High Nature Value Farmland in Wales:
East Carmarthenshire Case Study Report

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Cover photo and above: The Twrch valley in the NW of the study area illustrates both the main types of HNV farmland in the area – upland and poorly-drained lowland

Executive Summary

The High Nature Value farming concept comes from a recognition that certain patterns of farming and of farmland are inherently of high biological richness, especially landscapes that contain a significant proportion of farmland in a semi-natural condition (e.g. unimproved pastures and hay-meadows, grazed woodland, traditional orchards).

On HNV farmland, the basic conditions that create and sustain high biodiversity values are already present. Maintaining these existing values should be a high priority for nature conservation strategies and for farming and landuse policies that aim to integrate biodiversity concerns. A large part of the challenge for maintaining these values is to address the economic difficulties of farming on agriculturally unimproved land. In policy terms, this is a very different challenge from paying incentives to improve biodiversity on intensively farmed land.

EU documents define High Nature Value (HNV) farmland as agricultural land with high species or habitat diversity or which supports a significant population of species of conservation concern. It is a major focus of EU Rural Development policy, being set as a priority for Axis 2 in the Community Strategic Guidelines. It is one of the Common Monitoring and Evaluation Framework indicators; Member States have to provide the European Commission (EC) with a baseline figure of HNV farmland and assess quantitative and qualitative change over the lifetime of their Rural Development Programme (RDP), as well as the impact of the RDP itself.

Guidance from the EC states that since HNV farming is a complex interaction between the land itself and particular farming systems and practices these different aspects should be incorporated in the final basket of information which should make up the national indicator. Nature value also operates at a range of scales, from patch and field through to landscape; monitoring should take account of these scale questions.

Wales has not as yet completed development a HNV farmland indicator, although work is now in progress. This project aimed to investigate a range of datasets to assess their suitability for use in HNV farmland identification and monitoring. East Carmarthenshire has a range of geological, soil, topographical and socio-economic conditions and was chosen as a test area.

Semi-natural vegetation is central to the HNV farmland concept. The Habitat Inventory of Wales (HIW), which is reaching completion, was tested on a range of field sites and found in general to be a reliable mapping tool for such vegetation, with the greatest inaccuracies on small fields with tall hedges. Given this apparent reliability, the project found that the use of additional datasets to make up for habitat mapping deficiencies would be necessary only in a narrow range of circumstances. They are however essential to indicate the presence of Type 3 HNV farmland, which is not dependent on semi-natural vegetation. The project did not however find any such dataset for the project region.

At the landscape scale, the CCW Habitat Networks mapping project provides a very interesting approach. It is essential that ways to strengthen its applicability to policy delivery are investigated and developed urgently, particularly in the context of the next CAP programming period.

At the farm scale, the amount of useful data already stored in the CAP Land Parcel Information System (LPIS) data was investigated. Potentially this data base can be used for identifying farmland with HNV-relevant characteristics, such as small field size. A draft farm-scale decision tree for

identifying potentially HNV farming systems has been proposed and needs field testing with real farm data.

Overall, the project suggests there is considerable scope for developing an effective and sufficiently accurate system for identifying HNV farmland in Wales, through integration of existing data bases. HIW would be the core of such a system. A degree of integration of HIW with LPIS would allow considerable enrichment of the latter policy management tool, and potentially more complete HNV farmland identification. Such a system would also provide the basis for effective monitoring of HNV farmland, although complementary methods such as use of Countryside Survey or a stand-alone sample survey system should also be considered.

The project also considered the extent to which existing policies are effective in supporting the maintenance of HNV farmland in the case study area. This assessment was informed partly by a series of farmer interviews.

Outside protected areas, conservation of HNV farming currently depends mainly on the application of instruments within the CAP, notably agri-environment schemes. These instruments, however, do not appear to be well targeted at high nature value farmland areas. Within this study HNV farming areas and in particular smaller holdings get relatively little recognition and financial incentive and where semi-natural land was seen to be managed in favourable condition, personal motivation and a sound knowledge in extensive farming was a key factor. The low financial incentive to join agri-environment schemes is partly as a result of the EU regulatory requirements that agri-environment payments can only be made for cost incurred and income foregone. This is most apparent on smaller farms with a high dominance of high nature value land, where there is a lack of financial recognition for existing habitats (existing environmental goods and services). There are particular problems associated with managing small fields, especially the control of scrub and bracken encroachment, which agri-environment schemes often are not able to address effectively.

Given the considerable achievements of grant schemes for capital works, and in order to support HNV farmland wherever it occurs, financial support needs to go beyond what has developed to be the 'traditional' scope of agri-environment schemes, for example, offering support to those who are not strictly farmers but none the less are landowners managing their land to conserve and enhance its biodiversity, and as a result are ensuring the delivery of the ecosystem services that HNV farmland can provide.

It is widely recognised that a proportion of HNV farmland lies outside management by agri-environment schemes or of designated sites. There are also farms and landowners that are not part of whole farm schemes for a variety of reasons.

There are also issues with Pillar 1 that work against the maintenance of HNV farmland. The fact that scrub habitat is excluded for eligibility under the SPS causes considerable problems. There is a confused message from government to landowners, in that scrub is valued under one payment scheme (agri-environment) and disregarded and liable to penalty if not declared as ineligible for payment under another (SPS). This could be avoided if scrub vegetation was reconsidered to be included eligible for SPS. Pillar 1 rules to limit the decline of permanent pasture are ineffective at protecting semi-natural grasslands for a variety of reasons.

Crynodeb

Daw'r syniad o ffermio o Gryn Werth i Natur (CWN) yn sgil sylwi bod rhai mathau o amaethu ac o ffermdir yn cynnal toreth o fywyd gwyllt; yn enwedig cefn gwlad sydd â chyfran helaeth o ffermdir lled-naturiol (h.y. porfeydd a gweirgloddiau heb eu gwella, coetiroedd pori a pherllannau traddodiadol).

Ar ffermdir CWN, mae'r amodau sy'n creu a chynnal bioamrywiaeth sylweddol eisoes yn bresennol. Dylai cynnal y gwerth cynhenid hwn fod yn flaenoriaeth nid yn unig i strategaethau cadwraeth natur ond hefyd i unrhyw bolisïau amaeth a defnydd tir sy'n ceisio cynnwys ystyriaethau bioamrywiaeth. Mae sut i wella sefyllfa economaidd anodd ffermwyr ar dir heb ei wella yn elfen bwysig o'r her i ddiogelu'r gwerthoedd hyn. O ran polisi, mae hon yn her go wahanol o'i chymharu â thalu'r rhai sy'n amaethu'n ddwys i wella bioamrywiaeth eu fferm.

Yn ôl dogfennau'r UE, yr hyn sy'n diffinio ffermdir CWN yw amrywiaeth sylweddol o rywogaethau a chynefinoedd, neu boblogaeth sylweddol o rywogaethau sy'n destun pryder o safbwynt eu gwarchod. Mae polisi Datblygu Gwledig yr UE yn rhoi cryn sylw i ffermdir o'r fath - yn wir, mae'n flaenoriaeth i Echel 2 yn ôl Canllawiau Strategol y Gymuned. Mae'n un o'r dangosyddion yn y Fframwaith Monitro a Gwerthuso Cyffredin; rhaid i Aelodau'r UE ddarparu gwerth 'sylfaen' eu ffermdir CWN yn ogystal ag asesu'r newid mewn arwynebedd ac ansawdd dros oes eu Rhaglen Datblygu Gwledig (RhDG), ac effaith penodol y RhDG yn y newid.

Gan fod ffermio CWN yn cymhathu'r tir ac arferion a systemau amaethu penodol, mae cyngor yr UE yn nodi'n glir y dylid cynnwys yr holl wahanol agweddau hyn yn y 'fasged' wybodaeth derfynol, sef y dangosydd cenedlaethol. I gael darlun cyflawn, rhaid mesur gwerth naturiol ar nifer o raddfeydd, o'r llain i'r dirwedd, a dylai'r cynllun monitro eu hystyried i gyd.

Nid yw Cymru wedi gorffen y gwaith o ddatblygu dangosydd ffermdir CWN, ond ei fod ar y gweill. Nod y prosiect yw edrych ar nifer o setiau data er mwyn asesu eu haddasrwydd ar gyfer y gwaith o adnabod a monitro ffermdir CWN. Dewiswyd dwyrain Sir Gaerfyrddin fel yr ardal brawf ar sail ei hamrywiaeth ddaearegol, o ran pridd a siâp y tir ac amodau economaidd-gymdeithasol.

Mae tyfiant lled-naturiol yn un o nodweddion hollbwysig ffermdir CWN. Rhoddwyd Rhestr Cynefinoedd Cymru, sydd bron yn barod, ar brawf mewn nifer o ardaloedd ac, ar y cyfan, gwelwyd ei bod yn ffordd ddibynadwy o fapio llystyfiant o'r fath. Cafwyd y camfapio gwaetha lle 'roedd caeau bach a chloddiau uchel. O ystyried pa mor ddibynadwy oedd y Rhestr, prin y byddai'n rhaid troi at ffynonellau eraill i lenwi bylchau. Serch hynny, byddai'n rhaid wrth setiau data ychwanegol i ganfod ffermdir CWN Math 3 nad yw'n ddibynnol ar lystyfiant lled-naturiol. Ond ni chafwyd unrhyw set ddata gyffelyb yn ardal y prosiect.

Ar raddfa'r tirwedd, mae dull prosiect mapio Rhwydweithiau Cynefinoedd y Cyngor Cefn Gwlad yn un hynod ddiddorol. Mae'n hollbwysig mynd ati ar frys i wneud yn siŵr ei fod yn addas i ddylanwadu ar sut mae polisïau'n cael eu datblygu a'u rhoi ar waith, yn enwedig yng nghyd-destun y newid sydd ohoni yn y Polisi Amaethyddol Cyffredinol (PAC).

O ran y fferm, edrychwyd ar y wybodaeth ddefnyddiol sydd eisoes yn cael ei chadw ar System Adnabod Parseli Tir (SAPT) y PAC. Gallai'r gronfa ddata hon fod yn ddefnyddiol i fesur o leia *rai* o nodweddion CWN – caeau bach, er enghraifft. Lluniwyd drafft o allwedd ddeubarthol er mwyn nabod ffermydd â systemau amaethu sy'n debygol o fod yn rhai CWN a dylid ei phrofi gan ddefnyddio data o ffermydd iawn.

Ar y cyfan, mae'r prosiect yn awgrymu y gellid datblygu system sy'n ddigon effeithiol a chywir i adnabod ffermdir CWN yng Nghymru trwy ddod ynghyd â gwybodaeth o wahanol ffynonellau - y Rhestr fyddai craidd system o'r fath. Byddai integreiddio'r Rhestr a'r SAPT yn cyfoethogi'r System Adnabod yn aruthrol fel arf rheoli polisi ac fel modd o wella sut mae ffermdir CWN yn cael ei adnabod. Gyda system o'r fath, gellid monitro ffermdir CWN yn dra effeithiol, er y dylid ystyried defnyddio dulliau eraill hefyd - yr Arolwg Cefn Gwlad neu arolwg pwrpasol, er enghraifft.

Bu'r prosiect hefyd yn pwyso a mesur pa mor effeithiol yw'r polisïau presennol fel ffordd o gynnal ffermdir CWN yn ardaloedd yr astudiaethau achos. Cafodd ffermwyr eu cyfweld fel rhan o'r asesiad.

Mewn ardaloedd heblaw'r rhai sydd wedi'u diogelu, mae cadwraeth ffermdir CWN yn dibynnu'n helaeth ar fesurau'r PAC, yn enwedig mesurau amaeth-amgylcheddol. Ymddengys nad yw'r mesurau hyn wedi'u targedu'n effeithiol at ffermdir CWN. Yn ardal yr astudiaeth, prin yw'r gydnabyddiaeth a'r cymhellion ariannol i ffermydd o'r fath, ac yn enwedig llefydd bach, a phan oedd porfa lled-naturiol mewn cyflwr da, 'roedd gwybodaeth y ffermwr am ddulliau addas a'i ddiddordeb ynddynt yn hollbwysig. Mae'r cymhellion ariannol bach a gynigir gan gynlluniau amaeth-amgylcheddol yn adlewyrchu'n rhannol y ffaith na ellir ond talu am gostau ychwanegol neu incwm a gollwyd. Mae hyn yn amlwg iawn ar ffermydd llai lle mae'r rhan fwya o'r tir yn lled-naturiol – 'does fawr o gydnabyddiaeth ariannol i'r cynefinoedd sydd arnynt eisoes (eu gwasanaethau neu gynnyrch amgylcheddol). Anaml y mae cynlluniau amaeth-amgylcheddol yn mynd i'r afael yn effeithiol â phroblemau penodol caeau bach – rheoli rhedyn a phrysg, er enghraifft.

O ystyried llwyddiant prosiectau sy'n talu am waith cyfalaf yn unig – cloddiau, ffensys, llidiardau – ac er mwyn rhoi cefnogaeth i ffermdir CWN, waeth lle y bo, rhaid i unrhyw gymorth ariannol edrych tu hwnt i ffiniau traddodiadol cynlluniau amaeth-amgylcheddol. Er enghraifft, gellid cynnig peth help i ddeiliaid tir nad ydynt yn ffermwyr yn yr ystyr technegol ond sydd, serch hynny, yn rheoli'u tir er budd cadwraeth gan ddarparu gwasanaethau amgylcheddol tebyg i'r rhai a welir ar ffermdir CWN.

Cydnabyddir gan lawer erbyn hyn nad yw cyfran bwysig o'r ffermdir CWN mewn ardaloedd sydd wedi'u dynodi neu'n cael eu rheoli gan gynlluniau amaeth-amgylcheddol. Hefyd, ceir enghreifftiau lu o ffermydd a deiliaid tir nad ydynt yn rhan o gynlluniau 'fferm gyfan', am bob math o resymau.

Mae rhai agweddau ar Golofn 1 hefyd yn tynnu'n groes i gynnal ffermdir CWN. Mae atal cynefinoedd prysg rhag cael y Taliad Sengl yn achosi cryn broblemau. Mae neges bolisi'r llywodraeth i ddeiliaid tir yn ddryslyd - mae prysg yn gynefin gwerthfawr (neges amaeth-amgylchedd) ond hefyd yn rhywbeth i'w ddiystyru neu ei gosbi (yn ôl rheolau'r cynllun Taliad Sengl). Gellid osgoi hyn drwy ail-ystyried rheolau'r Golofn Gyntaf a chynnwys prysgwydd fel rhan o'r Taliad Sengl; ar yr un pryd, 'dyw rheolau i warchod tir pori parhaol ddim yn gwarchod cynefinoedd lled-naturiol yn effeithiol, a hynny am nifer o resymau.

1. The HNV farming concept and EU policy

The HNV farming concept comes from a recognition that certain patterns of farming and of farmland are inherently of high biological richness, especially when existing on a landscape scale. This is particularly the case when landscapes contain a significant proportion of farmland in a semi-natural condition (e.g. unimproved pastures and hay-meadows, grazed woodland, traditional orchards).

Many studies have shown that increasing heterogeneity, connectivity and area of natural and semi-natural elements in an agricultural landscape tends to have a positive influence on species richness and abundance across a range of wildlife groups. The semi-natural patches need to be not only of sufficient quality but also of sufficient size and connectivity. Donald and Evans suggested that restoring (or maintaining where it still exists) the agricultural landscape matrix is a necessary prerequisite to helping ensure that European agri-environment schemes fulfil their potential (Donald and Evans 2006).

In intensified agricultural landscapes, beneficial conditions for biodiversity have been lost through the on-going conversion and fragmentation of semi-natural farmland. Biodiversity restoration generally occurs only at a cost to public finances, e.g. through agri-environment schemes, and even then there are limits to what can be achieved on land that is predominantly under intensive agriculture.

On HNV farmland, the basic conditions that create and sustain high biodiversity values are already present. Maintaining these existing values should be a high priority for nature conservation strategies and for farming and landuse policies that aim to integrate biodiversity concerns. A large part of the challenge for maintaining these values is to address the economic difficulties of farming on agriculturally unimproved land. This is a very different situation from paying incentives to improve biodiversity on intensively farmed land.

In East Carmarthenshire (the focus of the present report) it is recognised that while there is a scattering of designated "prime sites" – SSSIs and SACs – much of the biodiversity associated with the area is found beyond these boundaries on non-designated farmland, or what is known as the "wider countryside". But crucially, this wider countryside is not uniform, from either a biodiversity of farming perspective. Outwith the designated sites, there are considerable areas of farmland and farming that are directly associated with important biodiversity values.

HNV farmland and its associated values cannot be conserved entirely by protected areas and local initiatives such as "conservation grazing" projects. Can ways be found of ensuring the socio-economic viability of the farming systems that use and maintain semi-natural farmland in the wider countryside, and of ensuring their continued appropriate use, particularly on a landscape scale? Do existing policies (agricultural, rural development, nature conservation) provide the means to achieve this goal in their current form? If not, what improvements are needed? Answering these questions is central to the HNV farming concept.

Identifying, supporting and monitoring HNV farmland and farming systems has been a priority for EU rural development policy since 2005. In 2010, EFNCP joined up with local partners to run a series of local projects to identify HNV farming systems based primarily on semi-natural grasslands in England, Wales, Ireland and France. These projects aim to explore how HNV farmland and farming systems can be identified and their socio-economic needs assessed, as the basis for developing strategies for their effective long-term support.

