CS continuity project NEC04867

What are the costs and benefits of using aerial photography to survey habitats in 1km squares?

C.M.Wood, L.R.Norton, C.S.Rowland
CEH Lancaster, Library Ave, Bailrigg, Lancaster. LA1 4AP

1. Introduction

Undertaking a field survey, such as the Countryside Survey (Carey et al., 2008) or the Welsh Glastir Monitoring and Evaluation Programme (GMEP) (Emmett and GMEP team, 2014), is a relatively expensive and time consuming way of collecting habitat data in comparison with remotely sensed techniques. In order to assess the information gained from a field survey in relation to the information that can be gained from aerial photography, a short project has been undertaken with the following objectives:

- To measure the time taken to survey a 1km square using aerial photography (for a range of different and UK representative landscape types)
- To measure the accuracy and level of detail of data derived using this method relative to data collected using field survey
- To provide an idea of time costs associated with each of the methods
- To determine the extent to which Priority Habitats can be assessed using remotely sensed methods in addition to Broad Habitats

It should be noted that in Countryside Survey (and GMEP) field surveyors are routinely provided with both aerial photography and the underlying OS Mastermap for the squares which they are surveying in order to help map polygon structure and delineate boundaries between vegetation types where these may be difficult to interpret on the ground.

2. Methods

2.1 Site Selection

A selection of 6, 1km squares was chosen based on a range of different landscape types. The squares are all located in Wales so as to allow comparison with recent field data collected within GMEP, which is based on Countryside Survey methods.
The range of squares was achieved by selecting squares located from within different ITE Land Classes (Bunce et al., 1990) and ensuring the chosen squares had been surveyed in the summer of 2013.

2.1 Mapping methodology

The field survey was carried out according to the protocols laid out in Maskell et al. (2008). All landscape lines, points and areas in the 1km are visited by the habitat surveyor and a range of attributes are recorded, such as hedgerow species, linear feature heights, dominant species within areas, field margins, tree species and land use. Since 2007, these features have been mapped using a digital data capture system with software developed by ESRI based on ArcMap (Forester). The data is stored in Oracle databases accessed via ArcSDE. The time taken by the surveyors to map the square is recorded during the survey.

Aerial photographs were obtained for the corresponding survey squares. The photos were taken 3-4 years prior to the field survey. In order to record information from the aerial photos, a new database was created, and the Forester mapping software was used to map the squares, using exactly the same protocols as used in the field survey. The same attributes as recorded in the field were used, where possible. The time taken to map each of the 6 squares was recorded carefully and any difficulties or issues were noted. All mapping was *de novo*.

3. Results and Discussion

3.1 Survey time

The time taken to map the square both in the field and by aerial photography is given in table 1 below and shown in figure 1. It is clear that field surveys can take approximately 12 times longer on average than mapping from aerial photography. In addition to the time taken for the actual work of mapping in the field, time must be factored in for accessing the square from the surveyor's base which in some cases may be up to 2 hours or more if there is no access road. However, mapping is just one part of the survey process and therefore this time is part of an overall survey cost, rather than specifically attributable to the mapping alone.

Table 1. Time taken to survey

Square	*Time taken in field (minutes)*	*Time taken from AP (minutes)*	*Field time/AP time*
A	1800	195	9.1
B	1350	135	10
C	2250	125	18
D	1800	135	13.3
E	450	55	8.2
F	2250	170	13.2

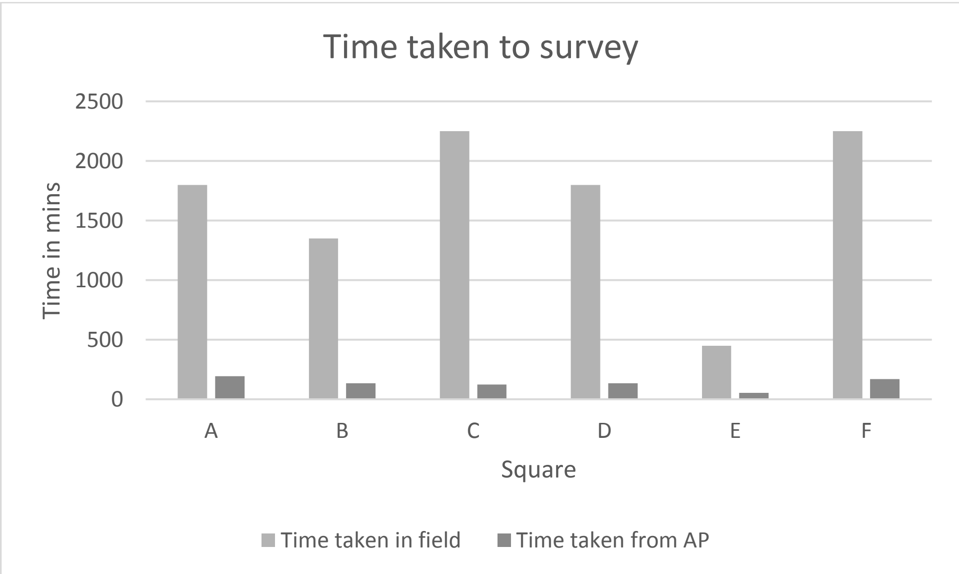

Figure 1. Time taken to map square in field and using aerial photography.

The completed maps of Broad and Priority Habitats can be seen in Appendix 1. Although, at first glance, the maps appear similar in many respects, there are important differences between those created in the field and those mapped from aerial photography. The similarities and differences are discussed in the following sections.

The total area of each square which it was possible to map is shown in table 2. In the field, access to land may be restricted due to lack of permission from the landowner, or due to dangerous livestock or awkward terrain. In the squares surveyed in 2013 in the field, access varied from 63 percent of the total area to 100 percent. In contrast, mapping from aerial photography allows 100 percent coverage (assuming the photography is available).

