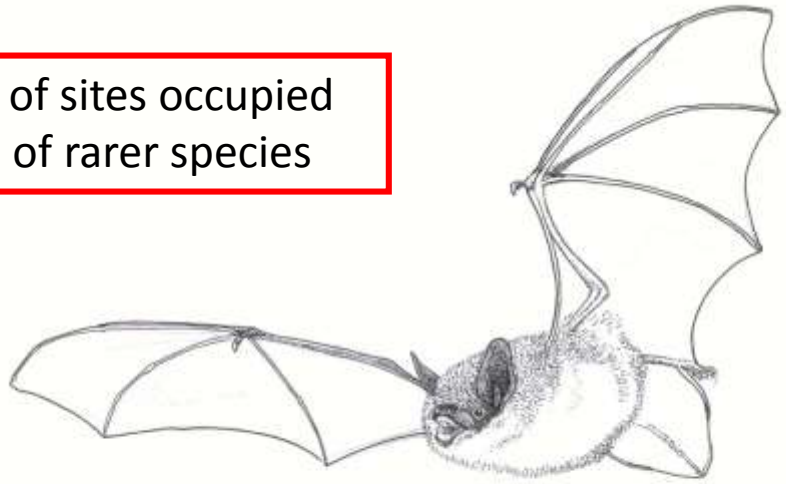


Minimum number of surveys required to determine presence

Trial methods to determine occupancy in relation to detectability at 'good' sites

Species	Detection probability *p* [1 SE]	Occupancy *psi* [1 SE]
Barbastella barbastellus	0.78 [0.08]	0.68 [0.15]
Myotis mystacinus/*M. brandtii*	0.89 [0.06]	0.78 [0.13]
Myotis nattereri	0.44 [0.11]	0.71 [0.16]
Plecotus auritus	0.29 [0.09]	0.80 [0.15]
Rhinolophus hipposideros	0.49 [0.11]	0.70 [0.16]

70-80% of sites occupied by each of rarer species



Determine the number of such sites that need to be surveyed, three times/year to detect a 50% change in occupancy

Species	***p***	***psi***	Required Sites
Barbastella barbastellus	0.78	0.68	31
Myotis mystacinus/*M. brandtii*	0.89	0.78	22
Myotis nattereri	0.44	0.71	56
Plecotus auritus	0.29	0.80	124
Rhinolophus hipposideros	0.49	0.70	47

60 sites across the country covers most species (120+ for *P. auritus, M. bechsteinii*)

More surveys per site: fewer sites needed

More surveys & more sites: detect more subtle changes more quickly

National monitoring

Survey a large number of sites, 3 or more times/year

Monitor change on the basis of site occupancy – now a very widely used approach

Local monitoring

More frequent surveys allow for assessment of population level changes at a local scale

Site assessment

Method suitable for site assessment/site inventory

Where next, given the resources?

Recruit volunteers to survey one or more woods, each wood to be surveyed a minimum of three times/summer

Equip with appropriate direct sampling detectors, and other essentials – future proofing

Give detailed guidelines on:

- Site selection
- Transect methodology
- Data recording
- File handling and submission

Optional – DIY analysis instructions/software

Central data compilation, analysis and reporting for a national perspective, but scope for local studies