# Habitat Map of Wales resurvey pilot – field survey

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# 1.Crynodeb Gweithredol

Mae'r map cyfredol o Gynefinoedd Cymru, sy'n seiliedig ar arolwg maes cynhwysfawr, bellach rhwng 25 a 43 oed ac felly mae'n gynyddol anghywir. Credir nad yw mapio cynefinoedd trwy ddefnyddio dull synhwyro o bell awtomataidd a dehongli ffotograffau o'r awyr yn rhoi gwybodaeth gywir ar gyfer rhai cynefinoedd. Mae CNC yn dymuno datblygu methodoleg a fydd yn ail-fapio cynefinoedd Cymru yn y ffordd fwyaf effeithlon ac effeithiol gan ddefnyddio cyfuniad o ddata synhwyro o bell a data maes..

Bwriad y contract cyfredol oedd casglu data maes o ardaloedd dethol. Bydd contract ar wahân yn cymharu'r canlyniadau â data synhwyro o bell i benderfynu pa dechnegau y gellir eu defnyddio'n ddibynadwy i asesu pa gynefinoedd. Mae'r contract hwn hefyd yn rhoi brasamcan o'r adnoddau sydd eu hangen i ymgymryd ag elfennau maes ail-fapio.

Roedd y prosiect yn cynnwys cynnal arolwg maes Cam 1 sampl o 30 tetrad (sgwariau 2 x 2 km) yn Sir Gaerfyrddin a Chastell-nedd Port Talbot, treialu mapio digidol yn y maes ar gyfrifiadur llechen, er mwyn galluogi datblygu dull hybrid o ail-fapio cynefinoedd Cymru yn y dyfodol, gan ddefnyddio arolygon maes a synhwyro o bell. Prif ganlyniadau'r prosiect yw:

- Haen ddigidol o gynefinoedd Cam 1 ar gyfer pob un o'r 30 tetrad.
- Haen ddigidol o'r llystyfiant "gwasgaredig" ar gyfer pob un o'r 30 tetrad.
- Map arolwg digidol o wrychoedd ar gyfer 10 o'r tetradau.
- Haen ddigidol o unrhyw Gynefinoedd Blaenoriaeth sydd heb eu mapio o'r blaen (a gynhyrchwyd fel rhestr) ar gyfer pob un o'r 30 tetrad.

Roedd y defnydd o setiau data oedd yn bodoli cyn yr arolwg i nodi ardaloedd "eithriedig" lle nad oes angen arolwg yn effeithiol iawn ac yn lleihau ymdrech yr arolwg.

Roedd cynnal arolwg Cam 1 ar gyfrifiadur 'llechen' wedi'i lwytho â haenau OSMM addasedig yn ddull cyflym ac effeithiol o fapio cynefinoedd. Yn ystod yr arolwg, ni chododd unrhyw faterion difrifol o ran defnyddio llechen ar gyfer mapio maes. Fodd bynnag, nodir rhai problemau yn y casgliadau (adran 8).

Mae angen i unrhyw ddyfeisiau digidol wrthsefyll gwlybaniaeth yn llwyr, a rhaid cael sgrin mor fawr ag sydd bosibl i hwyluso edrych ar ddelweddau o'r awyr a bod yn weladwy mewn golau llachar. Mae oes batri hir neu'r gallu i ailwefru yn y maes yn hanfodol.

Roedd cynnwys mapio gwrychoedd yn golygu cynnydd sylweddol o ran amser ac ymdrech wrth arolygu. Yn y mwyafrif o achosion, roedd yn bosibl neilltuo gwrych yn fanwl i'w gategori cywir gan ddefnyddio delweddau o'r awyr, ond gall rhai ffensys a chloddiau pridd achosi anawsterau wrth fapio.

# 2. Executive summary

The existing Habitat Map of Wales, based on comprehensive field survey, is now between 25 and 43 years old and therefore increasingly inaccurate. Habitat mapping by automated remote sensing and aerial photograph interpretation are thought not to provide accurate information for some habitats. NRW wishes to develop a methodology that will most efficiently and effectively remap the habitats of Wales using a combination of remote-sensed and field data.

The present contract was intended to collect field-based data from selected areas. A separate contract will compare the results with remote-sensed data to determine which techniques can reliably be used to assess which habitats. This contract also provides estimates of the resources required to undertake the field elements of remapping.