Semi-natural farmland is an essential building block of HNV farming. The concept is focused primarily on farming landscapes that still retain a significant proportion of semi-natural land within the farming system. In the UK, recent reports such as the National Ecosystem Assessment (Semi-natural grasslands chapter by James M. Bullock) and the Lawton report to DEFRA *Making Space for Nature: a review of England's wildlife sites and ecological network*, have emphasised the valuable ecosystem services of semi-natural farmland, as well as its continued decline. The major reason for this decline, especially into the future, is under-use due to the lack of economic viability of the low-intensity and low-productivity farming systems that use them. Also, with the exception of Natura 2000 sites and SSSIs, most of England's semi-natural habitats important for wildlife are reported by Lawton as "insufficiently protected and under-managed".

A sound starting point for addressing HNV farming through policy therefore is to identify the location and extent of semi-natural farmland in its different forms – pastures and meadows, orchards, features such as hedges and ponds – particularly beyond the boundaries of designated sites.

In the UK, the largest contiguous expanses of semi-natural farmland are found in the uplands. This predominantly semi-natural farmland has been labelled "Type 1" HNV farmland. High nature values may also be present in landscapes where a smaller but still significant proportion of farmland is in a semi-natural state, especially when found in a mosaic with semi-improved grassland and/or low-intensity arable cropping. In this situation of fragmented semi-natural farmland, landscape elements such as hedges and copses can make a particularly important contribution. This has been labelled "Type 2" HNV farmland.

Figure 1. Species supported on HNV farmland are often poorly reported: anthills at Porthyrhyd

Landscapes dominated by intensified farmland are usually devoid of significant biodiversity. Wildlife habitats are reduced to fragments divorced from the farming system (hedges, ponds, small woods). An exception is that some bird species are better able than other forms of wildlife to adapt to more intensively farmed landscapes. In some situations, farmland with minimal or no semi-natural component continues to support significant populations of certain wildlife species, particularly birds. Intensively managed grassland used by geese is one example. This has been labelled "Type 3" HNV farmland.

There is no hard line between Type 1 and Type 2 HNV farmland, rather there is a continuum. Whereas predominantly semi-natural landscapes are relatively easy to identify and determine as HNV farming, the Type 2 situation is less clear cut – at some point, the proportion of semi-natural habitat becomes so small that opportunities for wildlife are reduced to a minimum, but determining this point is something of a value judgment and depends on local conditions.

There are other considerations that determine nature value in a Type 2 situation. For example, the presence of semi-natural landscape features, such as large hedges and patches of woodland; the size of semi-natural patches, and the distance between them; and the condition of the "improved" farmland within which the semi-natural land sits – for example, an area of semi-improved grassland surrounding or adjacent to semi-natural grassland can act as a buffer from nitrogen and biocides, as well as allowing colonisation from the semi-natural seed sources. A field of intensively cultivated maize, for example, does not provide these complementary benefits. Arable fields under low-intensity use, and with characteristics such as winter stubbles, can also contribute to the nature value of Type 2 HNV farmland.

Figure 2. Abandonment is sometimes described positively, but usually occurs on land which is already biodiverse

High Nature Value farming came into EU policy from the 1990s. Under the 1998 EU Biodiversity Strategy, the Commission emphasised that biodiversity cannot be conserved solely through Natura 2000. Among the key accompanying actions required was "to prevent intensification or abandonment of high–nature–value farmland". More recently, the European Agricultural Fund for Rural Development (EAFRD)[1] regulation Strategic Guidelines[2] on rural development established HNV farming as one of three priorities for Axis 2 of Rural Development Programmes (RDPs).

In order to include effective measures for HNV farming in their RDPs, Member States need to do some background evaluation of needs and how best to address them. The 2007-2013 RDPs should demonstrate that measures are in place to maintain HNV farming and forestry systems. The effects of programmes will be evaluated against this objective, by applying specific "HNV indicators"[3][4]. The Common Result Indicators include:
- Area under successful land management contributing to:
      (a) biodiversity and high nature value farming/forestry
      (e) avoidance of marginalisation and land abandonment

The Common Impact Indicators include:
- Maintenance of high nature value farmland and forestry

These policy requirements raise important questions for national authorities, which chime with some of the recent thinking in the UK referred to above (NEA[5], Lawton 2010) and the growing interest in landscape-scale conservation. Which are the types farmland and farming that still retain high biodiversity values? Where are they and how much is there? What is happening to this farmland at the farm and landscape scales, and if we don't know, can we set up a monitoring system that will give a reliable indication of trends over the period of a rural development programme? What is the best policy response for maintaining the values associated with this farmland? Broadly, these are the questions addressed by the present report for the case study area of East Carmarthenshire.

2. Situation in Wales

High Nature Value farmland hardly features in the 2007-13 Wales RDP. Development of the HNV indicator has been slow, as in many other parts of the EU.

In the absence of overall progress, the Countryside Council for Wales (CCW) undertook a small 'look-see' exercise, following the pattern followed in other countries. Semi-natural vegetation was taken as an indicator of 'Type 1' and, completely separately, land cover diversity was taken as an indicator of 'Type 2' (overlooking the *managed at low-intensity'* element of the definition). Some species data were also investigated. The resulting maps are shown in Figure 3. The approach is valuable,

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1 Regulation 1698/2005 establishing EAFRD

2 Council decision 2006/144 on Community strategic guidelines for rural development (programming period 2007 to 2013)

[3] Beaufoy, G. and Cooper, T., 2008. Guidance Document to the Member States on the Application of the HNV Impact Indicator.

[4] Lukesch, R. and Schuh, B. 2010. Working paper on approaches for assessing the impacts of the Rural Development Programmes in the context of multiple intervening factors. Findings of a Thematic Working Group established and coordinated by The European Evaluation Network for Rural Development.

[5] http://uknea.unep-wcmc.org/

and it would be interesting to investigate those areas where high levels of landscape diversity are present *outwith* the zones with high cover of semi-natural vegetation. It would also be necessary to consider further whether the maps produced would make viable *monitoring* tools, or would possibly be more useful for targeting or for broad-scale evaluation of resource allocation by Government.

The Welsh Government (WG) has commissioned a comprehensive monitoring and evaluation programme covering all impact indicators across all Axes 2 RDP schemes in January 2009, including that for HNV farming.
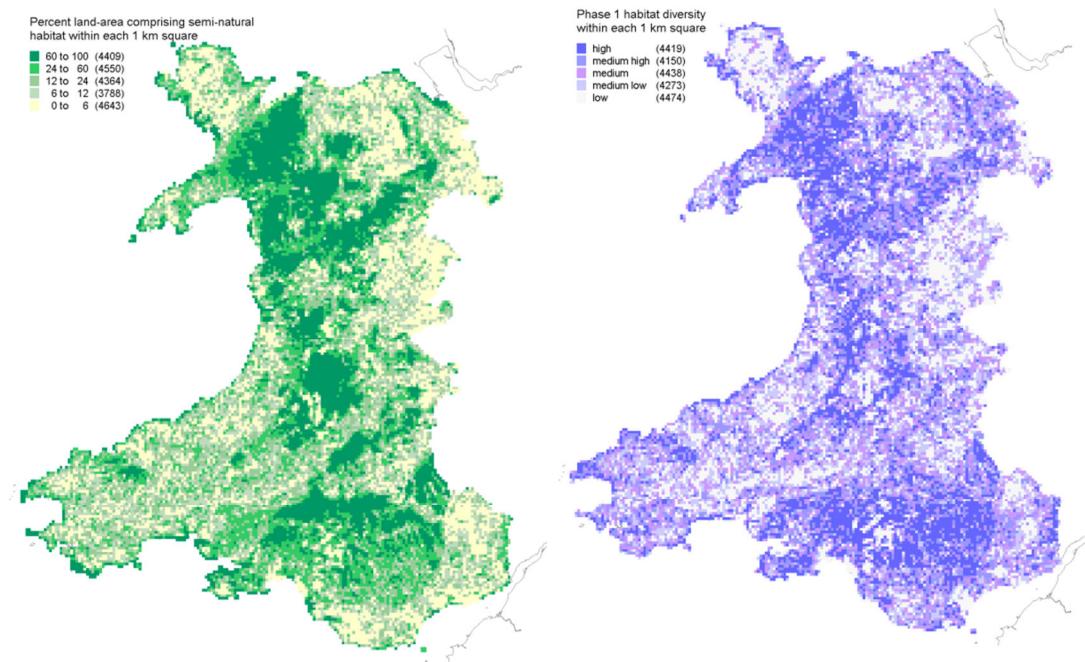
Figure 3. Draft maps of spatial distribution of (left) semi-natural vegetation and (right) landscape diversity in Wales

This evaluation will be available at the end of the three-year programme, and by the end of the current RDP in 2013. However the current monitoring and evaluation programme is being used to assess the accuracy and sensitivity of HNV as an informative indicator.

The WG is proposing six steps to develop the CMEF HNV indicator:
1. Interpretation of HNV
2. Identification of appropriate indicators to allow assessment of extent of HNV
3. Assessment of farm system / type relationship with natural resource value
4. Identification of monitoring indicators of HNV allowing scientifically robust assessment of change in extent and condition of HNV
5. Inclusion and testing of HNV indicator for monitoring quantitative and qualitative changes
6. Utilization of HNV in Glastir scheme design

In May 2009 the then Welsh Minister for Rural Affairs announced her decision to launch the new Glastir scheme in response to a review into delivery of RDP Axis 2 schemes. It is clear that WG sees the HNV indicator as something to be closely aligned to the targeting and monitoring of Glastir. Aligning the approach to agri-environment and HNV has advantages in principle, but carries with it the risk that the indicator may no longer serve its core purpose of identifying farmland of high biodiversity and monitoring its maintenance and enhancement.

The WG interpretation of HNV is "more representative of the collective Natural Resource", rather than being limited to farmland biodiversity. This interpretation of HNV includes not only some measures of ecologically significant species and habitats but also extends to soils and water (see Figure 4). Clearly there are significant interactions between these factors and the suggested approach has a certain resonance in the light of the ecosystem services approach.

At the same time, the current WG approach presents a number of difficulties, as follows:

- Significantly different datasets are layered one on top of the other (with a subjective relative value assigned to each). This means that it would be quite possible for a significant score to be reached on the basis of high significance for soil carbon storage or significance for water quality improvement (whist the latter is an indicator of *low* environmental quality).

- Areas representing both current and *potentially* valuable natural resources (features of high biodiversity on the one hand and areas requiring an improvement in water quality on the other, for example) are given a similar rating. It is difficult to see how such an indicator could fulfil the EU requirement for the measurement of change against a baseline.

WG also state (despite current agri-environment schemes paying for maintenance to some extent) that since agri-environment pays for *change*, it is wrong to have a HNV 'qualifying factor' which rewards *current* high performance in this regard. EFNCP has always argued that HNV farming is not merely an agri-environment or pay-for-change issue, but something which retargets support towards recognising public goods which by definition cannot be rewarded through the market. But in any case, WG's approach conflates two very different ideas – targeting and monitoring.
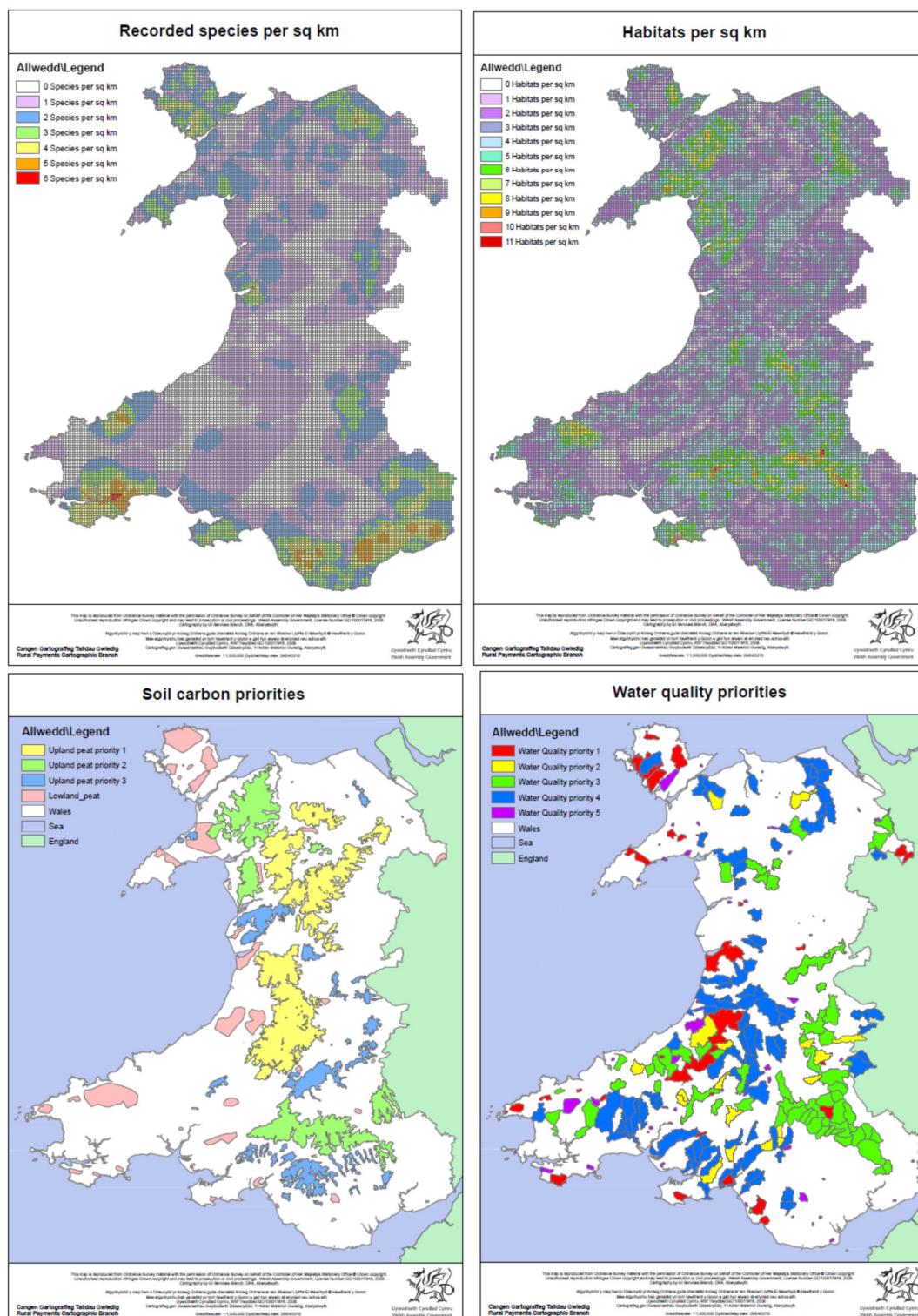
Figure 4. Data layers which WG proposes using for its HNV CMEF indicator. Recorded species density (top left); habitat diversity (top right); priority areas for soil carbon storage (bottom left); priority areas for water quality improvement (bottom right)

3. Objectives of this project

The perceived need for this project arose out of the slow initial pace of progress in developing the CMEF HNV farmland indicator for Wales. EFNCP approached CCW in 2010 suggesting that it would be useful to investigate this at a local, 'real', level, and suggested that the eastern portion of Carmarthenshire would be a suitable case study area, combining a range of altitudes, farm types, land cover, geologies and socio-economic contexts. CCW agreed to provide grant aid to match EFNCP's contribution from its DG Environment funded work programme.

The WG is now progressing this work, but its novel approach, which involves redefining HNV to include non-biodiversity elements; combining actual delivery with potential and diluting the independence of targeting and delivery poses a significant challenge. If we follow a path closer to the EC guidance documents, , then how would HNV farming be defined in Wales; how should it be monitored; what kind of needs should we be assessing and how should we target support?

The project aims to investigate:

- What types of farmland in East Carmarthenshire are most valuable from a wildlife perspective (and can therefore be classed as HNV)?
- Can we characterise the different farming systems or farm types that currently support HNV farmland in East Carmarthenshire (e.g. in terms of production sector, production systems, management practices, farm size, ownership, etc.)?
- Do existing databases and inventories show the full extent and location of these types of farmland? If not then what types of farmland are missing? Do we know approximate locations on the basis of expert knowledge?
- What are the potential ways (now or in the future) in which the extent and location of this farmland can be identified e.g. through more inventories, sample surveys, use of UK Land cover data, Landmap, IACS?
- What are main factors influential in maintaining HNV farmland, including policy and socio-economic trends but also, for example, hobby farmers, tourism, personal motivation of certain farmers?
- How are these farming systems or types likely to evolve in future e.g. intensification, abandonment or change of land use?
- What are the key issues that need to be addressed on the ground, in order for HNV farmland to be maintained? This includes social and economic questions, but also practical issues such as availability of livestock to graze small, difficult to manage fields, and how such activities can be organised and continued.
- To what extent does the current package of policy measures ensure the maintenance of HNV farmland e.g. Pillars 1 and 2 of CAP, BAP etc.? If not, what is missing, what needs to be improved?
- How can we monitor trends in HNV farmland and then evaluate the success of RDP measures in maintaining it (as required by the European Commission), both in this programming period and in future?

The project combines a desk-based assessment of datasets with field testing in a number of test grid squares and the gathering of complementary socio-economic data.