Table 2. Area of squares mapped

Square	*% of total square mapped (Field)*	*% of total square mapped (AP)*
A	72	100
B	63	100
C	84	100
D	100	100
E	94	100
F	95	100

3.2 Point features

Point features are individual landscape elements that occupy an area of less than 20 x 20m. Features may include trees, standing water bodies, patches of scrub or small buildings. The total number of points recorded in both the field survey and the maps created from the aerial photography are shown below in table 3 and figure 2. As point features are small, they can easily be missed in aerial photographs. This is clear from the fact that less than half the total number of points were recorded from the aerial photography than in the field survey. In two of the squares (C and D), this drops to around a third and in one (B), less than a quarter. In only two squares (A and E) are more points recorded in the aerial photography maps. These are squares where the overall number of points is low anyway. The differences are likely to be differences in interpretation e.g. two or more points representing individual trees versus one point representing a group of scattered trees.

Table 3. Number of points recorded in field survey versus aerial photograph interpretation

Square	*Points Recorded (Field)*	*Points Recorded (AP)*
A	17	22
B	100	24
C	72	20
D	62	18
E	2	3
F	37	21
Total	289	108

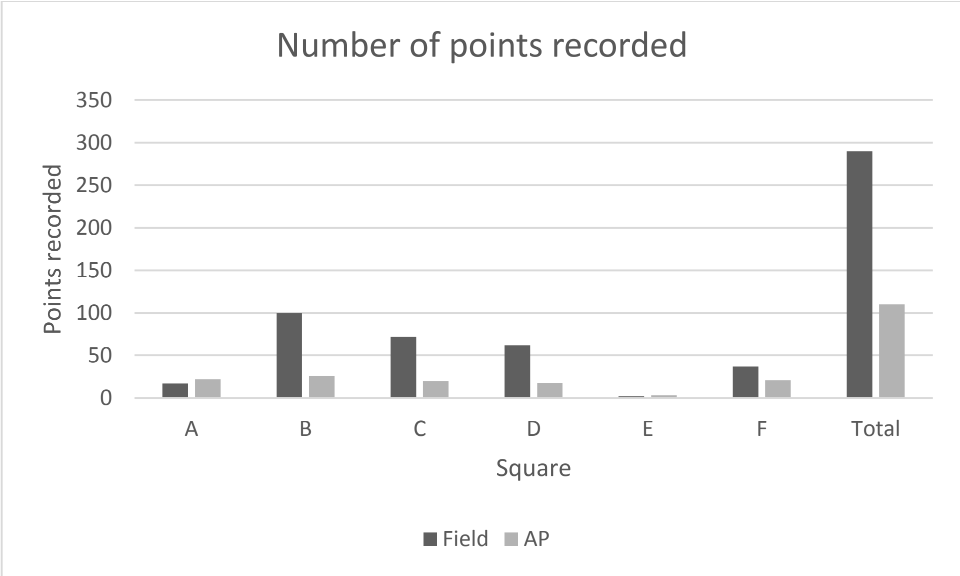

Figure 2. Number of points recorded in field survey versus aerial photograph interpretation

The differences between the attributes recorded for points in the field compared to those recorded from the aerial photos are shown in table 4 and figure 3. Many of the discrepancies are in the types of trees recorded. Fewer individual trees (61) are recorded from the aerial photos than in the field (118). Some of these may have been hard to identify from the aerial photos, and some may have been recorded as scattered trees instead. One big discrepancy is in the recording of clumps of trees and patches of scrub. One reason for this could be that from above, groups of trees look bigger due to the overhanging canopy, and may have been mapped as larger, mapped woodland areas. Another reason may be that the scrub was not easily identifiable from the air. Ponds are also an area of discrepancy with only a quarter of the ponds recorded in the field identified from the aerial photography. Ponds can often be surrounded by tall grass, obscuring the appearance of the water, or may be surrounded by trees or woodland, making them very difficult to identify from above. They can also be very shallow and appear to blend in with surrounding habitat. From table 4, it is clear that many types of feature have not been identified in the aerial photos, such as dead trees, rock outcrops, wells, areas of waste, soil erosion and historic features.

Table 4. Number of points recorded by type in field survey versus aerial photograph interpretation

Type	*Count in Field*	*Count from AP*
Scattered trees (2-5)	0	14
Individual trees	118	61
Clump of trees	68	6
Scattered scrub	1	8
Pond	20	5
Building	11	13
Quarry/mine	1	1
Dead Standing Tree(s)	1	0
Rock outcrop & cliff < 5m	1	0

Well	1	0
Waste - domestic	1	0
Other land	2	0
Dead Lying Tree(s)	3	0
Individual scrub species	5	0
Soil erosion	6	0
Waste - industrial	6	0
Patch of scrub	40	0
Historic features	4	0