The contract involved undertaking a sample Phase 1 field survey of 30 tetrads (2 x 2 km squares) in Carmarthenshire and Neath Port Talbot, trialling in-the-field digital mapping on a tablet computer, to enable the development of a future hybrid approach to re-mapping the habitats of Wales, utilizing both field survey and remote sensing. The primary outputs of this current work are:

- A digitised layer of the Phase 1 habitats for each of the 30 tetrads.
- A digitised layer of the "scattered" vegetation for each of the 30 tetrads.
- A digitised hedgerow survey map for 10 of the tetrads.
- A digitised layer of any previously unmapped Priority Habitats (produced as a list) for each of the 30 tetrads.

The use of existing datasets prior to survey to mark off "excluded" areas where survey is not required proved very effective in reducing survey effort.

Undertaking a Phase 1 survey on a tablet computer loaded with adapted Ordnance Survey MasterMap GIS layers proved to be a quick and effective method of habitat mapping. During the survey, no serious issues arose with regard to the use of a tablet for field mapping. However, some issues are noted in the conclusions (Section 8).

Any digital devices need to be fully waterproof, have as large a screen as possible to aid in viewing aerial imagery, and be viewable in bright light. Long battery life or a means of recharging in the field are essential.

The inclusion of hedgerow mapping involved a considerable increase in survey time and effort. In the majority of cases, it was possible to accurately assign a hedge to its correct category from aerial imagery but some fences and earth banks can cause mapping difficulties.

# 3. Introduction

Wales is unique in Europe in having comprehensive, ground-truthed (Phase 1) habitat data at a field parcel level for the whole country (Habitat Map of Wales; Blackstock et al, 2010). This data was collected from two ground-based field surveys: the Upland Survey (covering 20% of Wales) from 1979 to 1986, and the Lowland Survey from 1987 to 1997.

The existing Habitat Map of Wales is now between 25 and 43 years old and is, therefore, becoming increasingly inaccurate. Habitat mapping by automated remote sensing and aerial photograph interpretation are thought to not provide accurate information for many habitats, especially grasslands, which cover 62% of Wales. Remote sensing capability is continually improving but often suffers from insufficient ground truthing. It has been more effective at mapping broader 'land cover' classes, but issues can arise when a higher level of detail is needed.

Aerial photograph interpretation has also been utilised in habitat mapping (e.g. in Neath Port Talbot: Environment Systems, 2021). However, as with other forms of remote sensing, experience suggests that grasslands, particularly dry grasslands, present particular issues with accuracy without ground truthing. The efficacy of remote sensing for habitat mapping requires further investigation, noting recent advances.

Due to the increasing age of the existing Habitat Map of Wales, NRW wishes to develop a methodology that will most efficiently and effectively remap the habitats of Wales using a combination of remote-sensed and field data.

The present pilot project is intended to collect the data that will allow NRW to determine which remote sensing techniques can reliably be used to assess which habitats. The pilot also provides estimates of the resources required to undertake the field elements of remapping. A separate contract will compare the results of the field-based data collected in this project with remote sensed data.

The pilot involves undertaking a sample Phase 1 field survey to enable the development of a future hybrid approach (utilizing both field survey and remote sensing) to remap the habitats of Wales. The work involved undertaking a sample Phase 1 field survey of 30 tetrads (2 x 2 km squares), trialling in-the-field digital mapping, to enable the development of a future hybrid approach (utilizing both field survey and remote sensing) to re-mapping the habitats of Wales.

The data collected during fieldwork will contribute to the overall project aims to:

- Provide an estimate of change on the ground between now and the original Phase I survey (Blackstock et al, 2010).

- Enable an assessment of the accuracy of remote-sensed habitat maps produced by Living Wales (Lucas et al, 2011) and Neath Port Talbot (Environment Systems, 2021).

- Confirm the efficiency and efficacy of corrections to existing upland data using available remote-sensed data and sample ground-truthing.

- Provide resource estimates for the field survey element of resurvey.

- Enable the extent and distribution of terrestrial 'priority habitats', as listed under the Environment (Wales) Act 2016, to be re-evaluated.