4. What types of farmland in East Carmarthenshire can be classed as HNV?

4.1 Landscape character of the study area
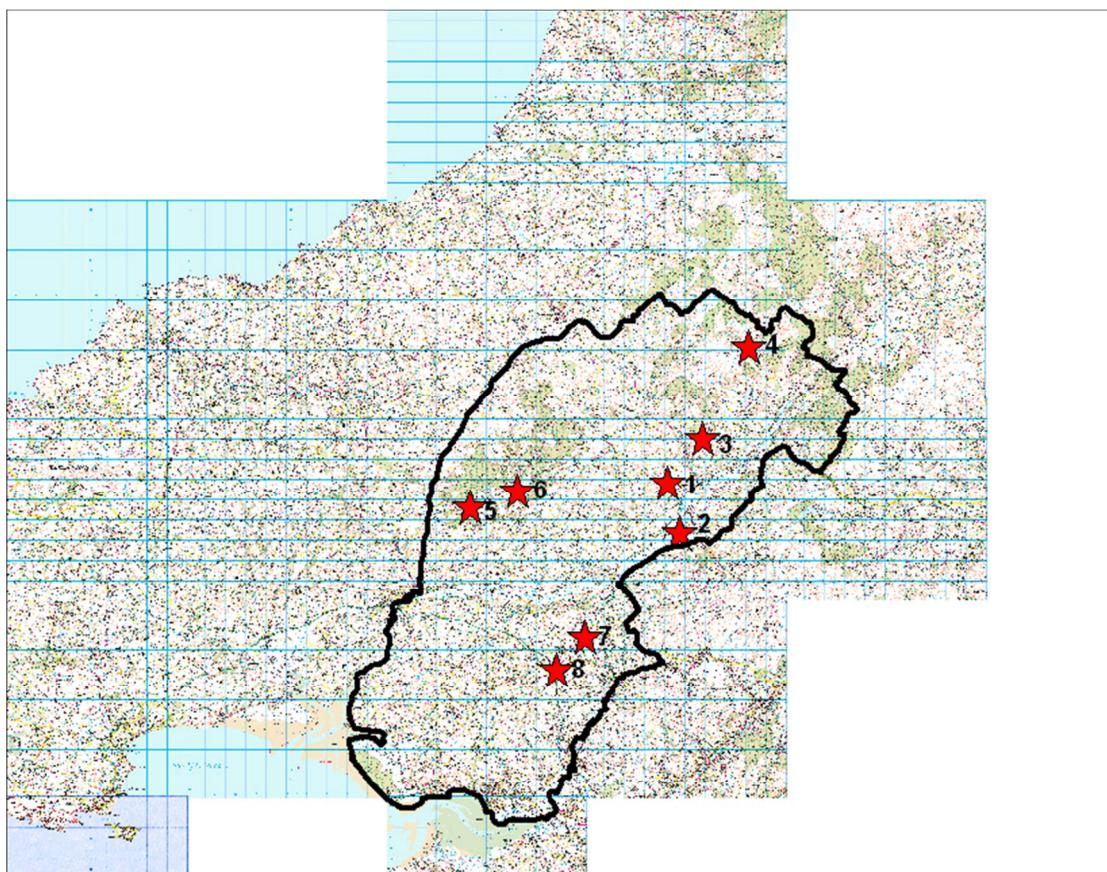
Figure 5. Map of study area
Sample locations: 1 Waunclunda; 2 Felindre, Llangadog; 3 Porthyrhyd; 4 Gwenffrwd; 5 Llanllawddog; 6 Llystyn; Brechfa; 7 Carmel; 8 Mynydd Mawr.

The study area (Figure 5) is overwhelmingly pastoral, managed with varying levels of intensity. The field pattern is varied and includes irregular medieval fields, medieval strip fields and 19th century rectilinear Parliamentary Enclosures. There are several areas of unenclosed common land, Mynydd Mallaen in the north being one of the largest. The area is relatively well wooded with an estimated 15% cover which is made up equally by small farm woodlands distributed fairly evenly across the areas and larger forestry plantations, most of which are located in the north of the region. Hedgerows and trees are very much a feature of this area and also contribute to its well wooded appearance.

Within this area the landscape reflects a range of physical features, not only altitude and exposure, but also geology, drainage and soil types, and topography. In addition they have all been shaped by man over centuries, and by a range of farming and other land use practices (such as forestry). Over the last 150 years there has been a huge change in the landscape in terms of the wildlife habitats and species it supports.

4.2. Farming systems in East Carmarthenshire

Farming systems have played a very important role in shaping today's agricultural landscapes, and perhaps have contributed more to the diversity of the landscapes we see today than any other factor. Immediately next to an intensively managed farm with flailed hedges, few if any hedgerow trees, where almost all the land is improved, there can be a farm with much taller and wider hedges, significant numbers of hedgerow trees, some poorly drained areas and semi or unimproved grassland on steeper slopes. The physical features of the farms might be essentially similar and the differences due to how the land has been managed for agriculture over the years, and the farming systems that have been in operation.

The farming systems that exist within the area are varied and range from relatively intensive dairy units in the Tywi Valley milking over 300 cows and intensively run sheep farms in the hills, neither of which support any significant HNV farmland, to small extensively managed herds of rare breed beef cattle, which can sustain a variety of functioning farmland ecosystems, the grazing regime being very much in line with conservation grazing practice. The majority of farms are managed in a way that is somewhere between the two. Land that can be used for silage has usually been improved while small fields and inaccessible, poorly drained and steep land, is often recognisable as HNV farmland, if the stocking densities are appropriate.

4.3. LBAP habitats and species associated with farmed landscapes

Farmland is widely recognised as having the capacity to support a range of habitats and species. In East Carmarthenshire it is recognised that while there is a scattering of designated sites – SSSIs and SACs, much of the biodiversity associated with the area is found beyond these boundaries on non-designated farmland.

The Local Biodiversity Action Plan (LBAP) identifies habitats and species that are associated with our farmed landscapes. In total 75 stand-alone LBAP action plans have some relevance for the study area.

4.4. Ecological connectivity and HNV farmland

HNV farmland supports a range of wildlife habitats (and consequently species) and has the capacity to provide the ecological connectivity – the 'Green Infrastructure' - across our agricultural landscapes which is critical for biodiversity conservation. Without the farmland habitats that provide this essential ecological connectivity, designated sites would become disconnected and vulnerable islands of declining biodiversity interest.

To use the current jargon, farmland is undoubtedly providing an ecosystem service when it is managed in such a way as to deliver firstly the habitats which are the building blocks of the service, or the service network; and secondly, when these habitats are joined together, the ecological connectivity which is now considered essential for biodiversity conservation - habitats and species cannot survive long-term in isolated pockets. HNV farmland in East Carmarthenshire is found in landscapes with significant ecological connectivity. Features of East Carmarthenshire farmland that contribute to this connectivity include:

- water courses with some element of semi-natural bank side vegetation e.g. woodland, marshy grassland, scrub
- well-developed hedgerows ideally with hedgerow trees; narrow lanes hedged on both sides
- hedgerow and field trees, particularly veteran trees
- semi-natural or unimproved grassland, tussocky grasslands

- scrub
- wetland habitats: marsh; fen; wet woodland; ponds
- woodlands of all types
- traditional orchards
- arable fields with permanent grassy field margins
- traditional buildings

4.5. Land management and HNV farmland in East Carmarthenshire

The way in which an agricultural holding has been managed in the past and how it is managed today has a huge influence on whether or not it has the capacity to provide habitats for wildlife. In general terms the more intensively managed a holding is in terms of its agricultural productivity; the less likely it is to support a variety of wildlife habitats and HNV farmland.

Figure 6. HNV landscapes can contain improved grassland and pose a challenge to HNV farmland identification

Land management practices that have contributed to a loss of biodiversity on farms in east Carmarthenshire include:
- application of NPK fertilisers as this results in a loss of diversity of grassland species and is usually applied to swards that have already been reseeded with commercial mixes
- cutting silage (as this is requires an agriculturally improved sward)
- drainage of wet areas – flushes, marshy grassland
- neglect of ponds
- grazing and trampling of river banks
- loss of river side vegetation
- cultivation of fields right up to water course
- annual flailing of all hedgerows on a holding
- neglect of hedgerow e.g. hedgerows that are not protected from stock
- loss over the years of hedgerow and field trees
- removal/ clearance of scrub
- lack of appropriate woodland management

- loss of traditional orchards
- loss of traditional buildings or access to traditional buildings that can be accessed by bats and birds
- reduction in arable crops that are of benefit to conservation
- use of avermectins in parasite control.

Land management practices that tend to conserve and enhance biodiversity include:
- Grassland management that aims to increase species and structural diversity of the sward
- Limited or no application of NPK fertilisers
- Very limited drainage of wet areas, including marshy grassland
- Hedgerow management that ensures that the hedges on a holding are cut or laid on rotation so there is always a proportion or at least 2, 3 and 4 year old growth.
- Laying of a proportion of the hedges on the holding every year, or every other year.
- Retention and replacement of hedgerow and field trees
- Management of water courses that encourages the development or retention of river side vegetation, including riverside trees
- Appropriate management of ponds
- Retention of scrub, ideally with some management on rotation
- Woodlands that are managed with conservation in mind.
- Conservation and restoration of traditional orchards
- Retention of headlands on arable fields
- Management of buildings so as to ensure access by bats and nesting birds is possible

Other farming operations may or may not be beneficial to the nature value of the farmland depending on context and location:
- Spreading of farmyard manure – no problems with poor improved grassland or even semi improved, but could be detrimental where there are sensitive plants such as orchids and wax cap fungi
- Ploughing of permanent pasture (in this case the benefits would derive solely from the replacement crop)
- Control of Juncus spp. (e.g. application of herbicide) this may enhance species diversity but it might adversely affect habitat structure
- Liming – often considered as a traditional practice and can maintain sward productivity without using NPK fertiliser, but detrimental if applied to a species–rich acid grassland

HNV farmland in East Carmarthenshire is that land which supports LBAP habitats, and which demonstrates ecological connectivity with other habitats beyond the farm boundary.

4.6. Importance of grasslands for biodiversity; what role do they have as a habitat within HNV farmland?

Grasslands on farms vary enormously, not only in terms of their species composition, but how they are managed. How much and what type of fertiliser is applied? Are they limed? Are they cut for silage, or for hay? Are they grazed in winter? Topped?

Grasslands can be species-rich, or support particular species of biodiversity interest such as the food plant of the Marsh Fritillary butterfly – Devil's-bit scabious. They can support groups of species that are not widespread, such as waxcap fungi. They can provide a structure that provides habitat for

other species – e.g. tussocky marshy grasslands can support amphibians on which otters feed; drier tussocky grasslands that support high density of small mammals that are important for Barn Owl. In a mosaic of habitats grasslands have a role that is more complex than just their species diversity; their structure is also crucially important. This needs to be recognised within the concept of HNV farmland.

Agri-environment schemes have often sought to identify species-rich grassland, in terms of the botanical species they support, and to a lesser extent by the structure of the habitat they provide. In terms of providing ecological connectivity, grasslands that may not support a huge variety of plants may none the less support biodiversity, as a result of their habitat structure and/or of a long history of uninterrupted management (especially important for soil organisms). They may be poorly drained and therefore be a valuable wet feeding areas for some birds.

An area of poorly drained yet species-poor grassland may be surrounded by tall hedges and hedgerow trees; the ecological juxtaposition of these two habitats is far greater than the sum of their parts. They provide a rich ecotone – a habitat rich in invertebrates and bird life. Possibly this is an aspect that is not fully addressed by most habitat surveys; these tend to be concerned with classification of the habitats present on the ground, rather than an analysis of what they contribute to the ecology of an area. This gap implies the need for a further step in the HNV farmland identification process.

The identification of HNV farmland in East Carmarthenshire will need to look beyond species composition when it comes to HNV grassland. It should consider grasslands which:
- provide structure for small mammals and amphibians - tussocky grasslands, grasslands with ant hills (Figure 1)
- support waxcap fungi (there are few known sites as surveys have thus far been limited to designated areas and other previously-known locations)
- have a value in association with a well-developed field boundary, riparian zone, wetland feature, or other feature of HNV farmland e.g. Porthyrhyd sample area
- may be species-poor but are marshy and poorly drained –often important feeding and breeding areas for birds and mammals
- are of a scale and proportion that link in well with the local landscape, and reflect the local field pattern, have not been created as a result of the removal of field boundaries in recent years, and have well developed boundaries often with other HNV land (see **Error! Reference source not found.** below) are very unlikely to have been treated with fertiliser or cut for silage because of their inaccessibility – e.g. riverside grasslands in the Gwenffrwd sample area.

4.7. HNV farmland in East Carmarthenshire
Over the last 50 years those parcels within the study areas that can be cultivated and drained have generally been improved for agricultural purposes and can now considered to be lower in their nature conservation value than it was when they were wetter or supported more diverse swards. Land that is difficult to drain or too steep or too awkward to cultivate, or manage mechanically, has tended to escape this level of agricultural improvement and is considered to be more likely to support a greater diversity of habitats and species, and this is where the HNV farmland will be found in these landscapes.

The eight case-studies (see section 6) that have been used in this assessment of HNV farmland in East Carmarthenshire highlight the variety of agricultural landscapes and farming practices within

the study area, but with more emphasis on the enclosed land (on the basis that the HNV character of large areas of enclosed semi-natural vegetation was not in question). Not surprisingly the pattern and distribution of HNV farmland within these landscapes is also very varied. In very general terms the amount and distribution of HNV farmland within East Carmarthenshire appears to be inversely proportional to the success of agricultural improvement and intensification.

5. Existing data bases that might contribute to the identification of HNV farmland in Carmarthenshire

The following data sets were investigated:
- Landmap
- Wildlife Sites – Criteria for selection
- Biological Records – West Wales Biodiversity Information Centre, Whitland
- CCW's Phase 1 Habitat Survey c.1994
- CCW's Habitat Network Mapping
- Aerial Photos, 2000, 2006 and 2009 (Welsh Government)
- Environment Systems/CCW Habitat Inventory Map of Wales (HIW), available to us in draft form for part of the study area (i.e. pre-ground truthing within the study area)
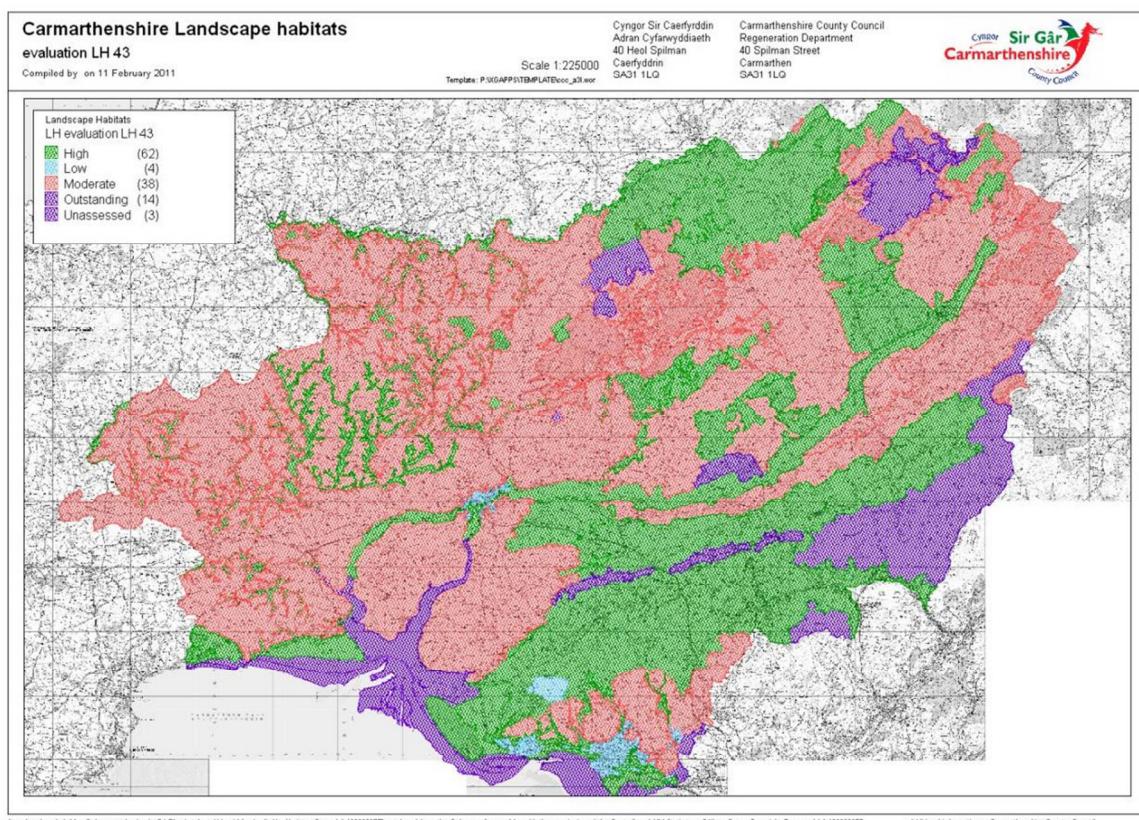

Figure 7   Landmap assessment of Carmarthenshire – Landscape Habitats layer, showing how the different areas were evaluated

5.1. Landmap

Within this Wales wide assessment of landscape, the Landscape Habitat MapInfo layer and data is most relevant for identifying HNV farmland as it looks at 'the distribution of habitats and is the basis

for landscape ecology.'   Within the East Carmarthenshire there are a number of nationally and internationally designated sites that are evaluated in this layer as outstanding in terms of their landscape habitats, e.g. Mynydd Mallaen. Much of the rest of the area is evaluated as high or moderate, and while the "high" areas will contain significant areas of HNV farmland, there will be exceptions to this in the form of intensively managed pockets of land. Similarly one would expect to find less HNV farmland in the areas that score moderate or low, but here there will be still be some areas with a considerable amount of HNV. The case study areas studies confirm this.

Landmap assessments were not carried out with the purpose of identifying HNV farmland. It is of limited use in identifying discrete areas of HNV, but will indicate where there is likely to be more and less HNV.