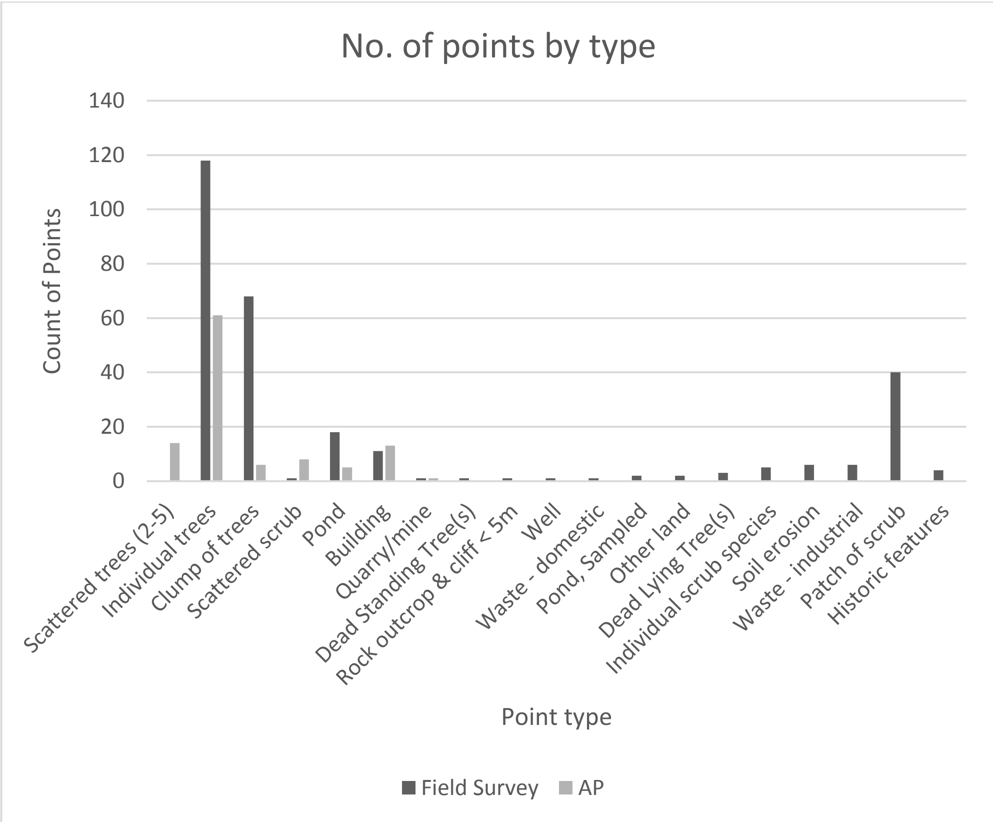

Figure 3. Number of points recorded by type recorded in field survey versus aerial photograph interpretation

In table 5 and figure 4, the range of different codes recorded for each point attribute is shown. For example, under species (of trees and shrubs recorded), a wide range of 31 different species have been recorded in the field, whereas from the aerial photo, only 2 different species have been recorded (which are 'gorse' and 'unspecified broadleaf'). Although it may be possible to guess at some species from the aerial photographs, only those that could be mapped with 100 percent certainty were recorded. Many attributes could not be ascertained at all from the aerial photos, such as buffer zones around trees, Diameter at Breast Height (DBH) of trees, condition of trees and presence of habitat boxes and disease. Although veteran trees were not present in the squares mapped, descriptions of these (such as identifying hollow trunks, missing bark, dead limbs or epiphytes) would not have been possible from the aerial photos.

Table 5. Numbers of different attributes recorded for all points in field survey versus aerial photograph interpretation

Attribute	Field Survey	AP
LUSE	6	4
HABT_CODE	20	7
SPECIES	31	2
PROPORTION	7	4
USE	2	3
BUFFER	2	0
TREE_DEAD	0	0
MISSING_LIMBS	0	0
DEAD_WOOD	0	0
DEAD_MISSING_BARK	0	0
LIGHTNING_STRIKES	0	0
HOLLOW_TRUNK	0	0
MODAL_DBH	7	0
VETERAN_TREE_TYPE	0	0
EPIPHYTE_COVER	0	0
IVY_COVER	0	0
CANOPY_LIVE	0	0
CONDITION	2	0
DISEASE_SIGNS	1	0
HABITAT_BOXES	2	0

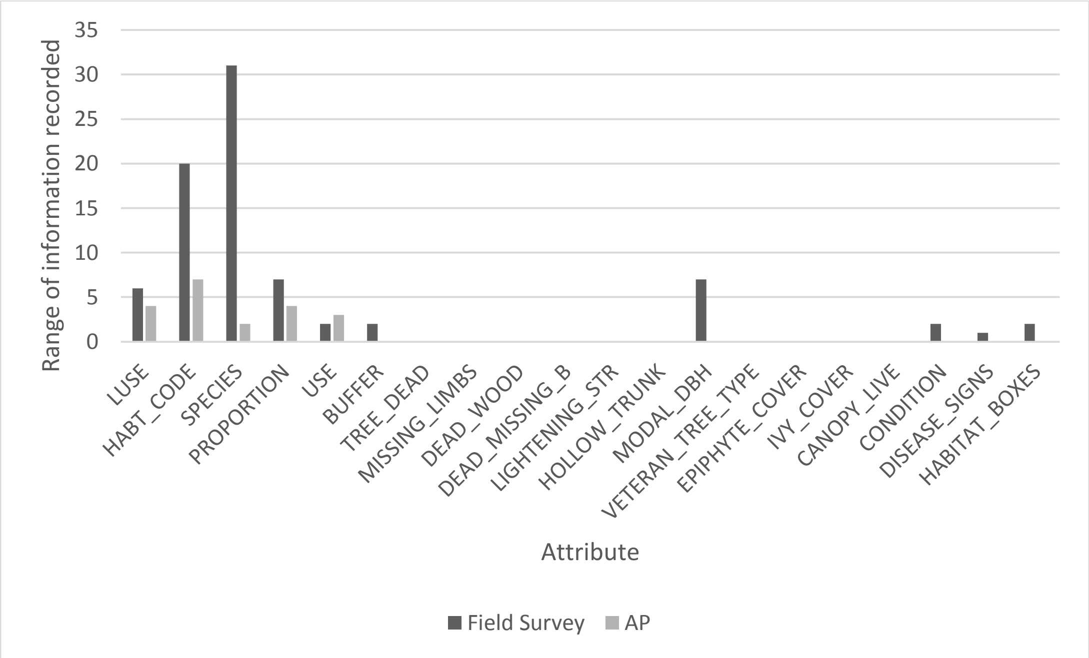

Figure 4. Information recorded for all point attributes in field survey versus aerial photograph interpretation

3.3 Linear features

Linear features are landscape elements less than 5m wide that form lines in the landscape such as walls, hedges and fences. Linear features are ecologically significant, as well as providing a refuge for species unable to persist in managed fields, the Boundary and Linear Features Broad Habitat can provide corridors for the movement and dispersal of a range of species.

Table 6 shows the total lengths of different types of linear features mapped in the survey squares both from the field squares and from the aerial photo squares. Letters in brackets are land use (LUSE) codes. Overall, only around half the length of linear features was recorded from the aerial photos as in the field, and only 6 types of features as opposed to 11 in the field. The type of feature with the longest length completely missed was banks, as they are very hard to distinguish from a 2D aerial photo. Transport (mainly tracks) and walls were mapped fairly successfully from the aerial photography, at 73% and 95% of the field total respectively. Woody linear features of an unnatural shape (hedges) have been over-mapped from the aerial photos at 156% of the mapped field total. This could partly be down to confusion with naturally shaped woody linear features (lines of trees), or alternatively they could have been mapped in the field as belts of trees or similar, as part of the forestry features category. In the field lines of trees and hedges may be mapped along the same linear feature where they co-occur (or are within 5m of one another). Distinguishing individual woody linear features (hedges, lines of trees or belts of trees from the canopy is complex as differences between such feature types are subtle. Almost half of the streams and ditches (Inland Water) have been missed in the aerial photography, these features often occur within woodland or tall vegetation so are hard to identify on aerial photos. Only 17% of fences present in the field were mapped from the aerial photos. This is likely to be because fences are often very thin and therefore indistinct on photos, but also because they are likely to be associated with another feature (most commonly a type of hedge or woodland boundary), and are therefore obscured by this second feature.