# 4. Methods

This contract involves undertaking a sample Phase 1 field survey (JNCC, 2016) of 15 tetrads in Carmarthenshire and a further 15 in Neath Port Talbot. Tetrad locations were provided by NRW prior to survey work beginning. The aim is to enable the development of a future hybrid approach (utilizing both field and remote sensing) to remap the habitats of Wales. The project involved:

- Initial collation of data and information to inform the field survey (see 4.1)

- Developing a field mapping system for use on a tablet computer

- Fieldwork to survey a sample of 30 tetrads at Phase 1 level

- Mapping and categorising the hedgerows within 10 tetrads

- Time recording/analysis of resource requirements

Survey work followed the standard Phase 1 methodology (Handbook for Phase 1 habitat survey (jncc.gov.uk)), with minor modifications to the habitat definitions applied during the original Welsh Phase 1 survey. Mapping was undertaken on a 1:10 000 scale OS backdrop, using Google and Bing aerial overlays to aid mapping.

Dominant species codes were recorded for semi-natural vegetation (see Phase 1 Handbook), except for woodland. The dominant species in improved grasslands (Phase 1 code B.4) were noted using the standard species codes (e.g. Lp: *Lolium perenne*) or a single letter "O" code where the grassland was improved but dominated by grasses other than perennial rye-grass *Lolium perenne*.

In 10 of the tetrads, the presence of hedges was recorded to allow an assessment of the time element this would require on a wider scale. Hedges were coded into one of three simple categories, 'intact', 'gappy' or 'relict', as defined by NRW prior to survey.

Scattered habitats were recorded onto a separate "scattered" layer as points, their density and distribution giving a representation of the density and distribution of the scattered habitat in question.

Target notes were required only if new areas of priority habitats were identified that weren't recorded on the original Phase 1 survey.

# 4.1 Survey preparation

In order to reduce the area to be surveyed on the ground the following datasets (provided by NRW or available on the "Lle" Geo-Portal developed as a partnership between Welsh Government and NRW) were loaded into QGIS and used to identify those areas of land that could be excluded from field survey due to the availability of other good data sources (see below). This included all areas mapped under the following categories:

- Urban and built land (c.7% Wales land cover) from OS Master Map,

- Arable and temporary grasslands from WG annual returns (c.10% land cover),

- Existing woodland (c.14% land cover) from the National Forest Inventory,

- Recently surveyed sites from NRWs Phase 2 (NVC) databases (approximately 25% of uplands and up to 5% of lowlands).

The following datasets were used to assist and speed up field survey work:

- The original Phase 1 Habitat Map of Wales survey maps (to help identify key areas/habitats)

- Map of deep peat (to help distinguish areas of bog and fen from wet heath, marshy grassland and flush)

## 4.2 Setting up a tablet for field mapping

All of the above layers were added to a QGIS "project" on a laptop computer. This QGIS project also incorporated layers for recording the main Phase 1 habitat polygons, the "scattered" Phase 1 habitats, any target notes and a final layer for hedgerow recording.

The "Phase1 veg" and "Phase1 scattered" layers provided by NRW were adapted to create drop-down lists of Phase 1 habitat codes and dominant species codes, to allow rapid data entry in the field. The "Phase1 veg" layer was based upon the Ordnance Survey Master Map OSMM, allowing polygons to be very simply selected and coded with the appropriate Phase 1 code.

The "Hedgerow" layer was similarly adapted to create a drop-down list of the three hedgerow categories.

The project did not allow sufficient time to create anything more than a very simple target note layer and therefore, just basic target note information was collected (see section 8).

After building the "project" in QGIS it was loaded onto a Samsung Galaxy Active tab3 android tablet computer running "Qfield", mobile data capture software linked to QGIS. This involved manipulation of the shapefiles provided by NRW, field testing and subsequent adjustments and improvements. Where more than one habitat was present in a single polygon, Qfield has good functionality including allowing "holes" to be cut in polygons or to be split into as many parts as required.

# 5. Fieldwork

## 5.1.    Phase 1 habitat survey

The method of Phase 1 survey as set out in the Handbook for Phase 1 habitat survey was followed. Where possible, each parcel of land in the survey area was visited and the vegetation was mapped onto the digital OSMM at a scale of 1:10,000. However, where land parcels were inaccessible or ownership could not be established, mapping was carried out from roads and public rights of way, using binoculars at relatively short ranges to identify the vegetation where this was possible. Where this was not possible, the area was mapped as "NA" (Not Accessed). Aerial imagery was also used to inform the survey. Each parcel was assigned a Phase 1 habitat code or was split into separate polygons where more than one habitat was present. Built-up areas and land around houses and other buildings (gardens, farmyards etc) were generally left out of the survey and marked as "NA".