5.2. HNV farmland and Wildlife Sites

Carmarthenshire County Council adopts the use of Wildlife Sites Criteria as set out in Wales Biodiversity Partnership 2008 Wildlife Sites Guidance Wales as a means of evaluating a site proposed for development in terms of its ecological importance.

However it has not designated Wildlife Sites within the county due to there being no resources allocated for their management. Had they been designated, many would have been on farmland. Using the Wildlife Sites Criteria for identifying HNV would require a field by field survey of farmland at an appropriate time of year, and as such would be prohibitively expensive.

5.3. Biological Records

The West Wales Biodiversity Information was set up in 2006. The information held reflects recorder effort as much as the distribution of a particular species. While there are records of species indicative of HNV farmland and reliant on farmland ecosystems for some of the case study areas– e.g. barn owl, brown hairstreak and dormouse, records do not represent a comprehensive data set that can be used across the study area. Neither is there one species indicative of HNV that occurs across the study area in sufficient number to be a reliable indicator. Other sources of biological records have also been investigated, but have also proved to be inadequate. For example, the British Trust for Ornithology Breeding Birds Survey or National Bird Atlas data are at too coarse a resolution to be useful for the identification of HNV farmland.

5.4. CCW's Phase 1 Habitat Survey

Completed by c.1994, the survey is by now rather dated, as habitats have changed over the intervening 18 years, either due to natural succession, or as a result of management. The survey does provide useful background for the identification of HNV, but it also includes inaccuracies.

5.5. CCW Habitat Networks Mapping[6]

Maps of networks are available for a range of habitats across Wales. They provide a guide to general ecological connectivity, and are intended to be used by CCW staff and partners as a tool to help plan and implement biodiversity action. It is uncertain whether they can be used reliably for field by field analysis. The networks are not based on any particular species, but use values selected to represent a broad range of biodiversity.

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[6] See J Latham, TH Blackstock & EA Howe (2008)
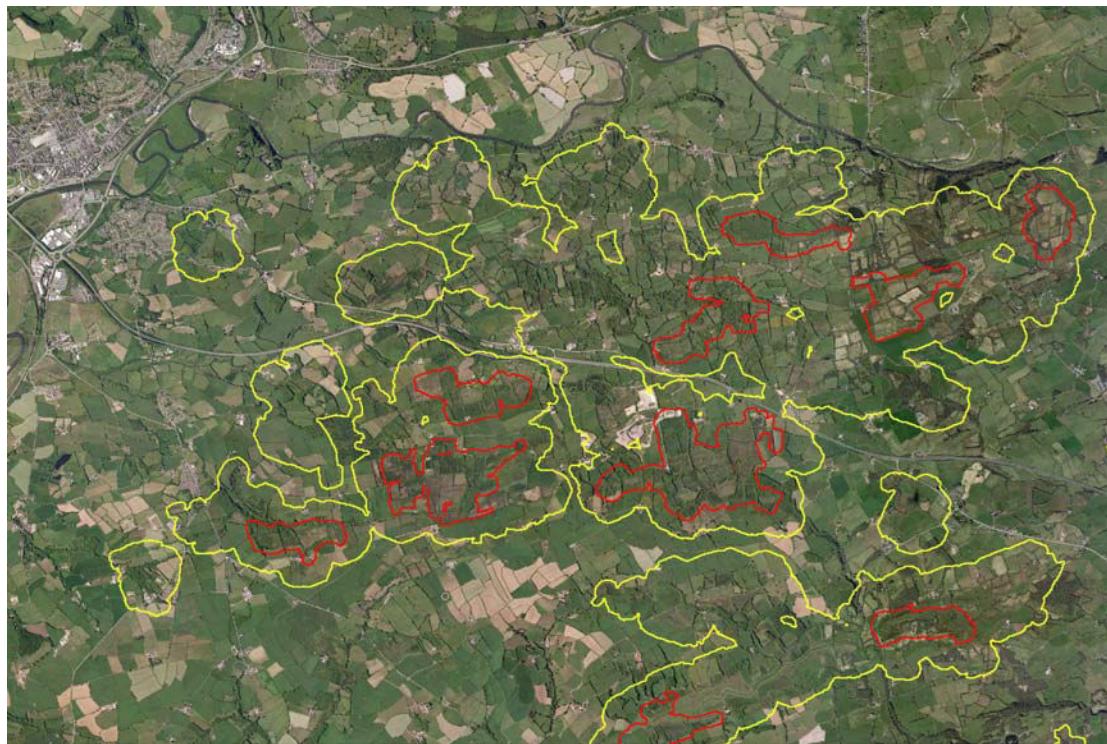
Figure 8. Habitat networks modelled for marshy grassland to the east of Carmarthen (from Latham, op. cit.)

This example from Latham et al.'s work lies to the east of Carmarthen, within the project area but to the south and west of the HNV sample areas. The areas outlined in red are *core* networks – the areas within which species that require extensive habitat and disperse poorly are able to move; areas outlined in yellow are *focal* networks – the areas within which species tolerant of smaller habitat patches and with greater dispersal ability are able to move. The networks include marshy grassland and, to varying degrees, other habitats, and represent marshy grassland ecological connectivity at two scales.

Network maps are available for:
- Broadleaved woodland
- Ancient woodland
- Unimproved grassland (all types combined)
- Calcareous grassland
- Marshy grassland
- Heathland
- Fens
- Bogs

Environment Systems are working with the Habitat Networks project, and together they could produce an extremely useful tool for identifying HNV farmland. Connectivity is a vital part of any assessment of individual land parcels within their landscapes (see section 4.4 above).

Using the Land Parcel Identification System it is possible to run a query and identify all the fields below a certain size threshold in a given area. Unfortunately due to IT security permission issues it has not been possible to provide such map in this report, but it is a simple query to run and very flexible. Small improved fields that provide an important link in the wider HNV landscape can easily be identified. This approach certainly merits further investigation.

5.6. Aerial photographs

These have the potential to provide the most up to date coverage across Wales. CCW hold aerials from 2009, which is more recent than those used in Landmap or the images used as a basis for the draft National Habitat Inventory of Wales (HIW, see 5.7 below). They should certainly be used in conjunction with the HIW maps, particularly when monitoring HNV on the ground. It is not clear however whether they have any advantage over frequently updated remote sensing imagery.

5.7. Habitat Inventory of Wales

The HIW is a new mapping project developed by Environment Systems for CCW. It aims to produce detailed habitat maps of Wales through the use of aerial photography and satellite remote sensing data *'to help monitor landscape-scale biodiversity, habitat connectivity, ecosystem function and the green infrastructure of Wales. A key principle is to maintain continuity with traditional field-based survey methods while allowing future use of the enormous power of satellite-based measurements of productivity, habitat structure, soil moisture, biomass and seasonal patterns in phenology'.*[7]

6. Analysis of the HIW in the sample areas

Within the East Carmarthenshire study the usefulness of the HIW in identifying HNV farmland was assessed by ground truthing within the eight sample areas, each of which consisted of at least two, usually adjacent, 1km squares. Only in the case of Waunclunda sample was there just one 1km square in the sample.

Winter was not an ideal season to undertake the surveys, as it was difficult to discern the category and quality of some habitats at this time of year, particularly short-grazed grasslands. Without landowner permissions many fields could only be assessed from their edges, gateways (often enriched) or with binoculars.

Fields were assessed as to whether or not they might qualify as HNV and compared with the HIW, and the 2009 aerial photos which provided an image of the landscape in the summer months. Fields which could not be surveyed were marked as such. All the non-'improved' habitats recognised by the HIW were taken to qualify as HNV; the only habitat where there may be some doubt is 'poor improved grassland'. At present (see Llanllawddog and Llystyn, Brechfa case studies below) there is in fact within HIW a considerable degree of variation in the different grasslands that fall into this category. Grasslands which lack both species and structure may not strictly be HNV, though a judgement of 'species-poverty' may often be too narrowly focussed on higher plants.

Field surveys were recorded on 1:10,000 paper maps and were then transferred to GIS, excerpts of which are included below.

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[7] www.gwylio.co.uk and Appendix below for more details on the project methods and outputs

	Description	Location	Grid refs	Chosen for	Landmap category	Comparison of field work with HIW maps - summary
1	Mixed valley system	Waunclunda west of Llandsadwrn	SN6831 SN6832	Variety of habitats on HIW good access, roads and PROW	Medium	Good hedgerows and hedgerow trees throughout, at least some small fields with High HNV farmland. Good connectivity. HIW did not identify areas of new woodland planting
2	Lowland riparian	Dolau, Felindre, Tywi floodplain	SN6826 SN6927	Example of a largely improved agricultural landscape	~75% High, 25% Medium	HIW accurately mapped: nearly all of landscape (improved pasture)
3	Valley system, higher elevation than 1	South of Porthyrhyd	SN7135 SN7136	Variety of habitats on HIW good access, roads and PROW	High	HNV typically in valleys and on slopes, where steepness and drainage are issues. Elevated land tends to be improved for agriculture. HIW fairly accurate, but does not recognise new woodlands.
4	Upland/lowland interface	Gwenffrwd	SN7545 SN7645	Variety of habitats on HIW good access, roads and PROW	Upland areas Outstanding, rest medium	HNV on uplands, river valleys with small fields some of which are be HNV. Improved land in between. HI accurate.
5	Dairy, beef, sheep and horses	Llanllawddog	SN4728, SN4729, SN4828, SN4829	Offered comparison to Brechfa mixed farming including diary until 2011	Medium~10 % High	The small areas of habitat that remain tend not to connect well to each other. Much of the land is improved and has been managed intensively for decades. HI mostly accurate with some error on habitat classification where it was not improved land
6	Mixed organic farm	Llystyn, Brechfa	SN5230 SN5231 SN5330 SN5331	Organic system in agri-environment schemes	15-20% High, rest Medium	HNV farmland accurately shown on HIW, but does not recognise new woodlands. Query re poor improved grasslands - this was one of the areas to include this category.
7	Limestone ridge	Carmel	SN5816	Example of	NNR	Most of NNR within this

			SN5916	limestone habitats	Outstanding, rest High	1 x 2km area is either woodland or semi-improved grassland, much of rest ranged from improved through poor improved to semi-improved. HIW identified most of the semi-improved as improved.
8	Marshy grassland	Mynydd Mawr	SN5615 SN5712 SN5713 SN5714 SN5715 SN5810 SN5811 SN5812 SN5911 SN5912	Example of farming in the coalfield	All High	Mosaic of small enclosures, including extensive rhos pasture. While some specific habitats not correctly identified on HIW maps (eg some confusion between marshy grasslands and fens),HIW map fairly accurate at identifying HNV land.

Figure 9. Summary of case study areas

6.1. Waunclunda, Llansadwrn

This sample was included as it appeared to contain a diversity of habitats on the HIW and was well served by road and footpaths. One 1 km square was surveyed from two footpaths. This is an area with some intensively managed farms, some less so, and some abandoned agricultural land. There are numerous small fields (less than 2 ha), and many well–developed hedgerows with a striking number of trees, sometimes giving the appearance of strips of woodland within the landscape, making it appear more wooded than it actually is. Even on the more intensively farmed land there are some impressively large hedgerow trees in the flailed hedges, as well as field trees. In the river valleys the fields are even smaller and typically poorly drained. Here the hedgerows have often spread out into fields. Scrub is encroaching into areas that cannot be easily managed, suggesting that stocking is not particularly high. Areas of unimproved grassland with Devil's Bit Scabious and Whorled Caraway are present.

Further grassland surveys are required to ascertain the quality of some of the areas that do not seem to be cut for silage and therefore may be HNV - some were fairly tussocky, others were very steep and had not been intensively grazed, so may qualify as HNV. This is a landscape that demonstrates strong ecological connectivity particularly within the valleys.

Correctly shown as marshy grassland

Shown as improved & fen/flush. It is marshy grassland with *Succisa pratensis*

Southern ½ is semi-improved with less scrub than shown

Woodland edge shadow hides most of field, which only appears as a line of pixels
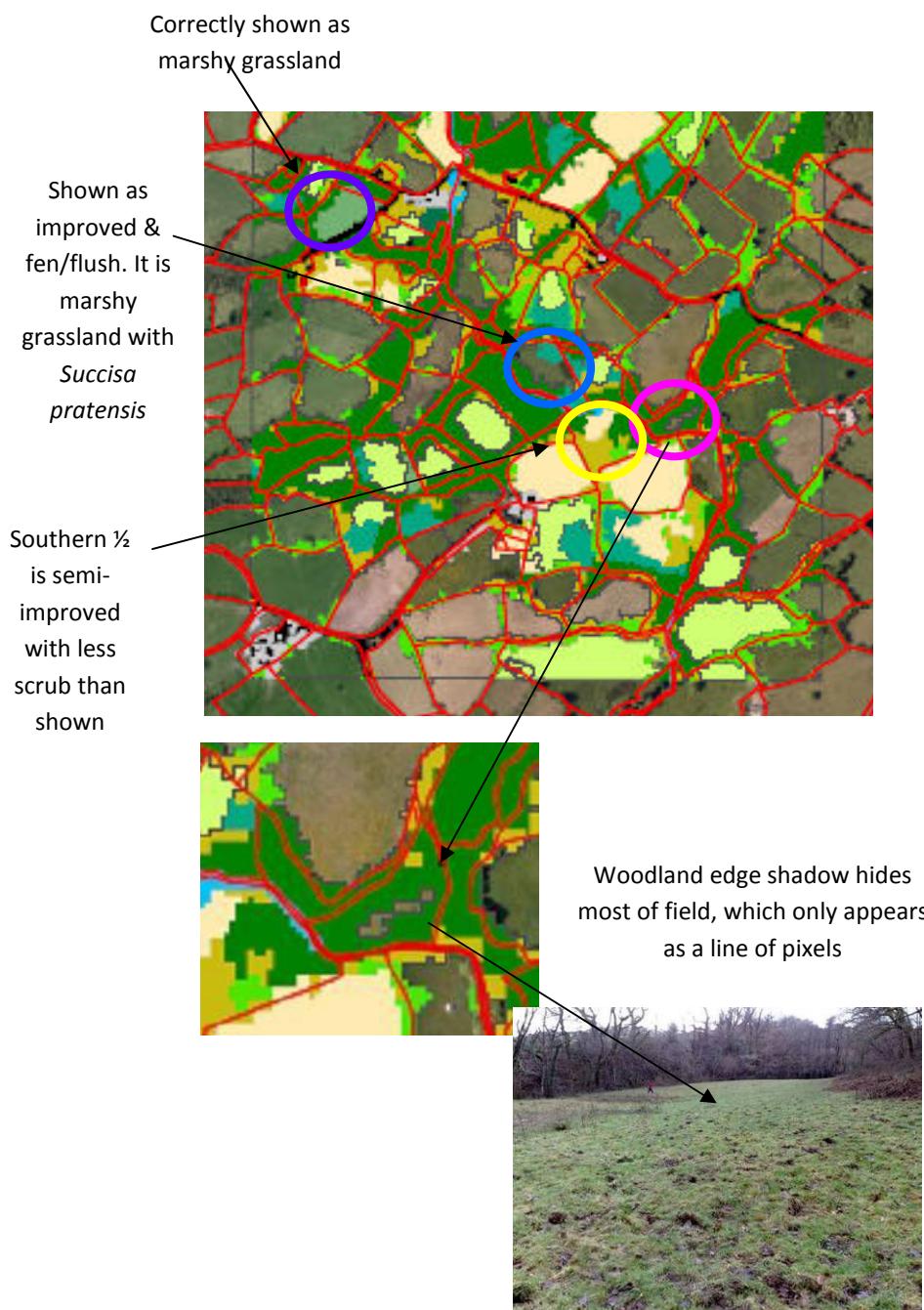
Figure 10. Assessment of remote sensing, Llansadwrn case study
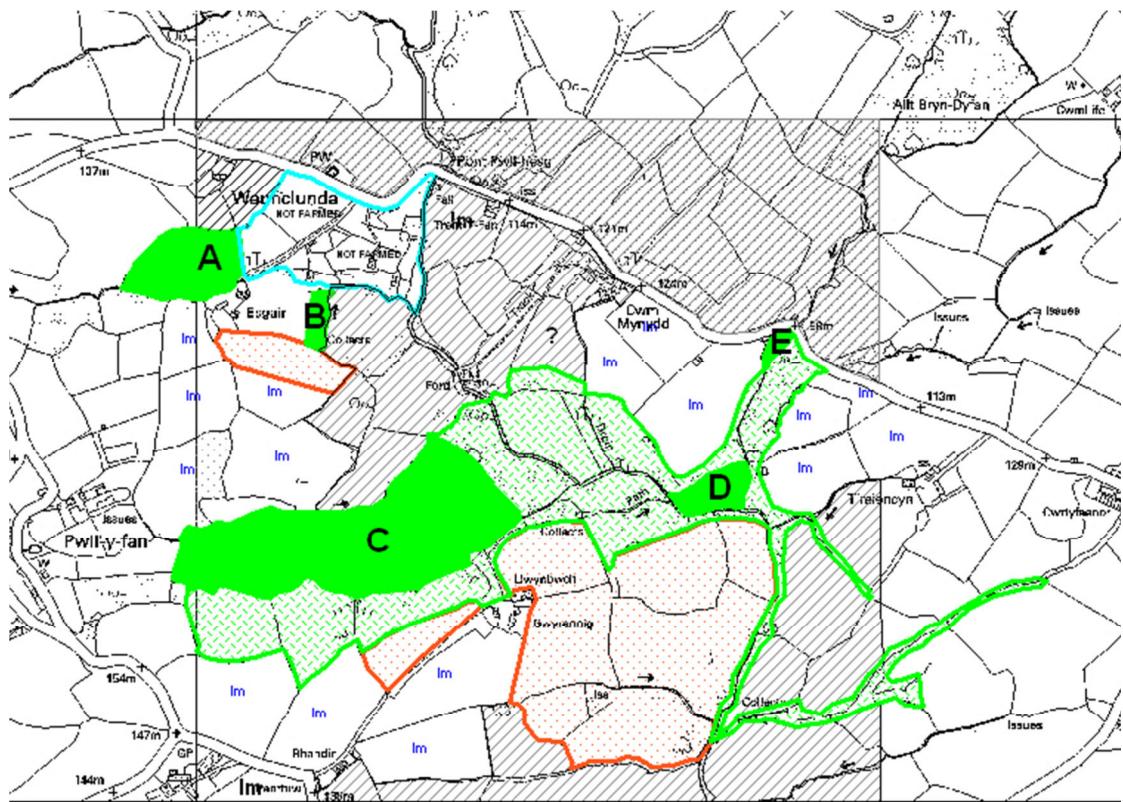
Figure 11. Llansadwrn case study area