Table 6. Total lengths of linear feature types in field survey versus aerial photograph interpretation

Feature Type	*Length of features m. (Field)*	*Length of features m. (AP)*	*Amount of field feature mapped from AP as a %*
Agriculture/Natural Veg. (AN)	372	0	*0*
Bank (B)	22566	0	*0*
Fence (F)	55866	9717	*17*
Forestry (FO)	2086	0	*0*
Inland Physiography (IL)	911	0	*0*
Inland Water (IW)	17124	8759	*51*
Structures (ST)	67	0	*0*
Transport (TR)	8952	6546	*73*
Wall (W)	9898	9456	*95*
Woody linear feature (Natural shape) (WNS)	15571	12044	*77*
Woody linear feature (Unnatural shape) (WUS)	18750	29287	*156*
Total	152628	80274	*53*
No. of feature types recorded	**11**	**6**	***55***

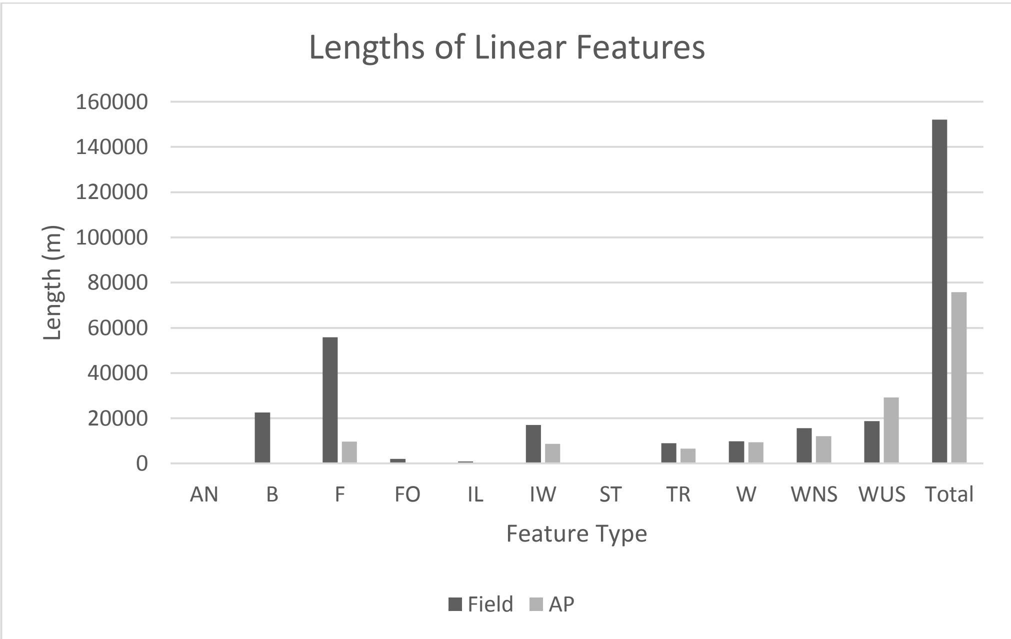

Figure 5. Total lengths of linear feature types in field survey versus aerial photograph interpretation

Table 7 shows the variation in the numbers of different attributes recorded for linear features. For many of the attributes, no information at all could be gained from the aerial photography. This includes the base height of a hedge feature, the height or width of features, the DBH of any trees in the feature, the condition of features (walls and fences), signs of hedge management, margins, the presence of staked trees or tree protectors or the presence of felled trees (stumps). In terms of species recorded in lines of trees (woody linear features in which trees take their natural shape), only 2 different types were recorded from the aerial photos, either 'Mixed broadleaf' or 'Unspecified broadleaf'. However, in the field, 31 different species were recorded along linear features. The only proportion that could be recorded from the aerial photos for different species was '95-100%', i.e. 100% unspecified or mixed broadleaf.'

Table 7. Number of attributes recorded for linear features in field survey versus aerial photograph interpretation

Attribute Type	**Field Survey** *No. of different attributes recorded*	**AP** *No. of different attributes recorded*
LUSE	11	6
HABT_CODE	27	10
HEIGHT	5	0
BASE_HEIGHT	2	0
WIDTH	0	0
MODAL_DBH	5	0
CONDITION	6	0
HISTORIC_MANAGEMENT	2	0
EVIDENCE_ MANAGEMENT	3	0
STAKED_TREES	2	0
TREE_PROTECTOR	1	0
LINE_STUMPS	2	0
VERTICAL_GAPS	5	0
MARGIN_WIDTH_L	3	0
MARGIN_WIDTH_R	4	0
SPECIES_COMPOSITION	3	1
SPECIES	31	2
PROPORTION	6	1