## 5.2.    Hedgerow survey

Hedgerows were recorded in ten sample tetrads. In the majority of cases, it was found to be possible to accurately assign a hedge to its correct category (relict, gappy or continuous) from aerial imagery. Therefore, it was decided to map as many hedges as possible in each of the ten tetrads from aerial imagery and to field map only those hedges that it was not possible to confidently assign to one of the three categories. However, in some cases fence lines can be mistaken for hedges and very heavily trimmed hedges are difficult to differentiate from earth banks with a growth of bracken, bramble or other coarse vegetation. This allowed mapping to be carried out rapidly in the office, with the accuracy of the desk-based mapping ground-truthed later in the field. Any corrections were then made in the field, as required. See also section 7.

# 6. Time recording

Table 1 Survey elements and times

| Survey Element | Summary of work | Number of days | Comments |
|---|---|---|---|
| **Survey Preparation** | Building a "project" in QGIS and enabling it for Qfield, the linked mobile data capture software, involving manipulation of the shapefiles provided by NRW, field testing and subsequent adjustments and improvements | 3 | This element would only need to be undertaken once for a survey to be carried out |

| Survey Element | Summary of work | Number of days | Comments |
|---|---|---|---|
| **Fieldwork (Phase 1 Survey** | Phase 1 survey of 30 tetrads | 43 | |
| **Hedgerow survey** | Hedgerow survey -assessment of the condition of the hedges in 10 tetrads | 6.5 days. (4 days office, 2.5 days fieldwork) | The hedge survey was undertaken using the methods described in section 5.2 above - i.e. most hedges were mapped using aerial imagery with any that could not confidently be categorised checked in the field |
| **Post survey data editing and checking** | Checking 30 tetrads for errors in field mapping, gaps, overlaps, duplicates, missed polygons and creating further polygon splits not done during fieldwork. Adding more detail to the "scattered" layer to better represent the distribution of scattered habitats (based on aerial images) | 8 | Whilst drop-down lists were useful and allowed rapid in-the-field data entry, sometimes the incorrect habitat code/species code was entered by mistake. Some fine-scale polygons adjustments were easier to make post-survey on the larger screen of a desktop computer running QGIS |
| Target Notes | This work was done whilst undertaking Phase 1 habitat mapping | Included within fieldwork above | In order to map all target notes to include all NRW required information is likely to take approximately 3-5 minutes per target note |

# 7. Results

**Phase 1 survey map.** A digitised Phase 1 survey map (Shapefile) was produced in the field for each of the 30 tetrads. This included 4485 separate polygons; approximately half of these were B.4 improved grassland.

**Scattered layer.** A digitised "scattered" vegetation survey map (Shapefile) was produced in the field (with further data points added in the office) for each of the 30 tetrads. This included 13341 separate points. The most commonly recorded scattered habitats were A.2.2 scrub and C.1.2 bracken with small amounts of E.2.1 acid flush and D.1.1 dry heath.

**Hedgerow layer.** A digitised hedgerow survey map (Shapefile) was produced for 10 tetrads. This included 3355 separate polylines 160 of which were categorised as relict, 252 as gappy and 3143 as continuous.

**Target note layer.** A digitised target note survey map (Shapefile) was produced in the field for each of the 30 tetrads. This included 46 separate points. This represents 42 new areas of B.5 marshy grassland and 4 new areas of B.2.1 of unimproved neutral grassland found since the original Phase 1 survey. Most of the "new" marshy grassland occurs in small stands in areas previously mapped as B.4 improved grassland or B.2.2 semi-improved grassland. The 4 areas of unimproved neutral grassland are in church or chapel burial grounds. One of these was previously mapped as B.2.2, the remaining 3 had not been surveyed previously.

# 8. Conclusions

This section analyses the practicalities, difficulties and advantages/disadvantages of various aspects of the project.