Key to maps: shaded green polygons – HNV; shaded orange polygons – grasslands in need of further survey to establish whether or not they qualify as HNV; shaded black - area not visited during survey; blue outline – not farmed; abandoned; Im - improved grassland; C – young coniferous plantation

	Area	Identification in HIW	HNV?	Field survey Feb 2011 and 2009 aerial photos	HNV?
A	1.4	improved grassland	n	marshy grassland	y
B	0.2	semi-improved grassland and scrub	y	marshy grassland, with less scrub than indicated on HIW	y
C	6.0	poor improved grassland with woodland on field boundaries	y	marshy grassland with well-developed hedgerows (viewed from a distance)	y
D	0.5	woodland	y	poor improved grassland	y
E	0.1	woodland	y	garden	n
Total	8.2		6.8		8.1

Figure 12. Llansadwrn HIW analysis
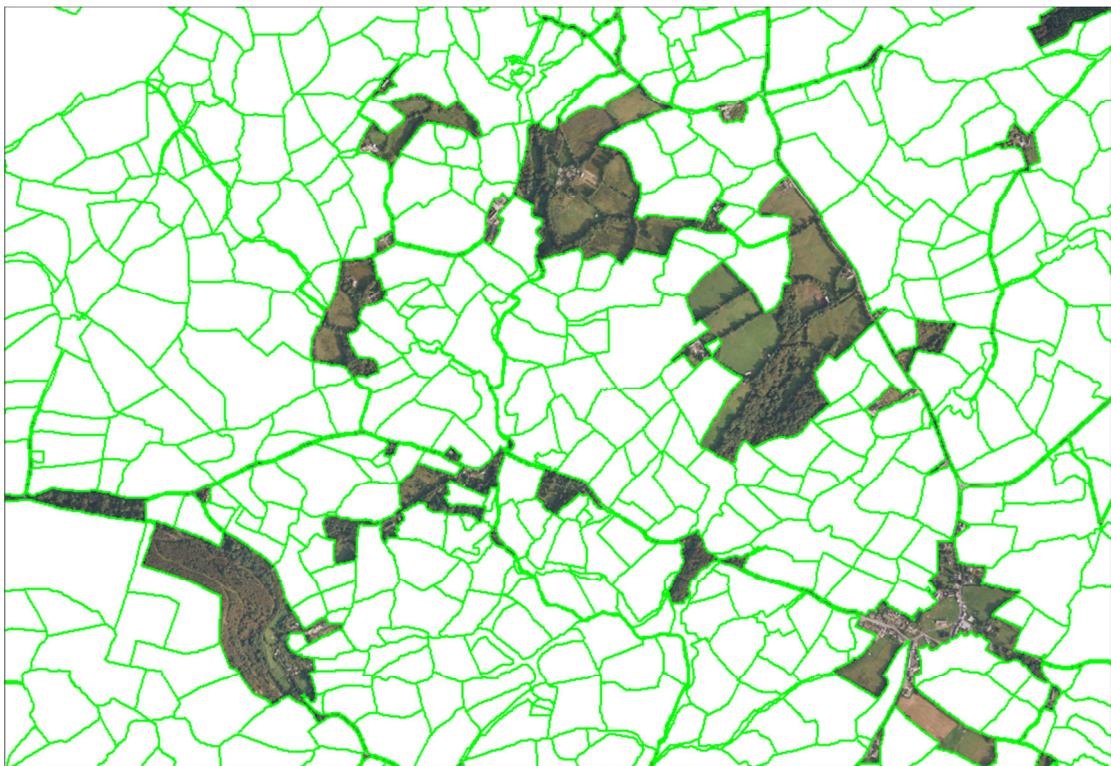
Figure 13 Land not registered in IACS in Llansadwrn (visible)

6.2. Dolau, Felindre, Tywi floodplain

Overall the lowland reaches of the Tywi Valley is a landscape where, despite the European SAC and UK SSSI designation (which apply only to the river channel) there is little HNV farmland, with only a few pockets of less intensively farmed landscapes. The rich alluvial soil on the Tywi River valley bottom near Llangadog has lent itself to agricultural improvement.

This sample area was included as it was known to be intensively farmed and an area where there had been many years of agricultural improvement, so it was considered important to test the methodology in such as landscape. It is not a landscape where one would expect to find a great deal of HNV farmland , albeit that there are small areas that are not farmed, or not farmed intensively, where there is some biodiversity interest as outlined above. It is an area where, other than the river, and the vegetation immediately adjacent to it, what habitats there are contribute relatively little in terms of ecological connectivity. The vast majority of the hedgerows appear to be flailed every year and are without hedgerow trees. Visually they are very important in this landscape, but they are not managed in a way that contributes to a functioning ecosystem. They will provide limited nesting sites for birds, little in the way of winter berries for birds, few song posts for birds, offer relatively little for invertebrates and they will not produce large quantities of flowers. Small mammals are likely to use the base of these hedges but they would be unlikely to support dormice. Bats would find little to feed off here compared to a more mature hedge that would support a richer invertebrate fauna.

It is noted that the HIW identify the Carreg Sawdde Common, important for it wax-caps, as "poor improved grassland " This example should be discussed with Environment Systems that are developing the HIW to see if there is a way of identifying the wax-cap grassland. In terms of its grassland ecology it may be accurately identified as "poor improved".

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In conclusion, and on the basis of this area at least, the HIW can be said to accurately identify the lack of HNV farmland in improved agricultural landscapes.
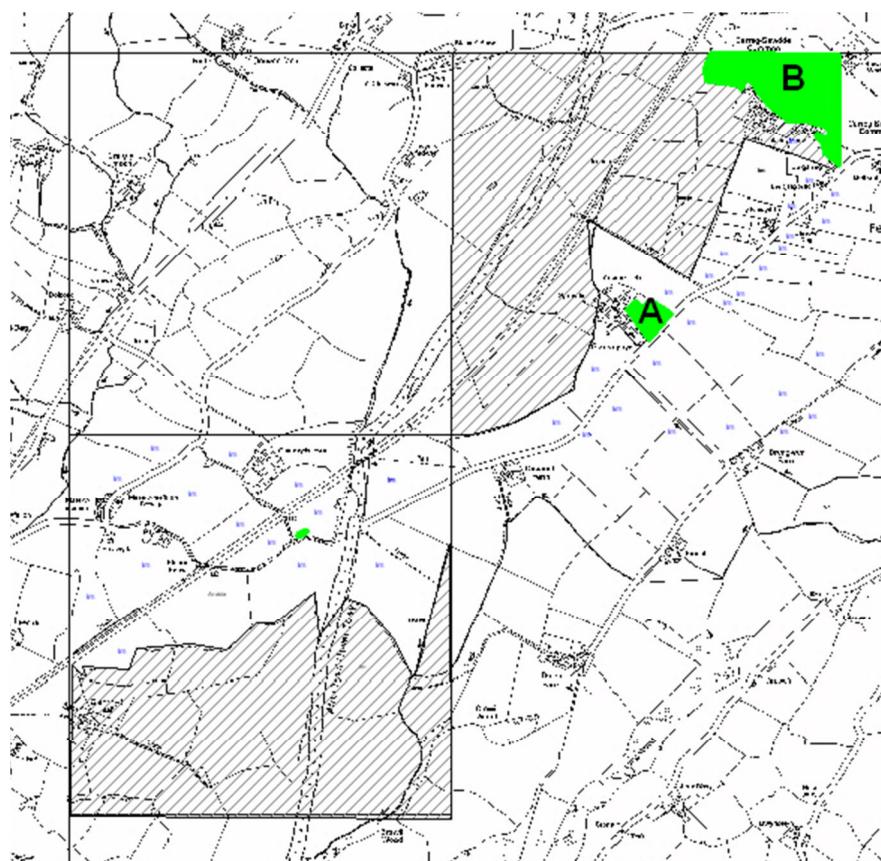

Figure 14. Llangadog case study area
Key to maps: shaded green polygons – HNV; shaded orange polygons – grasslands in need of further survey to establish whether or not they qualify as HNV; shaded black - area not visited during survey; blue outline – not farmed; abandoned; Im - improved grassland; C – young coniferous plantation

	Area	Identification in HIW	HNV?	Field survey Feb 2011 and 2009 aerial photos	HNV?
A	0.6	improved grassland	n	newly planted orchard	not at present
B	4.9	Poor improved grassland	n	semi-improved grassland with notable wax cap fungi	y
Total	5.5		0.0		4.9

Figure 15. Llangadog: analysis of HIW

Figure 16 Agri-environment uptake, Llangadog
(Tir Cynnal outlined in blue, Tir Gofal outlined in red)
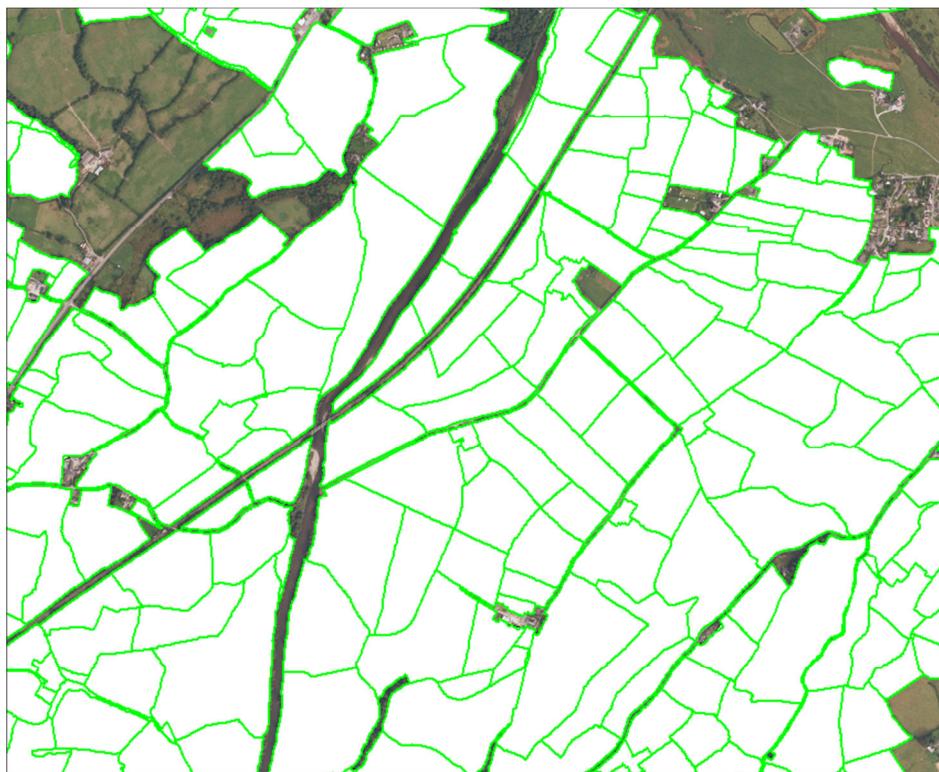
Figure 17 Land not registered in IACS, Llangadog (visible)

6.3. South of Porthyrhyd, Llansawel

An area of rolling hills and river valleys with a diversity of habitats shown on HIW; improved land is found on the more elevated, better drained land, and here the hedges are in fairly poor condition, or have been replaced with a fences. Some of the steeper slopes support broadleaved woodland and bracken - Banc Bwlchdrebannau is one of the few semi-natural upland areas, with unenclosed bracken land with some rocky outcrops There are several small areas of new tree planting both on slopes and in the wetter river valleys.

The river valleys are poorly drained; the grassland here is often marshy and, if not unimproved, dominated by rushes. In the river valleys the hedges tend to be well developed with significant numbers of hedgerow trees - far more than on the more elevated land, giving the impression that the landscape is more wooded than it actually is. This area illustrated the importance for HNV of small damp improved fields that have well developed boundaries and are adjacent to other HNV habitat, such as riparian woodlands as HNV (e.g., west of Cwm To Fach). In this landscape, ecological connectivity is found in the river valleys, not on the higher ground.

Most of the sample area was surveyed from highways and public rights of way. Some areas of grassland require further survey for correct classification. While areas of HNV had been correctly identified as habitat by HIW, the habitats ascribed to them were not always correct. New tree planting was not identified, and areas of semi-improved grassland on the map were found to be slopes with scrub and bracken.

The river valleys in the Porthyrhyd sample area include several small improved fields that are surrounded by well-developed field boundaries – typically broad hedgerows, with tall growth that has not been cut in recent years. Such areas can provide nest sites for birds, as well as autumn and winter berries. In addition they are likely to support a richer invertebrate fauna than a regularly flailed hedge, and will be an important feeding habitat for bats, particularly where they are associated with marshy grassland. These fields and their boundaries are considered to be important for maintaining ecological connectivity in this landscape, and this highlights the need for HNV farm land to consider, in certain landscapes, including small areas of improved land that provides bridges for biodiversity rather than barriers, and such fields are often adjacent to HNV habitats. These are not very productive fields, they tend to be damp, small (typically less than 2.0 ha and often less than 1.5 ha) and shaded by trees. They are very unlikely to be cut for silage or hay. Consequently the structure of the grassland here may well be important for small mammals.

The HIW failed to identify 1.3 ha of HNV in this study area, or 0.65% of the two 1km squares. 8ha, which equates to 4% of the study area was incorrectly classified by the HIW, but this was all identified as HNV in the field.
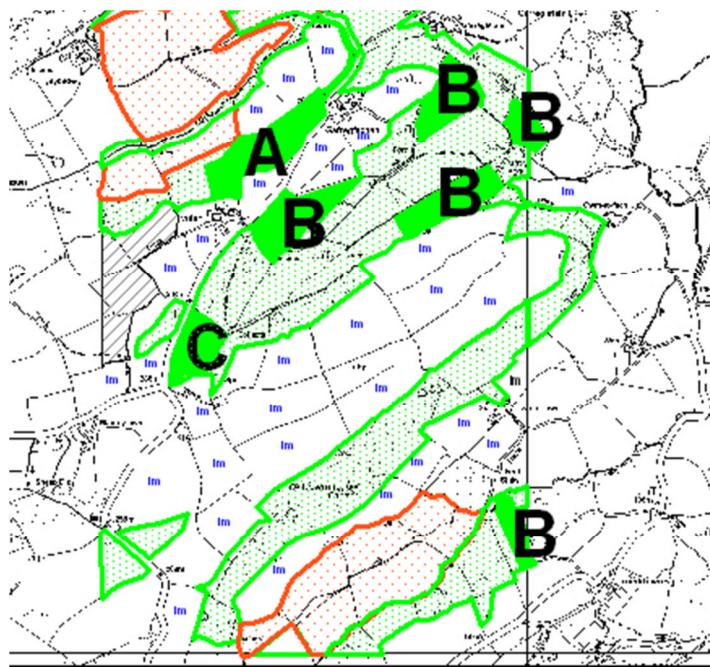
Figure 18. Porthyrhyd HIW analysis

	ha	identification in HIW	HNV?	field survey Feb 2011 and 2009 aerial photos	HNV?
A	2.0	semi-improved grassland	y	bracken and scrub	y
B	6.0	semi-improved grassland	y	thicket stage broad-leaved woodland	y
C	1.3	improved grassland	n	likely be semi-improved - contains large ant hills throughout, requires further survey	y
Total	9.3		8.0		9.3

Figure 19. Key to HIW analysis, Porthyrhyd

Figure 20. (Left) Typical gradation in agricultural improvement with gradient
Figure 21. (Right) Linear features at this site add significantly to nature value, but how important is the context in which they occur in when setting HNV farmland thresholds?

6.4. Gwenffrwd, Rhandirmwyn

Included as an example of farming in a more upland landscape and located in the upper reaches of the Tywi valley, the majority of land in the Gwenffrwd case study is open unenclosed semi-natural hill (and also SSSI and SPA). The Gwenffrwd valley consists of a matrix of small pockets of grasslands, some of which may be unimproved, marshy or tussocky, as well as scrub and woodland. The fields are generally surrounded by well-developed woodland belts, steep wooded tributaries of the Tywi, or marshy grassland, creating a rich mosaic of habitats. Even if improved, these fields appear as an integral part of a farming system that is delivering extensive areas of HNV and themselves form only a very small fraction of the total farmed area.

In the wider Tywi valley there are some larger flood plain meadows that have very weak field boundaries. Two flood plain hayfields are an exception to this – they are more diverse and abut areas of scrub.

Farms here have a very small proportion of flat land, and where this occurs, it has usually been improved. In the Gwenffrwd valley a third type of grassland is that on steeper slopes, sometimes abut in the unenclosed hill land, and often with an element of bracken.