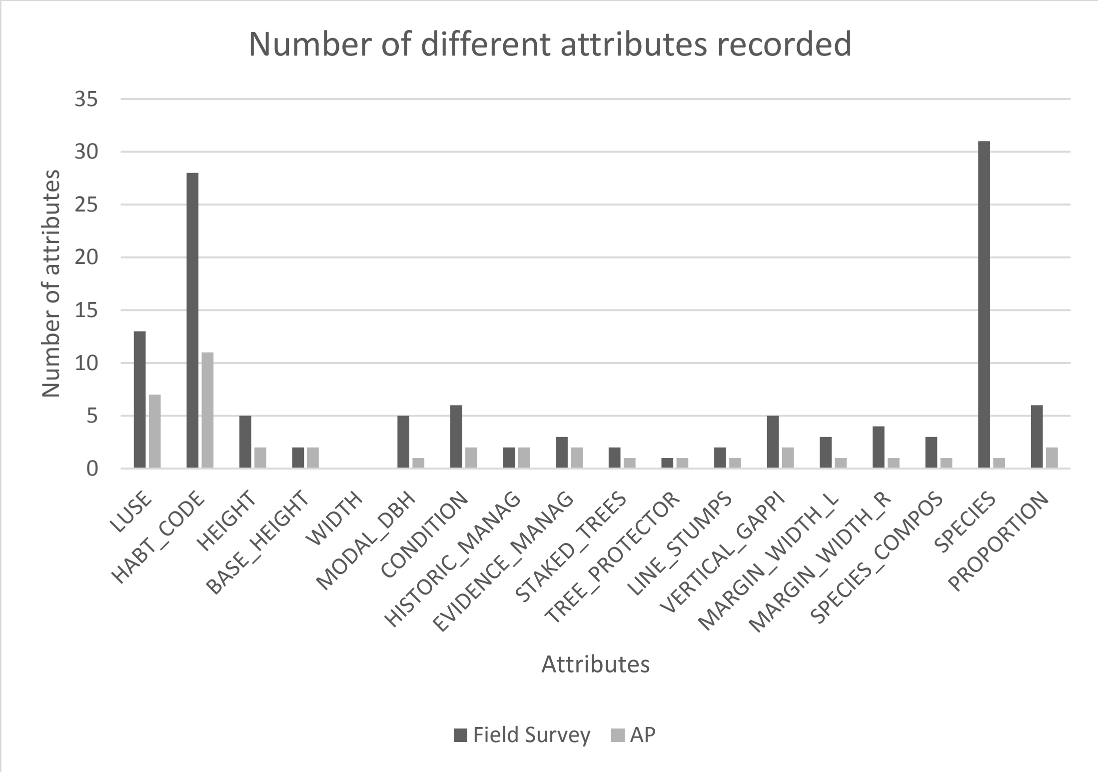

Figure 6. Information recorded for all linear attributes in field survey versus aerial photograph interpretation

The number of detailed habitat codes (HABT codes, table 7) recorded was 10 from the aerial photos as opposed to 27 in the field. From the aerial photos, only basic types of features could be identified, largely the same as those recorded in table 6 (LUSE codes). As shown in table 8, the range, type and condition of walls and fences mapped in the field have been missed in the aerial photo mapping. Features which were completely missed in the aerial photo mapping included; soil erosion, belt of scrub, cliffs, belts of trees, dead standing trees and all banks.

Table 8. Detailed habitat codes (HABT codes, table 7) recorded in field survey versus aerial photograph interpretation

Primary Attribute	*Recorded in Field*	*Recorded in AP*
Soil erosion	x	
Belt of scrub	x	
WLF natural shape	x	x
WLF unnatural shape	x	x
Perennial vegetation, tall herb/grass	x	
Cliff 5-30m high	x	
Belt of trees	x	
Dead Standing Tree(s)	x	
Rock outcrop & cliff < 5m	x	
Dry-stone wall	x	
Mortared wall	x	
Other wall	x	x
Fence - wood only	x	

Fence - iron only	x	
Fence - wire on posts	x	x
Other fence	x	x
Earth bank	x	
Stone and Earth Bank	x	
Other land	x	
Constructed track	x	x
Unconstructed track	x	x
Footpath (exclusive)	x	
Footpath (other)	x	x
Stream	x	x
Roadside ditch	x	x
Other ditch	x	
Historic feature	x	

3.4 Areas (habitats)

In Countryside Survey (and GMEP) areas (polygons) are recorded as UK Broad Habitats (Jackson, 2000). Surveyors also record a range of additional information including Priority Habitats such as Wet Woodland, Lowland Calcareous Grassland and Reed Beds, where appropriate. The areas of habitats mapped both in the field and from the aerial photos are shown in tables 9 (actual area in ha) and 10 (as a proportion of the mapped area) as correspondence matrices, created from a spatial overlay between the field survey and the maps interpreted from the aerial photographs. The overall correspondence between the two at the Broad Habitat level is 56.7% (including sea but excluding un-surveyed areas) or 44.8% (excluding both sea and un-surveyed areas). It should be noted that some of the mismatch may be attributed to seasonal differences in agricultural management (arable and grassland) and some may be attributed to surveyor interpretation.

The areas of terrestrial Broad Habitats having a correspondence higher than 50% (of the field area mapped) are Acid Grassland (50.8%, 8.3ha), Bog (72.1%, 12.7ha), Broadleaved, Mixed and Yew woodland (75.1%, 25.3ha), Dwarf Shrub Heath (61.6%, 23.6ha) and Improved Grassland (59.6%, 92.1ha). The coastal habitat of Supra-littoral sediment had a high correspondence of 93.6% (3.7ha). Urban areas were also mapped reasonably well with 81.6%., 29.3ha correspondence. Although Acid Grassland has a correspondence over 50%, the table shows that it is hard to distinguish from a variety of other habitats including Bog, Bracken, Dwarf Shrub Heath, and Improved and Neutral Grassland. 6.6% (2.2ha) of broadleaved woodland has been mapped as Coniferous Woodland in the aerial photography, and 6.3% (2.1 ha) as Dwarf Shrub Heath.

Habitats with the lowest correspondence are Coniferous Woodland (45.1%, 1.8ha), Fen, Marsh and Swamp (1.6%, 0.3ha) and Neutral Grassland (37%, 38.7ha). 53% (2.1ha) of the field mapped area of Coniferous Woodland was mapped as broadleaved woodland from the aerial photos. In the case of Fen, Marsh and Swamp, 98% of the 20.2ha mapped in the field has been mapped as a range of other habitats from the aerial photography, including Acid Grassland, Bog, Bracken, Dwarf Shrub Heath, Improved Grassland and Neutral Grassland. Often, identification of these habitats is very dependent on the species found within, therefore the inability to identify species from the aerial photography make these difficult habitats to map when not in the field. Additionally DSH, Bog and Acid grassland tend to grade into one another making the boundaries between them imprecise and difficult to map. Neutral Grassland has also been misidentified as a range of different habitats, most often as other types of grassland - Acid and Improved. Again, without knowing the species within the grassland, it is difficult to determine the type of grassland from an aerial photo.

The big mismatch between the Arable and Horticulture and Improved Grassland (tables 9 and 10) is likely to be as a result of seasonal differences between the time when the photos were taken and the year of the survey, with no areas of mapped Arable and Horticulture corresponding at all.