**Using datasets to reduce survey effort.** Time in the office spent loading the several datasets mentioned earlier – those to mark off "excluded" areas where survey was not required and those helpful in reducing survey effort – proved very worthwhile and indeed the excluded areas are vital. Being able to switch the original Phase 1 survey map on and off was also extremely useful (particularly to help confirm habitat type when scanning habitats from some distance). This can save a long walk to check a stand of scrub, bracken of similar. It was noticeable, however, that substantial parts of the original Phase 1 map were unreliable and that it is therefore best used only to help confirm a surveyor's thoughts in limited situations.

**Mapping directly onto digital devices in the field.** Mapping directly in the field onto a tablet computer with the OSMM base map was generally easy and very quick. Entering the data for each polygon took a similar amount of time as it would to mark up a paper map but without the need to later digitise these. The use of standardised drop-down lists in GIS attribute tables avoided the need for repetitive typing of Phase 1 habitat and dominant species codes. Any digital devices need to be fully waterproof, have as large a screen as possible to aid in viewing aerial imagery and be viewable in bright light. Long battery life or a means of recharging in the field are essential.

Mapping directly onto a tablet computer in the field was generally considered to be an efficient method of mapping. However, the following issues did arise:

1. It is easy to make an incorrect selection from the drop-down habitat or species codes lists. This led to some additional post-survey work to split multiple polygons and delete duplicates.

2. Where several parcels of land contain the same habitats and dominant species, mapping can be speeded-up by selecting multiple polygons and applying the same attributes to them. During this process, it is easy to accidentally select unwanted polygons.

Data was backed up onto a laptop immediately at the end of each survey day, but no data losses occurred on the tablet. The screen proved to be bright enough but, in direct sunshine, it was better to use the surveyor's head (or the shade of a tree or other object) to see the screen more clearly. The weather was generally hot and dry and working in wet weather was not tested. The surveyor is of the view that it would be no more difficult to use a waterproof tablet in the rain (possibly with a weather writer as well) than it is using paper maps!

There are several advantages to direct, in-the-field mapping on a tablet computer:

- Drop-down lists of habitat and dominant species codes allow rapid data entry.

- Polygons are pre-drawn and can be rapidly coded modified or split in the field.

- Once fieldwork is complete, the digital maps just need to be loaded into GIS software on a computer for final checking whereas paper maps would need to be digitised from scratch requiring considerable further time.

- A large volume of paper maps would need to be printed and carried on a day's survey.

- Paper maps can be easily blown away or become illegible in rain.

Photographs were taken directly using the tablet's in-built camera and notes were entered into a Microsoft Word document. In future monitoring, it may be useful to create a dedicated layer in which geo-referenced photographs can be stored.

**Phase 1 survey in the lowlands (without hedges).** This was generally straightforward and data entry in the field was rapid (particularly for polygons where a single habitat type was present). For example, the typical data entry time for an improved grassland polygon was around 20 seconds to enter the Phase 1 habitat and dominant species codes. Where more than one habitat was present in a polygon, there was a need to split the polygon. This was usually straightforward (though more time-consuming) but occasionally some polygons would not split. These were later split in the full version of QGIS – often there were problems with the geometry of such polygons which needed repair or re-digitisation. It took approximately 1.4 days per tetrad to map the Phase 1 habitats without mapping any hedges.

**Field survey - hedgerows.** Very early on in the survey it was noticed that mapping the hedges involved a considerable increase in time and effort. On average, mapping each hedge around a field took twice as long as it did to map a straightforward (single habitat) field. This suggests that mapping every hedge could have very large implications for the time required for surveying. Furthermore, many sections of hedgerow are broken up in OSMM into separate "polylines" and, therefore, many or most fields have more than four "hedges" to digitise. Often, the need to see each hedge means that every field must be physically accessed, whereas to just map the habitat, it is sufficient, in many instances, to just view the field from the gateway.

Following the first day of field mapping the hedges, the surveyor spent time looking at the hedges that had been surveyed that day on aerial imagery. In almost every case it was found to be possible to accurately assign a hedge to its correct category (relict, gappy or continuous) from aerial imagery. Uncertainties could be reduced by running both google and Bing maps at the same time and flicking between them. Close attention to the shadows cast by hedges on aerial images is also informative. The desktop-based, full version of QGIS has a Google "Street View" plugin that, with a single click, allows the user to view the street view images for that location at any point along a road. As well as being useful for recording roadside hedges, Street View allows the user a 360-degree view of the surrounding land in most places. The extent and quality of these images are perfectly sufficient to categorise the hedges.