Farming in this area is dominated by sheep with some beef. These farms have a very small proportion of flat land and where this occurs, it has been improved. Fields in this area are small and often, but not always, surrounded by well-developed woodland belts, steep wooded tributaries of the Tywi, or marshy grassland, so while in themselves they may not be considered as HNV, they are an integral part of a farming system that is delivering extensive areas of HNV and form only a very small fraction of the total farmed area, and commonly do so within a valuable mosaic. Without this small proportion of improved and intensively managed grassland, these hill farms would not be able to be farmed as they are at present. This area highlights again the need to consider the case for small improved fields that abut HNV farmland and which provides a bridge from one area of HNV to another, and thus deserve being considered as HNV farmland in their own right.

In the same area there are larger improved fields that have very weak boundaries and offer little nature value in themselves, although they lie between un-enclosed hill land (HNV) and riparian or stream side woodlands (HNV).

The majority of the two 1km squares were surveyed from highways and public rights of way. Having identified the majority of habitat that is considered to be HNV, field survey noted that HIW did not classify all the areas of habitat correctly. A narrow semi–improved field that was surrounded by woodland was classified as woodland, and an area of marshy grassland was classified as scrub, and small areas of marshy grassland were described a fen and flush. In total HIW identified 2.5 ha of habitat whereas the field survey identified 3.6 ha of HNV habitat. While all the habitat areas identified on the HIW map were considered to be HNV, 1.25% were incorrectly classified.
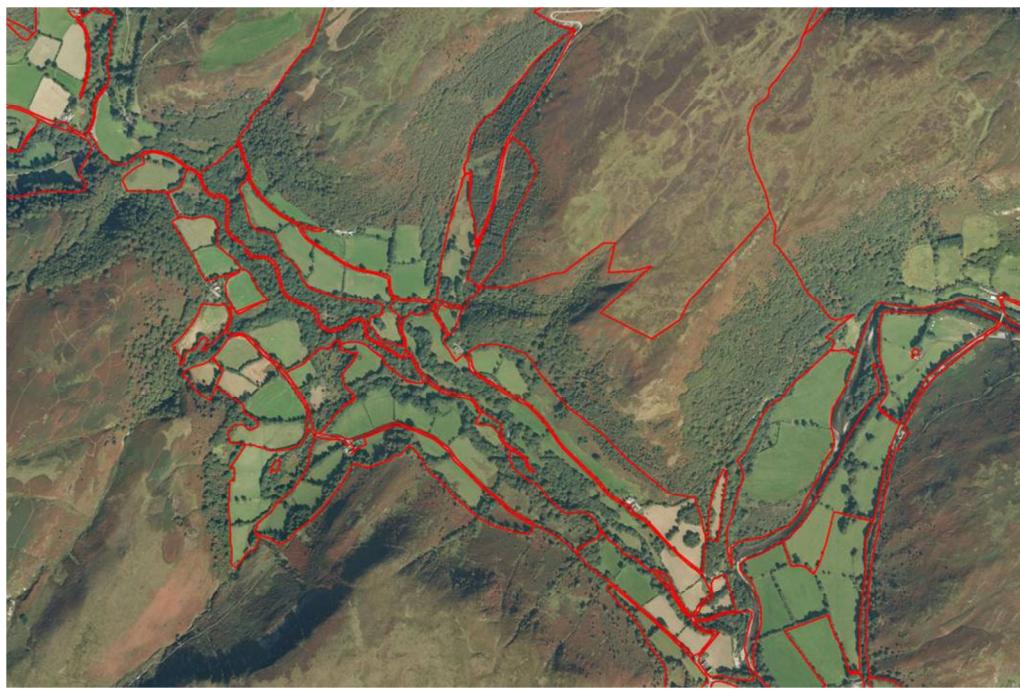
Figure 22. Gwenffrwd case study area, the red lines denote the areas registered under IACS

Figure 23. Some meadows in the Gwenffrwd area are species-rich

Figure 24. Unimproved flood plain habitats are unusual, and therefore valuable, in the Tywi catchment

Figure 25. Semi-natural woodlands, like these bryophyte-rich hazel woods, form part of the HNV mosaic in the Gwenffrwd area

Gwenffrwd exhibits a considerable degree of ecological connectivity, particularly within the main riparian zone, and up onto the hills via the numerous well wooded streams that flow from the hill land into the main river. This area includes riverside hay meadows that are adjacent to a fairly extensive area of riparian scrub land and are considered to be HNV.
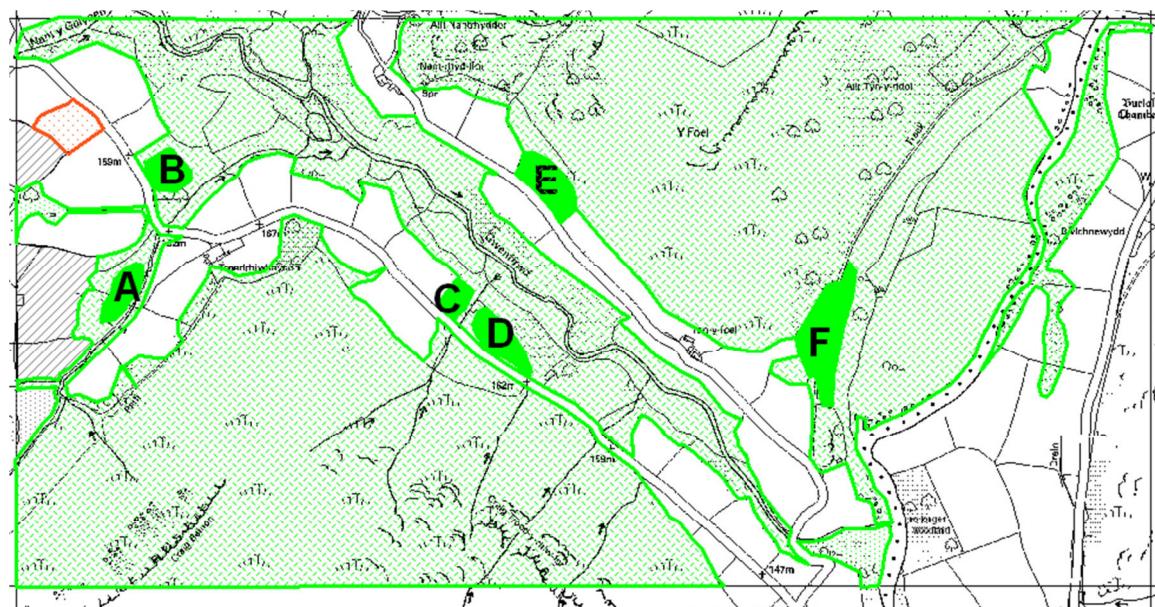
Figure 26. Gwenffrwd HIW analysis

	ha	Identification in HIW	HNV?	Field survey Feb 2011 and 2009 aerial photos	HNV?
A	0.4	unsure of colour, possibly poor improved grassland	y	marshy grassland	y
B	0.5	improved grassland	n	marshy grassland	y
C	0.3	fen and flush	y	marshy grassland	y
D	0.5	fen and flush	y	marshy grassland	y
E	0.6	improved grassland	n	bracken	y
F	1.3	Broad-leaved woodland	y	semi-improved grassland requiring further survey	probably
Total	3.6		2.5ha		3.6ha

Figure 27. Key to HIW analysis, Gwenffrwd

6.5. Llanllawddog

This sample area was included as it included small dairy farms, and was known to the authors. It includes five holdings, each of which abuts forestry land. The farms are typically on gently sloping land with some steeper land, and some wetter valley bottom land. Two of the holdings have been in Tir Gofal for 10 years and two others, having not been part of an agri-environment scheme, are both registered with Tir Cynnal. These have both been managed over the last 40 years as small mixed dairy farms with approximately 40 dairy cows each. The years of dairying have been a driver for maximising grass production, with regular applications of NPK fertilisers and at least two cuts of silage, as well as occasional re-seeding. The fifth holding is managed as a small holding and is let for sheep and horse-grazing with some silage being produced. All farms were surveyed from roads and forest tracks.

Despite the different ways in which these farms have been managed there all have comparatively little HNV, and what there is tends to be inaccessible or difficult to manage.

All the farms border Forestry Commission land, some of which is broadleaved woodland, so the farmed landscape here is buffered by a significant amount of woodland edge. This area highlights the importance of woodland edge in providing nature value to farmland, though not strictly farmland itself. Woodland edge contributes to the ecological connectivity and overall biodiversity of the area, (the edge often being more diverse than the wood itself). Unless the hedgerows in this area are particularly well developed they have been discounted from the HNV habitat mapping in

this study. On the HIW the weakest hedges are shown as discontinuous lines of habitat or as no habitat. There is some discrepancy here within the HIW, as areas of poor improved grassland – often dominated by Juncus spp. are mapped as marshy grassland, or as improved grassland, whereas in the Llystyn, Brechfa sample they are mapped as poor improved grassland. This is one area where the HIW needs to be more accurate and consistent, particularly as these habitats may well be borderline HNV.

Ecological connectivity is provided by the river valley and river side vegetation, small pockets of HNV e.g. poorly drained tussocky grassland, semi-improved grassland and hedgerows, and the woodland edge.

In the Llanllawddog the HIW failed to identify 1.9ha of HNV farmland, equivalent to 0.95% of the two 1km square sample area. It incorrectly classified a further 0.1ha of scrub and semi-improved grassland as woodland and improved grassland – a further 0.05% of the area.
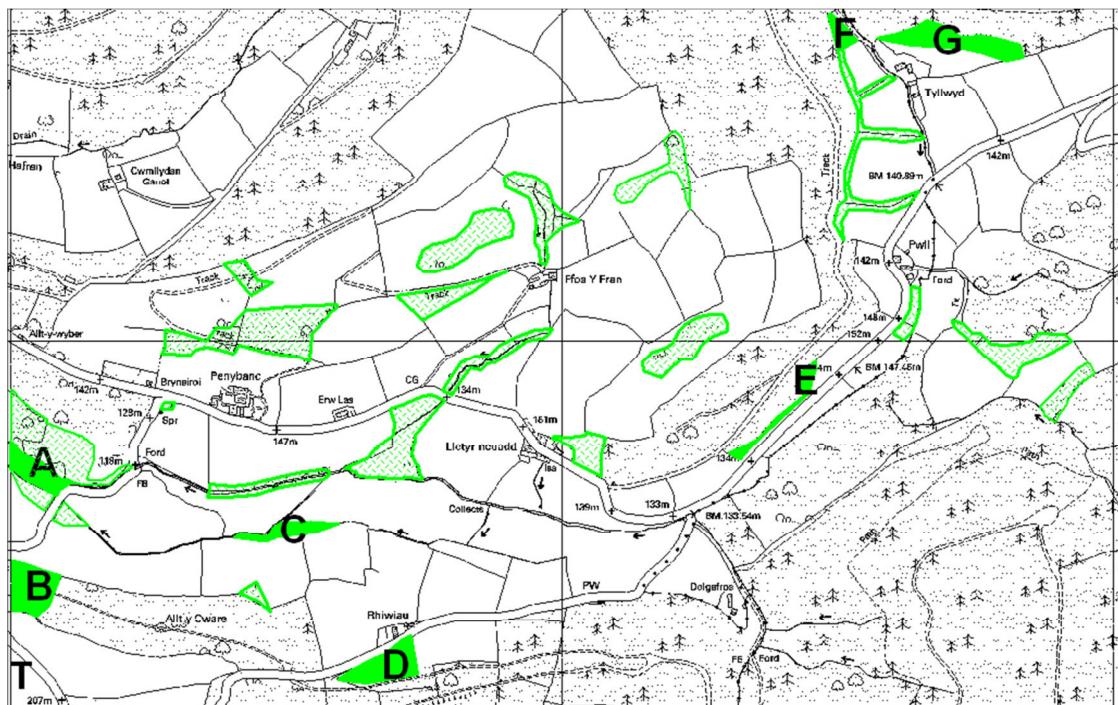

Figure 28. Llanllawddog HIW analysis

	Area	Identification in HIW	HNV?	Field survey Feb 2011and 2009 aerial photos	HNV?
A	0.4	improved grassland	n	marshy grassland/poor improved grassland	y
B, within forest land	0.6	semi-improved grassland	y	thicket stage mostly broad-leaved woodland	y, but forestry
C	0.3	improved grassland	n	marshy grassland/poor improved grassland	y
D	0.5	improved grassland	n	semi-improved grassland	y
E	0.2	hedge	y	scrub(gorse)	y
F	0.1	woodland and improved grassland	y	scrub and semi-improved grassland	y
G	0.7	improved grassland	n	semi-improved grassland with scrub	y
Total	2.8		0.3ha, excl. forestry		2.2ha excl. forestry

Figure 29. Key to HIW analysis, Llanllawddog

6.6. Llystyn, Brechfa

This sample was included as it was known to the authors and provides an insight into the impact of an organic system on HNV and a farm where nature conservation has had a considerable impact on decision making. Llystyn is set above the Cothi on the east facing valley sides. Over the past 20 years the owner has been proactive in managing the land to conserve and enhance its biodiversity. Several fields are recorded as semi-improved and are known from Tir Gofal to be particularly rich in flowering plants. Farmland birds have been recorded by RSPB as part of the Farmland Bird Survey. Existing woodland is managed and these areas have been extended and linked by new planting under various forestry grant schemes (although the new planting is difficult to see on aerial photographs).

Figure 30. Aerial image of Llystyn, Brechfa

As a result of the positive decisions as to how the land is managed, Llystyn now supports a significant area of HNV farmland. The hedgerows are well managed on the whole, but not particularly well developed and there is only one significant water course on the farm –along its northern boundary, which is not part of a habitat management scheme. On first impressions there seems to be relatively few linear features such as mature hedgerows, water course, woodland that would contribute to ecological connectivity, but on further analysis there is a considerable amount of semi-improved land on the farm as well as new woodland, so that the overall picture is one of contrast with Llanllawddog.

In contrast to the previous sample areas the areas identified as HNV at Llystyn are integral to the management of the farm – several of the fields qualify. In other samples it is the less accessible areas – wetter fields and the steep slopes that contribute to the HNV land; the majority of the land that can be improved has been. Llystyn is managed to meet organic standards, and also to conserve and enhance biodiversity. It is an example of a different farming system and benefits of this approach, in terms of delivering HNV, are easy to see in Figure 31.
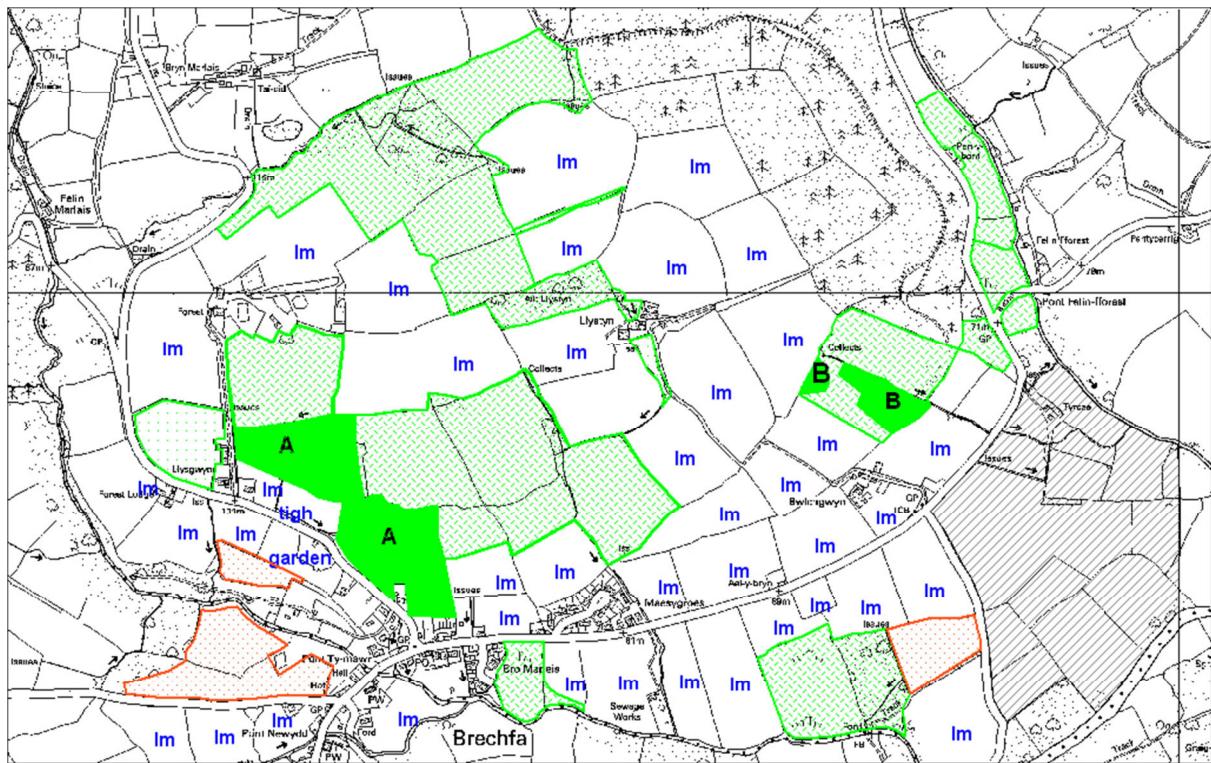
Figure 31. Llystyn, Brechfa case study area

Key to maps: shaded green polygons – HNV; shaded orange polygons – grasslands in need of further survey to establish whether or not they qualify as HNV; shaded black - area not visited during survey; Im - improved grassland.