The water habitats were mapped reasonably well from the air, with Sea at 100% correspondence, Standing Open Water and Canals at 73.5% correspondence and Rivers and Streams at 90.8% correspondence. Rivers and Streams have occasionally been confused with woodland, which is understandable as they would be hard to identify from above when beneath a woodland canopy.

Table 9. Correspondence matrix of areas of mapped habitats recorded in field survey versus aerial photograph interpretation (in ha)

Aerial Photography \ Field Survey	Acid Grassland	Arable and Horticulture	Bog	Boundary and Linear Features	Bracken	Broadleaved Mixed and Yew Woodland	Coniferous Woodland	Dwarf Shrub Heath	Fen, Marsh, Swamp	Improved Grassland	Inland Rock	Littoral Sediment	Mosaic	Neutral Grassland	No Allocation	Rivers and Streams	Sea	Standing Open Waters and Canals	Supra-littoral Rock	Supra-littoral Sediment	Urban	Total (AP)
Acid Grassland	8.3		3.2	0.1	3.3	0.2		3.6	6.0					3.1	0.2						0.2	28.2
Arable and Horticulture										42.5				3.3	5.6						0.1	51.5
Bog	2.6		12.7		1.7			11.0	2.0	0.1			0.1	0.2								30.5
Bracken	0.2								1.2					0.4	0.4							2.3
Broadleaved Mixed and Yew Woodland		0.1	0.1			25.3	2.1		1.3	0.2	0.2			1.3	4.9	0.4					0.7	36.6
Coniferous Woodland						2.2	1.8															4.1
Dwarf Shrub Heath	2.7		1.6		0.7	2.1		23.6	6.4					0.3	1.4						0.1	39.0
Fen, Marsh, Swamp									0.3	0.1				0.2	0.6						0.1	1.2
Improved Grassland	1.2	12.3				0.9			0.3	92.1			1.5	56.8	35.5						2.9	203.6
Neutral Grassland	1.1	2.2		0.1		1.6			2.6	18.1	0.5		2.6	38.7	12.5			0.1			2.3	82.2
Rivers and Streams						1.0					0.5					3.8						5.4
Sea																	64.0					
Standing Open Waters and Canals												0.3						0.1	0.3		0.2	64.9
Supra-littoral Sediment												11.3							0.4	3.7		15.4
Urban	0.2					0.4			0.2	1.3	0.1			0.1	3.2					0.2	29.3	35.2
Total (field survey)	16.3	14.6	17.6	0.1	5.7	33.7	4.0	38.2	20.2	154.5	1.4	11.6	4.3	104.5	64.5	4.2	64.0	0.2	0.7	3.9	35.9	600.0

Table 10. Correspondence matrix of areas of mapped habitats recorded from aerial photograph interpretation as a percentage of mapped field areas

Aerial Photography \ Field Survey	Acid Grassland	Arable and Horticulture	Bog	Boundary and Linear Features	Bracken	Broadleaved Mixed and Yew	Coniferous Woodland	Dwarf Shrub Heath	Fen, Marsh, Swamp	Improved Grassland	Inland Rock	Littoral Sediment	Mosaic	Neutral Grassland	No Allocation	Rivers and Streams	Sea	Standing Open Waters and	Supra-littoral Rock	Supra-littoral Sediment	Urban
Acid Grassland	50.8		18.0	58.7	58.6	0.7		9.5	29.6					3.0	0.3						0.7
Arable and Horticulture										27.5				3.2	8.6						0.3
Bog	16.0		72.1		29.9			28.8	9.9		0.8		2.8	0.2							
Bracken	1.2								5.9					0.4	0.7						
Broadleaved Mixed and Yew Woodland		0.7	0.4			75.1	53.0		6.4	0.1	17.1			1.2	7.7	9.1					2.0
Coniferous Woodland						6.6	45.1														
Dwarf Shrub Heath	16.5		9.3		11.5	6.3		61.6	31.5		2.8			0.3	2.2						0.3
Fen, Marsh, Swamp									1.6	0.1				0.2	0.9						0.2
Improved Grassland	7.3	84.5	0.2			2.6	0.7		1.3	59.6			35.8	54.3	55.1	0.1					8.1
Neutral Grassland	6.9	14.8		41.3		4.6	0.3		12.7	11.7	33.2		60.2	37.0	19.4			26.5			6.3
Rivers and Streams						2.9					38.8				0.1	90.8					
Sea																	100.0				
Standing Open Waters and Canals												2.4						73.5	46.2		0.5
Supra-littoral Sediment												97.6	1.0						53.8	93.6	0.1
Urban	1.3					1.2	1.0		1.0	0.9	7.3		0.1	0.1	5.0					6.4	81.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Far fewer detailed habitat codes (primary attributes) for areas were recorded using the aerial photography than in the field (table 11). Some features such as Forestry Features, Forestry Use, Historic Features and Wide Linear Features were completely missed from the air. The mismatch in area for most of the detailed habitat codes can be put down to species recording in the field (and not in the maps interpreted from aerial photography). Table 11, shows the numbers of detailed habitat codes used in the field survey versus those used in the aerial photography maps. Urban areas and structure use codes have been over-recorded from the air. This could be due to uncertainty over the use, therefore more than one code has been entered (e.g. residential use, agricultural use, commercial use) whereas in the field, it is easier to settle on one option. The number of Crop codes recorded from the area is higher from the air than in the field; this reflects the amount of the Arable & Horticulture Broad Habitat recorded (see next section).