These issues were raised with NRW during a mid-project meeting, and it was agreed that the best way forward was to map as many hedges as possible in each of the ten tetrads from aerial imagery and to field map only those that then remained doubtful. This allows mapping to be carried out rapidly in the office, with the accuracy of the desk-based mapping ground-truthed later in the field. Any required corrections can then be made in the field as required. This approach led to considerable time savings, with all of the hedges in the ten tetrads being mapped in just 6.5 days (4 days office, 2.5 days fieldwork). It is estimated that field mapping all of the hedges might approximately double the survey time.

**Phase 1 survey in the uplands.** This followed the same procedures as the lowland survey. Data entry could be rapid (where large homogenous polygons were present) but ascertaining the habitat within a large polygon could be time-consuming due to the extent of the area. Access was easy due to most of the upland areas being open-access land. Aerial imagery was especially useful in the uplands to help identify variations in the habitats and the location of habitat boundaries. For example, large stands of bracken or scrub are easily demarcated from aerial imagery with the need only for a view through binoculars for confirmation. In some upland areas, large polygons containing mosaics of habitats were encountered, making mapping difficult (especially where the mosaics are fine-grained and not clearly visible/identifiable from aerial imagery).

**Target notes.** Each target note is normally mapped as a point on a map with a unique target note number and with the following information.

1. Surveyor's name
2. Date of survey
3. Map sheet and target note number, using a 'P' prefix e.g. SN56SEP003, SJ12NWP007
4. Unitary Authority
5. Six-figure grid reference of target dot.

6. Habitats present − use Phase I major habitat group names e.g. Grassland, Coastland, Heathland.
7. Inspection code for site:
    a. seen from a distance
    b. seen from edge
    c. quick walk through
    d. detailed inspection
8. Detail of target note which should include the following:
    a) A brief pen−picture of the site − aspect, position, general vegetation.
    b) Short paragraph on each Phase I type found, including species names of dominants or species that identify the Phase I habitat, with an indication of abundance and cover. Note the NVC community if possible.
    c) Any rare or uncommon species
    d) A short sentence on the management, noting management features, e.g. grazed, hay ditched.

Due to time limitations, it was not possible to collect all of this information during the present survey. It was only possible to record grid reference, Phase 1 habitats and a brief note of dominant species. No drop-down habitat codes list was created for this layer which perhaps slowed data entry.

To be able to collect target note information in an efficient manner, a dedicated target note layer is required.  The following fields can be created so that they can be populated from drop-down lists.

- Surveyor's name

- Date of survey

- Unitary Authority

- Six fig grid ref (auto generated or auto filed in on desktop, depending of software available)

- Habitats present − use Phase I major habitat group names

- Inspection code for site

It would not be possible to complete the remaining required target note data from drop down lists and these would need to be hand typed.

- Map sheet and target note number

- Detail of target note

It may be worth also considering enabling the layer to support geo-referenced photographs.

However, it is worth bearing in mind that the target note layer can, as it is used only to identify new areas of Priority Habitats, be populated perhaps more efficiently in the office, post-survey by comparing the new survey map with the original Phase 1 map.

**Scattered vegetation.** Completing the scattered layer in the field was time-consuming. Early on in the survey, it was decided to map just a few representative points in any polygon where scattered habitats occurred. Adding more detail to the "scattered" layer back in the office was far easier and is likely to better represent the actual distribution of scattered habitats when based on recent aerial images – it would be both difficult and very time-consuming to attempt to field map the distribution of, for example, habitats such as scrub and bracken.

**Changes since the original Phase 1 survey.** No proper analysis was made by the surveyor of change since the original survey, but the impression gained in surveying these 30 tetrads was that there have been reductions in the extent of marshy grassland in particular. Field observations and historical aerial imagery suggest this has been through drainage and mowing, ploughing and re-seeding. This is a process that continues - an area of very recently destroyed marshy grassland was observed just outside of one of the tetrads. A similar impression was gained with regard to semi-improved acid grassland which was often found to now be a better fit for improved grassland.