	Area	Identification in NHIW	HNV?	Field survey Feb 2011, 2009 aerial photos, Tir Gofal records	HNV?
A	6.0	poor improved with some semi-natural grassland	y	semi-improved grassland	y
B	1.0	improved grassland, with some areas of semi improved grassland in the same field	n	semi-improved grassland throughout	y
Total	7.0		6.0		7.0

Figure 32. Llystyn, Brechfa - analysis of HIW
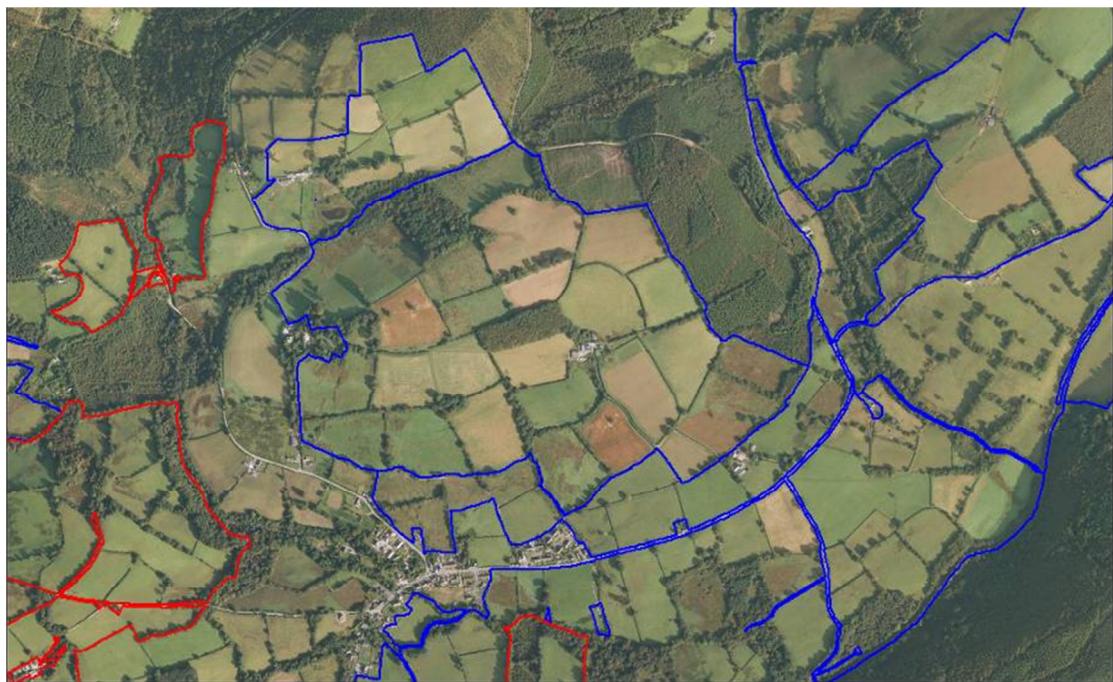
Figure 33. Agri-environment uptake in Brechfa
(Tir Gofal outlined in blue, Tir Cynnal outlined in red).

6.7. Carmel

The Carmel limestone ridge (and National Nature Reserve / Special Area of Conservation) contrasts with the wetter, poorly drained rhos pasture of Mynydd Mawr to the southwest. This once featured a thriving limestone quarrying industry, with abandoned quarries and limekilns dotted along the ridge (and a working quarry to the east of the study area). There is a rich mix of ancient and secondary woodland, neutral, calcareous and acid grassland, bracken, rush pasture and scrub.

Most of the HNV habitats lie in the western part of the reserve, which is managed for biodiversity by The Grasslands Trust. Most of this land is in receipt of agri-environment payments, and is grazed by local graziers. There is a considerable area of semi-improved neutral grassland here, much of it of reasonable quality with some species-rich patches; this was identified by both the Phase 1 survey and the HIW maps as improved grassland. The area along the ridge to the east of The Grassland Trust reserve is in private ownership but managed by CCW. Nearly all of the surveyed grassland here (and the area outside of and to the north of the reserve) is improved to poor improved, and intensively grazed by horses, sheep or cattle. Wetter areas feature rushy patches, which range from poor improved (very short grazed with patches of rush) to occasional HNV fields of rush pasture featuring a greater range of species.

The majority of holdings are IACS registered and in agri-environment schemes (Figure 36 & 36). The landscape contains a large amount of wooded habitat, which provides a connected habitat network for a rich range of woodland species, but is outside of the farming systems; the hedgerows are of variable quality.
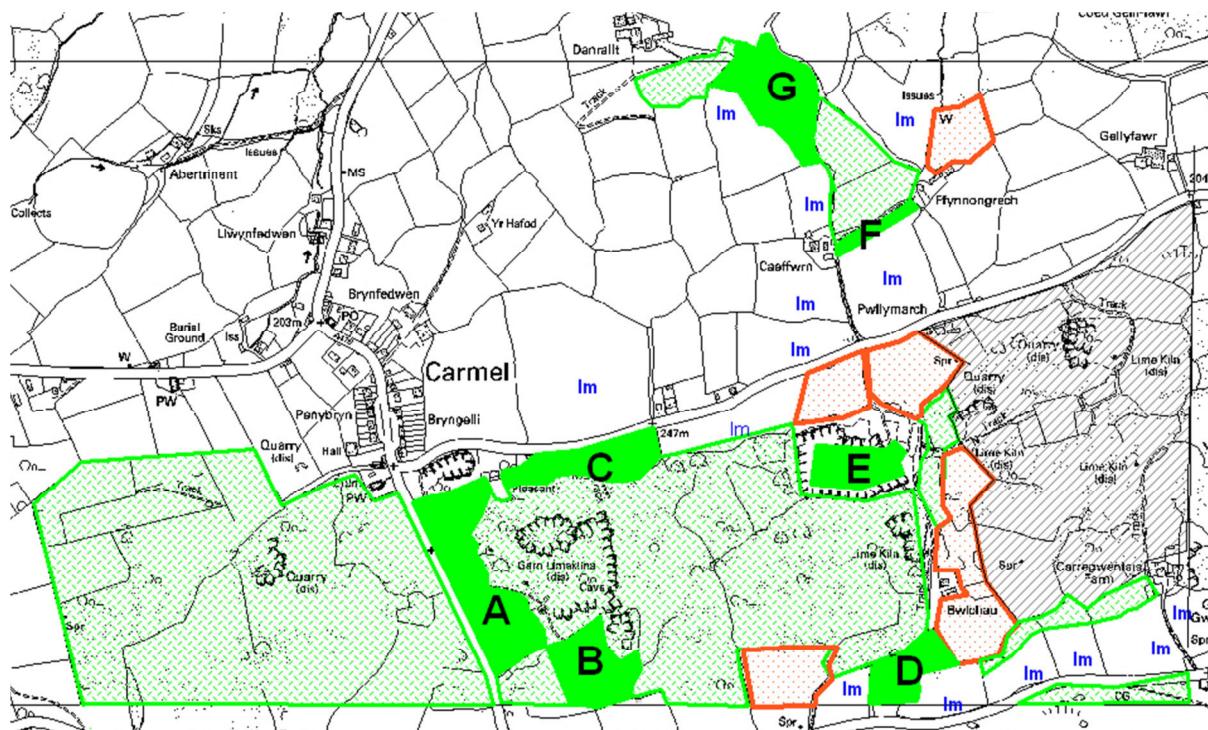
Figure 34. Carmel case study area

Key to maps: shaded green polygons – HNV; shaded orange polygons – grasslands in need of further survey to establish whether or not they qualify as HNV; shaded black - area not visited during survey; Im - improved grassland.

	Area	Identification in HIW	HNV?	Field survey Feb 2011 and 2009 aerial photos	HNV?
A	2.3	improved	n	semi-improved	y
B	1.2	improved	n	semi-improved	y
C	1.0	improved	n	semi-improved	y
D	0.7	improved with few pixels semi-improved	n	improved with broad semi-improved edge	n/y
E	0.8	bare ground	n	quarry floor covered in moss	y
F	0.2	improved / poor improved	n	semi-improved	y
G	1.6	improved/ poor improved	n	semi-improved	y
Total	7.8		0.0		7.1 - 7.8

Figure 35. Carmel - analysis of HIW
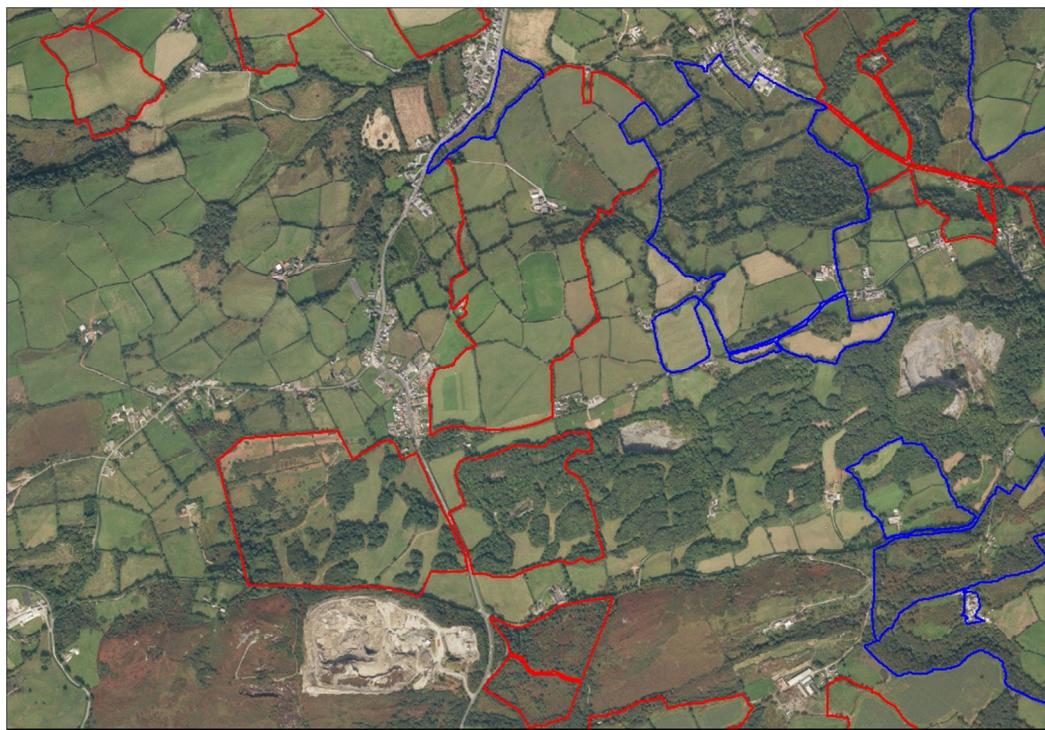
Figure 36. Agri-environment uptake, Carmel

(Tir Cynnal in
red; Tir Gofal
in blue)
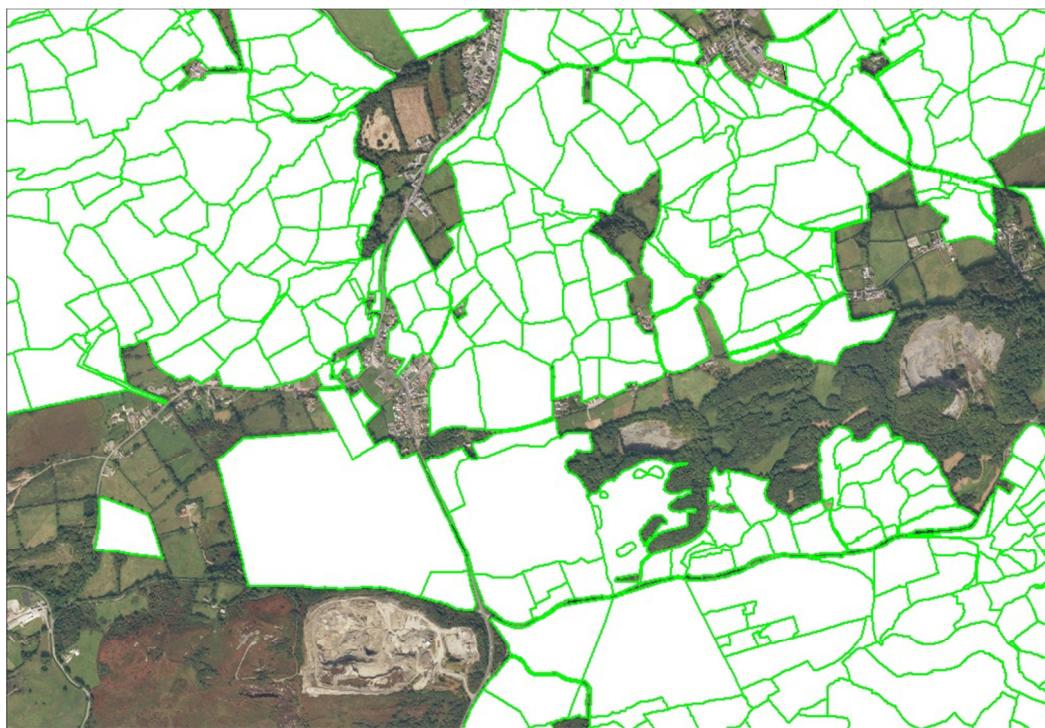
Figure 37. Land not registered in IACS, Carmel (visible)

6.8. Mynydd Mawr

The sample was included to highlight the characteristics of land management and habitats in the Carmarthenshire coalfield. This summary is based on the experiences of the Mynydd Mawr Project (a partnership between Butterfly Conservation Wales and CCW), which focused on the management of so-called 'rhos pasture' in a 24km^2 area around Cross Hands.

The Mynydd Mawr maps have been compiled using data collected as part of the CCW/Butterfly Conservation Mynydd Mawr Marsh Fritillary Project carried out in 2010. Only fields that were suspected of being suitable for the Marsh Fritillary were surveyed (although not all did prove to be suitable), and they were surveyed during the growing season. Thus they provide a useful additional test of the HIW maps in identifying HNV farmland.

This landscape contains over 250ha of land considered potentially-suitable for the Marsh Fritillary butterfly (tussocky grassland with Devil's-bit Scabious), along with a network of plentiful scrub, small copses, hedgerows, streams and other HNV habitats. A small amount of this land is designated as SSSI and SAC for this butterfly, but much of the habitat which is used by the metapopulation is not designated in any way.

Mynydd Mawr is a 'rural fringe' landscape of small land parcels in numerous ownerships, with an average field size of 1.43ha (range 0.13 to 4.86ha). Within this landscape is a mix of residential, retail and light industrial development, which disrupt the connectivity of the remaining marshy grassland and other HNV habitats. Most of the owners are not IACS registered (Figure 38), and rarely enter agri-environment schemes (Figure 41). They have different priorities and different ways of thinking about their land from farmers, for example, usually not looking for an economic return on their land.

Many owners have no stock, and much of the land has been abandoned to become rank and scrubby. While this does provide habitat for small mammals, birds, etc., large areas of what were species –rich grassland are deteriorating.

*Figure 38. Land not registered in IACS on Mynydd Mawr (visible)*
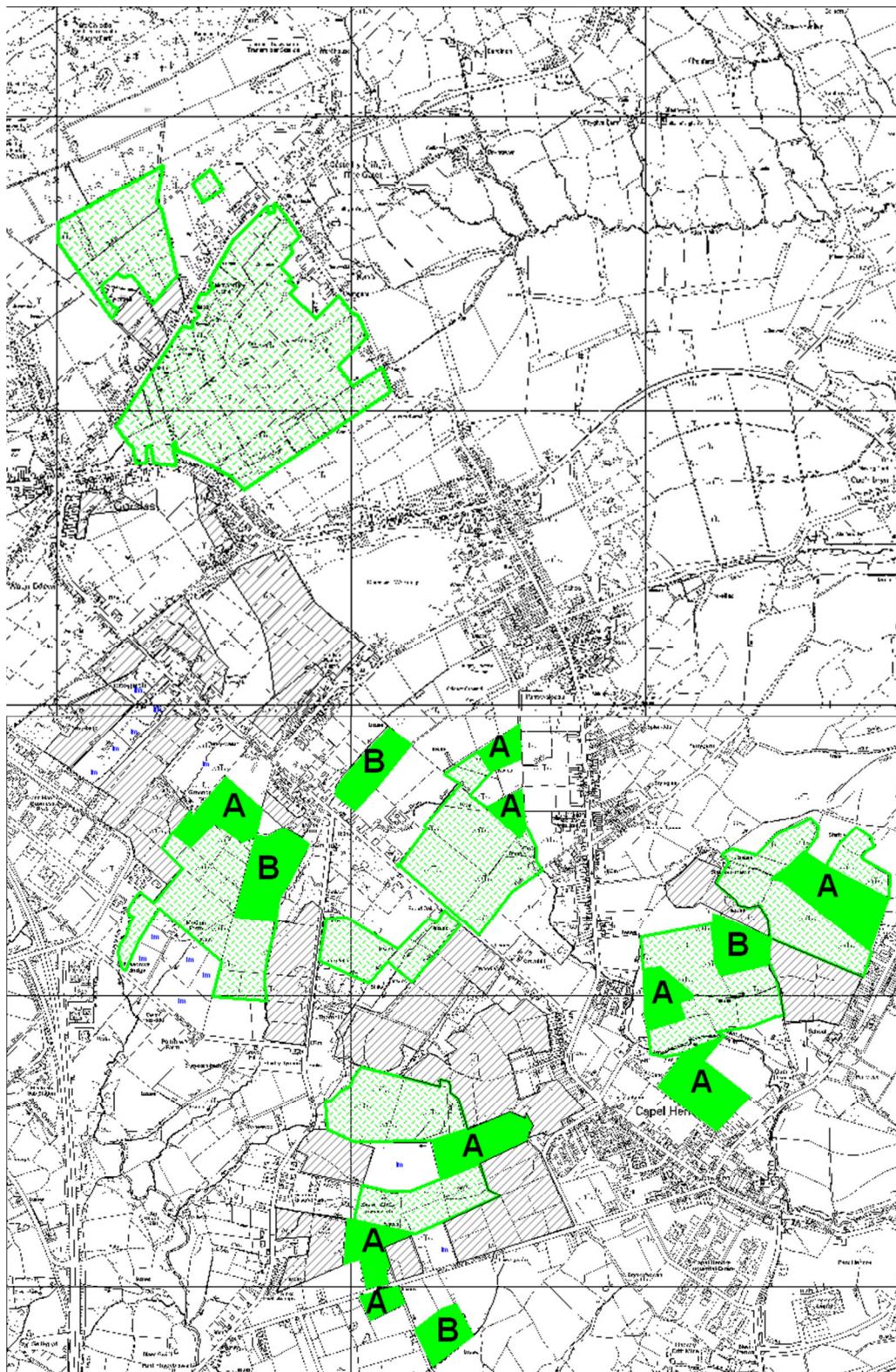
Figure 39. Mynydd Mawr case study area