Table 11. Counts of each LUSE (theme) Code recorded

LUSE Code	*Field Survey*	*AP*
Agricultural Crops	8	27
Agriculture/Natural Vegetation Use	383	100
Agriculture/Natural Vegetation	1427	296
Coastal Feature	12	2
Forestry	293	60
Forestry Feature	41	0
Forestry Use	3	0
Historic Feature	5	0
Inland Physiography	82	15
Inland Water	8	4
Wide Linear Feature	1	0
Recreation	32	3
Structures	47	60
Transport	25	19

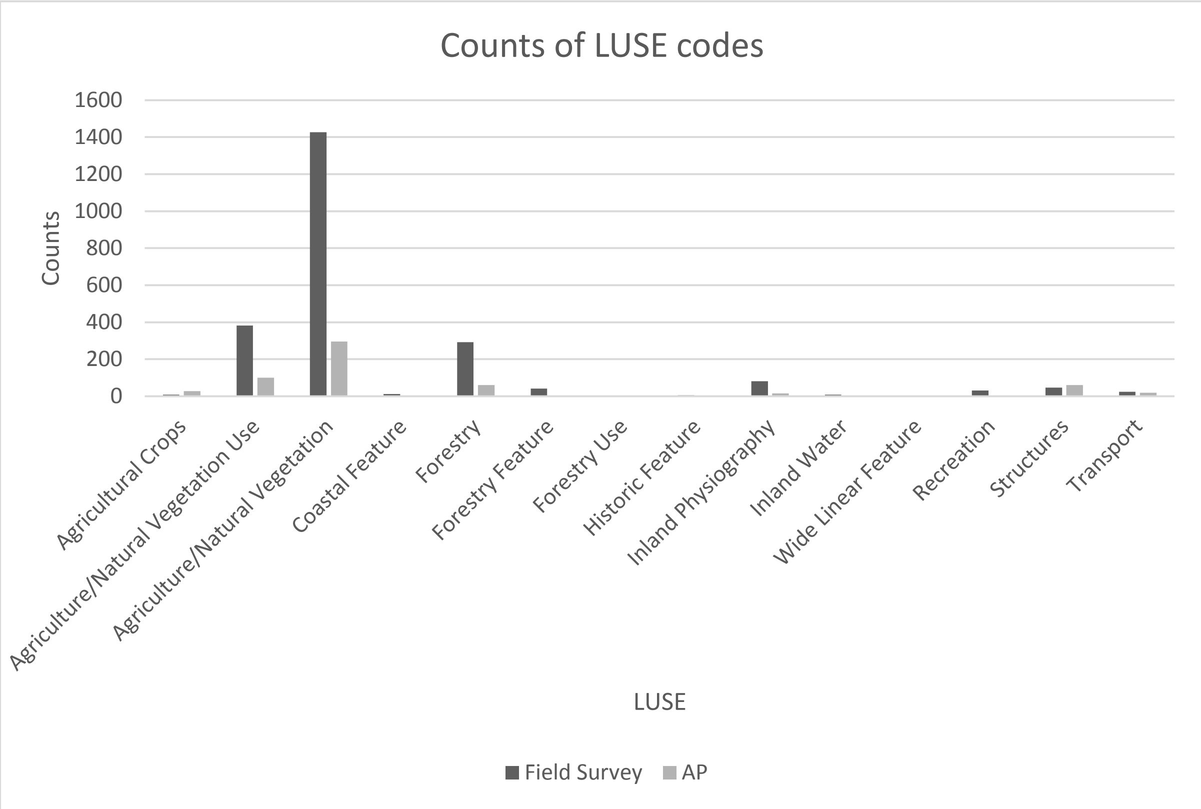

Figure 7. Information recorded for all area land use (LUSE) attributes in field survey versus aerial photograph interpretation

Table 12. Attributes recorded for areas in field survey versus aerial photograph (AP) interpretation

	Field Survey	AP
BROAD_HABITAT	29	16
LUSE	14	10
HABT_CODE	80	34
SPECIES	140	8
SPECIES_COVER	6	4
PRIMARY_QUALIFIER	8	0
STRUCTURE_USE	7	3
PHYSIOGRAPHY_COVER	6	2
ROAD_VERGE_A	3	0
ROAD_VERGE_B	3	0
MODAL_DBH	4	0
SWARD_COVER	6	0
SWARD_HEIGHT	7	0
SWARD_VARIATION	4	0
TUSSOCKINESS	3	0

The number of Broad Habitat codes (table 12) recorded was 16 from the aerial photos as opposed to 29 in the field. As for linear and point features, only basic types of features could be identified from the aerial photos. In particular, the number of species was far fewer using the aerial photography rather than in the field (table 12). From the aerial photos the following were recorded: unspecified *Sphagnum*, unspecified conifer, gorse, unspecified broadleaf, *Pteridium aquilinum*, *Juncus effusus*, *Lolium perenne* and unspecified grass, whereas a wide range of different species were recorded in the field. Using the aerial photography, it was not possible to determine the width of verges, the DBH of any trees, the sward height, cover and variation or the degree of tussockiness (table 12).

It was not possible to determine any Priority Habitats using the aerial photography, as illustrated in table 13. This shows that 6 more Broad Habitats were identified in the field than by aerial photography, and taking into account Priority Habitats, 14 types of habitat were missed in the aerial photo maps (of which 8 are Priority). Priority Habitats are generally difficult to identify with little species information.

Table 13. Number of different habitats recorded

	Field	AP
No. of Broad Habitats mapped	21	15
No. of Broad Habitats mapped including Priority Habitats	29	15