**Aerial imagery.** NRW were not able to provide an up-to-date aerial image layer suitable for use in the field as the map identified for use cannot be split into smaller parts just covering the tetrads. This led to the surveyor having to use "live" Google and Bing images pulled from the internet whilst in the field. Surprisingly, the need for internet access was not a constraint as Qfield appears to store the imagery viewed whilst connected to the internet until the application is closed or the tablet is shut down. Therefore, before setting off on a day's survey, the surveyor viewed all required aerial imagery whilst in good internet signal. Having both Google and Bing aerial imagery was very useful as both have advantages and disadvantages with regard to viewing different habitats.

**Equipment.** In order to carry out the survey, it was found that all the surveyor needed to carry was personal equipment (waterproof clothing, first aid kit, food etc), binoculars and a mobile tablet device. Spreadsheets of the Phase 1 habitat codes and dominant species codes were loaded onto the tablet as an aide memoir. Similarly, the JNCC Phase 1 survey handbook was also loaded onto the tablet. These were added as desktop shortcuts for easy access. A camera is not required if the tablet has an in-built camera. Any digital devices need to be fully waterproof, have as large a screen as possible to aid in viewing aerial imagery, and be viewable in bright light. Long battery life (or a means of charging) in the field is essential. The Samsung tablet used in this project had handwriting recognition software that was found to be very accurate and which did not require an internet connection. This facility made data entry and note-taking quick and easy.

**Access.** In some areas, access was not easy for a variety of reasons. Footpaths marked on OS maps are often either blocked or lost, landowners are often not home, and, in many places, security cameras and locked gates make approaching properties problematic. In other places, a lone surveyor could be at risk without being able to make prior contact with landowner/occupiers.

# 9. Acknowledgements

Thanks are due to Stuart Smith, Jonathan Rothwell, Clare Burrows, John Ratcliffe, Kathryn Birch and Dave Reed, all of Natural Resources Wales.

# References

Blackstock TH, Howe EA, Stevens JP, Burrows CR, Jones PS. 2010. Habitats of Wales – a comprehensive field survey, 1979–1997. Cardiff: University of Wales Press.

# Appendices

# Appendix 1 Hedgerow recording and definitions

**Recording Hedgerows**
Hedgerow definition: A hedgerow is defined as any boundary line of trees or shrubs over 20m long and less than 5m wide between major woody stems at the base, provided that at one time the trees or shrubs were more or less continuous. It includes an earth bank or wall only where such a feature occurs in association with a line of trees or shrubs. This definition includes 'classic' shrubby hedgerows, lines of trees, shrubby hedgerows with trees, and the gappy 'remains' of hedgerows.
Record the presence of a hedgerow by attributing a boundary line with one of 3 classes. These classes provide information on the continuity of canopy along hedgerows and involve roughly estimating the total length of gaps present as a percentage of the total hedgerow length.
If a hedgerow stops along the boundary length and becomes a wall or other traditional boundary, reduce the length of the boundary line to reflect the hedgerow length.
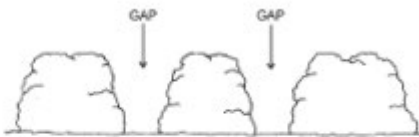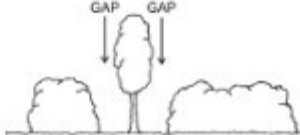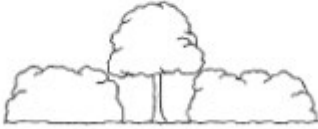Record in 3 classes of canopy continuity:
**Continuous**: 100 to 90% (10% or less of the hedge length is made up of gaps)
**Gappy**: 89 to 40% (more than 10% and less than 60% of the length is made up of gaps)
**Relict**: Less than 40% (more than 60% of the length is made up of gaps)

Definition of gaps:

| | |
|---|---|
| a) Complete breaks in the shrub canopy are considered as gaps. This applies even if the gaps are <1m (view facing hedgerow). |  |
| b) These are considered to be gaps as there are complete breaks in the tree/shrub canopy and the hedgerow (even if the gaps are <1m (view facing hedgerow). |  |
| c) There are no gaps as the tree canopy overlaps the hedgerow canopy (view facing hedgerow). |  |

(Clare Burrows, 23rd June 2022)


# Data Archive Appendix

GIS data outputs associated with this project are archived in **X: Biological > Phase 1 Habitat Mapping > Phase 1 Terrestrial > Resurvey Pilot 2022**.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record number: **NRW_DS125454**

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