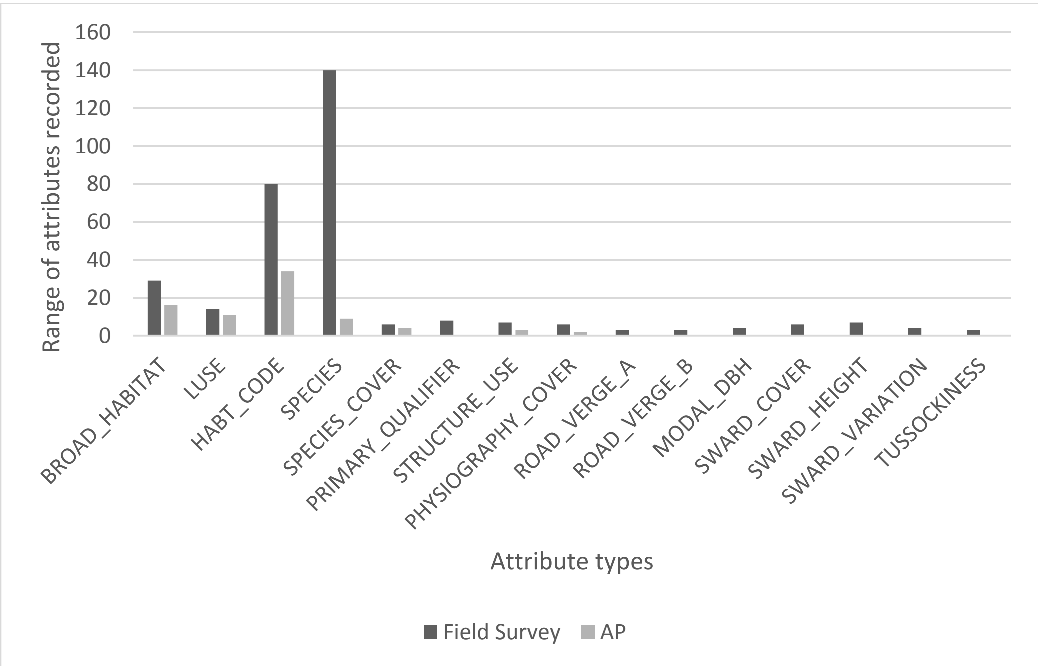

Figure 8. Information recorded for all detailed area attributes in field survey versus aerial photograph interpretation

4. *Conclusion*

In analysing the different maps, it must be acknowledged that due to the time saved (and therefore also cost) mapping habitats from aerial photography has some merits. One big advantage is that the entirety of a given area may be mapped, as refused access permission or difficult terrain does not create a problem. Therefore, in cases where no information at all is available from the field due to access constraints, there could be the potential for filling some Broad Habitat information from aerial photos. With some concession to accuracy (approximately 57% correspondence), Broad Habitats can be generally mapped from aerial photography, with some habitats, such as broadleaved woodland, being more successfully mapped from the air than others, such as Fen, Marsh and Swamp. To a certain extent, an (under) estimate of the number and type of landscape points can also be made, and also the lengths of linear features can be estimated.

However, it is clear that there are many features and more particularly, attributes, which cannot be mapped successfully from the air. Less than half the number of points were recorded from the air than in the field, and just over half the length of linear features, with certain features being misidentified, such as hedge types, and some features (such as banks) being completely missed. Ponds were also a key feature often missed. No detailed measurements or condition assessments were possible for any landscape feature. Virtually no species were identified for any of the feature types, or they were given only very general codes such as 'unspecified broadleaf'. Several Broad Habitats rely on a thorough knowledge of the plant species occurring there, before a correct identification can be attempted. This is particularly important in habitats such as Fen, Marsh and Swamp, and in differentiating between types of grassland. Priority Habitats in particular (for example Purple Moor Grass Rush Pasture) require detailed species knowledge before identification can be made.

In a survey such as Countryside Survey, from which estimates for the whole of Great Britain are produced (Carey et al., 2008), a significant national underestimate of many features would result if mapping were to be undertaken from aerial photos, and changes would be difficult, if not impossible, to assess. For example, many types of outputs produced from Countryside Survey data would not be possible, including: overall findings for stock and change of habitats from 2007 (Norton et al., 2012); the maps of ash distribution (in relation to the ash dieback disease outbreak) produced in 2013 (Maskell et al., 2013); inputs to the UK National Ecosystem Assessment (NEA, 2011) and many more listed on the Countryside Survey website (www.countrysidesurvey.org.uk/other-publications).

A summary of the main advantages and disadvantages of field mapping versus aerial photography mapping is given in table 14.

Table 14. Advantages and disadvantages of habitat mapping in the field and from aerial photography.

	Advantages	***Disadvantages***
Field Survey	• *Mapping at a disaggregated, detailed species level* • *Possible to map much more information regarding heights/widths/conditions of features* • *Easier to determine land use on the ground*	• *Time consuming, therefore expensive* • *Access permission can be refused* • *Land may be logistically difficult to access*
Aerial photography	• *Can map refused/inaccessible areas* • *Can map larger areas more easily* • *Quick* • *Photos fairly readily available*	• *Not always possible to determine Broad Habitat, or particularly Priority Habitat* • *Not possible to map crucial details such as species, feature heights/ widths/condition* • *Physical features are not in front of you, therefore once an area has been mapped from the background photo, it becomes easy to miss details as they become hidden under the mapping layer.*

References

Bunce, R.G.H.; Barr, C.J.; Clarke, R.T.; Howard, David; Lane, A.M.J.. *ITE Land Classification of Great Britain 1990* http://doi.org/10.5285/ab320e08-faf5-48e1-9ec9-77a213d2907f

Carey, P. D., Wallis, S., Chamberlain, P. M., Cooper, A., Emmett, B. A., Maskell, L. C., McCann, T., Murphy, J., Norton, L. R., Reynolds, B., Scott, W. A., Simpson, I. C., Smart, S. M. & Ullyett, J. M. (2008) Countryside Survey: UK Results from 2007. NERC/Centre for Ecology & Hydrology.

Emmett, B. E. & GMEP team (2014) Glastir Monitoring & Evaluation Programme. First Year Annual Report to Welsh Government (Contract reference: C147/2010/11). pp. 442. NERC/Centre for Ecology & Hydrology.

Jackson, D. (2000) Guidance on the Interpretation of the Biodiversity Broad Habitat Classification (Terrestrial and Freshwater Types): Definitions and the Relationship with Other Habitat Classifications. JNCC.

Maskell, L. C.; Norton, L. R.; Smart, S. M.; Carey, P. D.; Murphy, J.; Chamberlain, P. M.; Wood, C. M.; Bunce, R. G. H.;Barr, C. J.. 2008 *Countryside Survey. Field Mapping Handbook.* NERC/Centre for Ecology & Hydrology, 130pp. (CS Technical Report No.1/07, CEH Project Number: C03259)

Maskell, L. C., Henrys, P. A., Norton, L. R., Smart, S. M. & Wood, C. M. (2013) Distribution of Ash trees (Fraxinus excelsior) in Countryside Survey data. CEH.

Norton, L. R., Maskell, L.C., Smart, S.S., Dunbar, M.J., Emmett, B.A., Carey, P.D., Williams, P., Crowe, A., Chandler, K., Scott, W.A., Wood, C.M. (2012) Measuring stock and change in the GB countryside for policy: key findings and developments from the Countryside Survey 2007 field survey Journal of Environmental Management, 113, 117-127.

UK NEA (2011) The UK national ecosystem assessment. UNEP-WCMC, Cambridge.