Key to maps: shaded green polygons – HNV; shaded orange polygons – grasslands in need of further survey to establish whether or not they qualify as HNV; shaded black - area not visited during survey; blue outline – not farmed; abandoned; Im - improved grassland; C – young coniferous plantation

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	Area	Identification in HIW	HNV?	Field survey Feb 2011 and 2009 aerial photos	HNV?
A	27.0	shown as mix of poor improved, semi-improved and marshy grassland	y	all considered to be marshy grassland	y
B	13.1	poor improved grassland	y	semi-improved grassland with notable wax cap fungi	y
	41.0		40.1		40.1

Figure 40. Mynydd Mawr - analysis of HIW
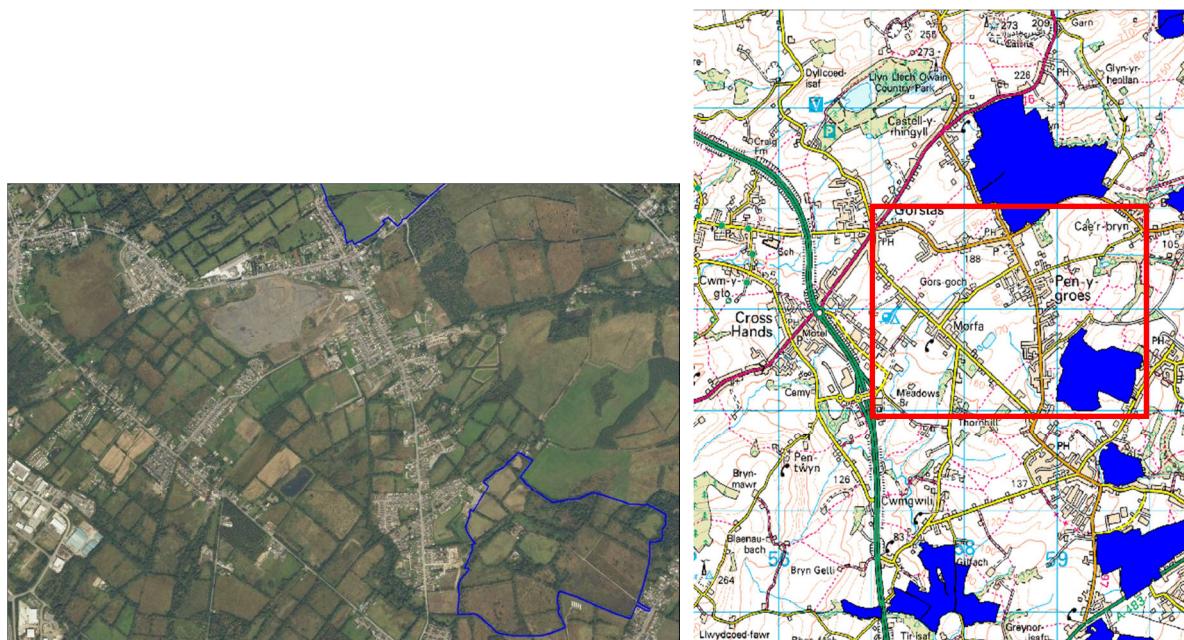
Figure 41. Agri-environment uptake on Mynydd Mawr

At the other extreme, over-grazed horse pastures also have limited value for biodiversity. Their botanical interest declines over time; little habitat is available for invertebrates, mammals or birds. Horse ownership is widespread in Mynydd Mawr, and horse-grazed land varies from sensitively grazed mosaics to short lawns with rank latrine areas produced by year-round overstocking.

7. Initial conclusions on using HIW as a means of identifying HNV farmland

As the development of the HIW progresses it will be ground-truthed (summer 2011) and it is expected that a significant proportion of the errors that have been identified by this project can be rectified. The HIW was planned to be accurate at a scale of 1:25000, so it is ideal for field by field analysis; however this scale limitation should be taken into account when considering the accuracy of mapping narrow features such as hedgerows. In this respect it is more akin to CCW's Phase 1 survey than a more detailed Phase 2 survey.

The errors identified in the study were as follows:

Sample	Size of sample	Area of HNV identified by HIW (ha)	Area of HNV identified from 2009 aerial photos and fields survey (ha)	Area of HNV missed by HIW (ha)	% HNV correctly identified as an HNV habitat by HIW	% HNV not identified by HIW
Llansadwrn	1km^2	6.8	8.1	1.2	84%	16%
Porthyrhyd	2km^2	8.0	9.3	1.3	86%	14%
Gwenffrwd	2km^2	132.5	133.6	1.1	99%	1%
Llanllawddog	2km^2	0.3	2.2*	1.9	14%	86%
Llystyn Brechfa	(whole farm)	6.0	7.0	1.0	86%	14%
Dolau, Felindre	2km^2	0.0	4.2	4.2	0%	100%
Carmel	-	46.2	54.0	7.8	85%	15%
Mynydd Mawr	-	160.2	160.2	0.0	100%	0%

Figure 42. Analysis of HIW - summary for 3 areas

In this study HIW has been used in eight different agricultural landscapes across East Carmarthenshire. While some shortcomings have been identified below, HIW has been able to identify at least 84% of the semi-natural farmed vegetation within six of these samples areas. No instances were identified where HIW identified an area as being semi-natural when it did not appear so on the ground or on aerial photos, which is a very significant positive attribute of HIW.

HIW appears to be reliable in identifying HNV habitat – i.e. land that would qualify as HNV in East Carmarthenshire. The amount of habitat land it fails to identify is less than 16% in six of the sample areas of the HNV identified in field surveys and aerial photos as part of this study. The two samples where it was least accurate were the areas where there was least HNV. In the Tywi sample a new orchard was not identified, this was planted over the last 2 years, and grassland in the field in which is located would be described as improved, so this error can be explained. Carreg Sawdde Common was correctly identified as poor improved grassland, but it is also known to be rich in wax-cap fungi. The second sample where the identification of HNV by HIW was poorer was in Llanllawddog. Here much of the HNV consists of narrow strips of habitat rather than entire fields. Some of the HNV areas identified in the field were at a scale below which HIW aims to be accurate, e.g. marshy grassland adjacent to the river, areas A and C on Figure 28, and these were missed, as was a narrow field of semi improved grassland on the forest edge, which may well be an error that HIW can correct. Another small field was identified as woodland but is surrounded by trees, making difficult to identify using remote sensing. It is also in this area that thicket stage woodland was classified as semi-improved grassland (although this area was excluded from the analysis as it was not farmland).

While appearing to be acceptably reliable in identifying HNV in most samples, HIW does not always correctly identify the precise habitat. For example, it is noted that marshy grassland has been identified as fen/flush; since both of these would qualify as HNV habitats; this error does not reduce the maps' effectiveness for the purpose of identifying HNV per se.

Problems with the draft HIW in the case study sample areas include:

HEDGEROWS AND WOODLAND
- Edge effect. Width of hedgerows and woodland edges are over or under-estimated, due to the shadow cast or lost (depending on the time of day the aerial photograph was taken), e.g. Llansadwrn. The extent of adjacent grassland is then over- or more frequently, under-estimated. Some small fields have been mostly or entirely mapped as woodland (Figure 10 Llansadwrn, and also in Gwenffrwd, and Llanllawddog). Since field size may be a key feature of the HNV indicator (small fields being less likely to have been agriculturally improved), this needs to be addressed if it is important to distinguish between woodland and grassland. If all

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small fields and all woodland were to qualify as HNV, the map would be useful as it is. Environment Services are addressing this problem and have improved their methodology since producing the East Carmarthenshire maps, but the time of day that satellite images are taken, and the consequent amount of shade, will remain an important factor.

- Hedgerows: the appearance of a hedge line on the HIW map should be treated with caution and not necessarily as a guide to its condition. A recently laid or coppiced and fenced hedgerow may appear as a weak narrow feature, as might a gappy, species-poor hedge. The maps appear to identify larger hedgerow trees as a widening in the hedge line, but smaller hedgerow trees are not identified.

NEW WOODLAND PLANTING
- Maps do not identify areas of new woodland planting e.g. in the Porthyrhyd case study area. This data would be available in GIS format from the Forestry Commission as it is practically all grant aided.

GRASSLANDS
- The maps do not consistently distinguish between
  o semi-improved
  o marshy grassland
  o fen and swamp
  o poor improved grassland
  o improved grassland

- Broadly similar *Juncus* dominated grasslands appear to be categorised as one of the following in Llanllawddog:
  o improved
  o marshy grassland
  o poor improved

- Short-grazed grassland appears to be difficult to categorise, whether by satellite data or field surveys. The remote data is not at a fine enough scale (10m) to identify species or to differentiate between herbs and grasses, but it can identify horizontal versus vertical spread, as a tool to identify the proportion of herbs to grasses, along with the amount of productivity, the amount of dead and living material and the shading by taller swards. Hence improved short swards appear similar to semi-improved short sward, unless there is a difference in productivity that can be identified.

Identification of different grassland habitats could be improved by comparing HIW data with areas where Phase 2 grassland surveys have been carried out by CCW.

Revised editions of HIW will be available in 2012 and the maps will continue to be improved as more data becomes available. With the revisions and improvements that are expected, HIW could provide a key tool for identifying HNV farmland in East Carmarthenshire, and across Wales, in association with aerial photographs. Similarly the two could be used for monitoring HNV farmland.

While accurate mapping of plant communities within individual fields will continue to rely on field survey, (HIW does not attempt to map at this level of detail, it aims at accuracy of 1:25000), HIW will provide useful information as to where HNV is likely to occur and where to target further field survey. Any grant scheme that relies on HIW for identifying habitats should also include ground-truthing of an agreed sample of sites, firstly to ensure accuracy, and secondly to continue to improve the accuracy of the HIW.

As it appears that the HIW could greatly assist in identifying HNV it is imperative that there is a clear understanding of the habitats that are considered to contribute to HNV and those that do not. One habitat that requires clearer definition is poor improved grassland. At present HIW identifies a range of grasslands within this category from

- those which are improved with occasional small areas of *Juncus*, but with no tussocks providing any structure to the grassland, and where the sward is closely grazed apart from the rush areas,
- to fields where *Juncus* is a dominant species and there is a tussocky structure to the habitat.

It is suggested that for poor improved grassland to qualify as HNV the habitat should
- provide some element of structure
- ideally be located adjacent to other HNV habitats, including mature field boundaries and water courses
- occur in relatively small fields under a certain size e.g. less than 1.5 ha in East Carmarthenshire.

Structure is a key feature because it proves habitat for small mammals, invertebrates and amphibians along with their predators. It may also be used by ground nesting birds. HIW is likely to be able to identify this type of habitat if appropriate parameters are set for its recognition, and to distinguish it from grasslands that do not provide these attributes.

In conclusion, it seems likely that HIW will provide a reliable way of identifying semi-natural farmed vegetation, except possibly in the case of the smallest hedged fields.

8. Land Parcel Information System and Integrated Administration and Control System (LPIS-IACS). What can these systems contribute towards the identification of HNV farmland?

Integrating semi-natural vegetation inventories with the Common Agricultural Policy (CAP) Land Parcel Information System (LPIS) is a very desirable step, which has been undertaken already by some Member States (e.g. Bulgaria and Slovakia). CAP payments are made through a combination of LPIS and the Integrated Administration and Control System (IACS), on the basis of individual field parcels within the holding. Even if HIW accurately identifies most semi-natural vegetation, LPIS information is needed for two reasons. First, policy is delivered mainly through the CAP, and therefore through LPIS. Secondly, LPIS parcel boundaries provide addition information with which to address the 'small field' issue.

The LPIS data held in CCW's Geographical Information System was interrogated to enable an analysis of the information held within it to be carried out. The WG's GIS team was consulted, to confirm what, if any, additional farm practice data was linked into their LPIS. The WG's Single Application Form was used to ascertain what information captured in IACS could be useful to link to the LPIS Farm Boundary and Field Information layers in GIS in order better to identify HNV farmland.

For the sample areas LPIS information was overlaid onto the aerial imagery layer to determine if there was HNV land that was not IACS registered and whether the proportion of unregistered HNV land varied within the study area, as had been suspected for Mynydd Mawr, for example.

Consideration was also given as to whether it would be possible develop the LPIS-IACS databases further to incorporate HNV variables.

It was found that the LPIS used by CCW and WG provides information on;
● Farm boundaries
● Size of parcel
● Less Favoured Areas/non-LFA
● Agri-environment scheme participation (Organic Farm Scheme, Tir Cynnal and Tir Gofal), including Tir Gofal habitat codes

The current CCW/WG LPIS does not provide information on farming characteristics/management practices such as;
● Type of farm and farming system
● SPS land use/crop codes
● Livestock type, livestock numbers or livestock units
● Common grazing rights/additional forage land

The farming practices data that is not currently available in LPIS is captured to some extent on the Single Application Form. It would be possible to attach additional data deemed useful as a potential HNV indicator into the GIS LPIS farm boundary and field information layers, linked via individual customer reference numbers (CRN). This information could then be filtered, for example:

• Farms with greater than X number of land use codes or farms with codes indicative of HNV habitats and features.
• Land use codes that could potentially be used to indicate semi-natural vegetation ('Type 1') and land cover diversity ('Type 2') are provided in the table below.

Semi-natural Vegetation codes	Arable Codes	Feature Codes (Ineligible for SPS)
GR2 Permanent grassland > 5 yrs.	BA1/3 Barley	ZZ90 Bracken
HE3/HE7 Heathlands	MC1 Cereals Mixed fodder	ZZ93 Ponds, Rivers and Streams
OR1 Orchards	FA1 Fallow	ZZ96 Scrub
GW1/BW1/WS1 Woodland	OA1/3 Oats	ZZ98 Individual trees, stumps
SC2 Streamside corridors	SW3 Swedes	
RE3 Reed beds	TU1 Turnips	
	WH1 Wheat	
	WB1/WB2 Wild bird Cover	

Figure 43. Potentially useful Land Use Codes from Single Application Form

Unfortunately, data on farming characteristics and practices recorded on the SAF were not readily available within the timescale of this project, so were not tested against the initial interpretation of land within the sample sites considered to be HNV on ecological grounds.

8.2. Limitations and considerations for development of the LPIS-IACS databases

Data on farming practices such as stocking density, land use and input use is not available within LPIS. In addition, information which is captured on the SAF submitted annually by landowners has its limitations for providing an accurate picture of how HNV land within a holding is managed.

8.2.1. Stocking density

The Welsh Single Application Form requires the provision of information on the total number of animals in different type and age categories, from which livestock densities per forage hectare could

then in theory be calculated. However, the current Welsh SAF requires that this reflects the livestock owned on the date of submission of the form, and therefore may not provide a stocking density that could be an accurate indicator of low intensity grazing on that holding throughout the year. Furthermore, although common grazing rights and land on long term grazing agreements are recorded in IACS, information is not requested relating to additional forage used on short term. Livestock densities could appear higher using figures recorded on the SAF than in reality, if additional short term grazing is used through the year or conversely, if a landowner has no stock and rents land out to third parties, numbers will be under recorded on that holding.

An average stocking rate per hectare per year on the holding, taking into account livestock movement on and off the farm throughout the year (grazing days) may provide a more useful indicator for the purposes of identifying extensive HNV systems.

In addition, it should be questioned as to whether a stocking density per ha is meaningful on a 'Type 2' farm with a high proportion of improved agricultural land and where semi-natural areas within the holding may be grazed at a lower density. In this instance, the average whole farm livestock unit/ha/yr could appear high, but not be indicative of how a particular holding manages semi-natural forage in reality. The mixed organic farm within this study (site 6) exemplifies this point quite clearly, in that the average whole farm stocking density per annum was calculated to be greater than 1.4LSU/ha, however the semi-improved pastures on the holding were grazed at 0.75LSU/ha and the unimproved marshy grassland not more than 0.4LSU/ha.

8.2.2. Land use codes

Current land use codes are limited in distinguishing semi-natural farmland (Figure 43). The permanent grassland code GR2, is used for unimproved, semi-improved or improved grassland that has not been ploughed or reseed for over five years. Permanent grassland reseeded directly back into grass within the last 12 months should be declared as GR8 on the Welsh SAF, thus GR1 (temporary grassland) and GR8 could be disregarded for the purpose of identifying HNV grassland. It would be useful to develop the SAF to include additional codes to separate out permanent grassland GR2 to indicate semi-natural forage at the parcel level i.e. distinguishing it from grassland that has been heavily fertilized.

This could be quite simple, for example, all landowners claiming SPS would declare GR3 semi-improved/unimproved pasture and GR4 semi-improved/unimproved hay meadow on their SAF, which could be linked in to LPIS to indicate HNV farmland. For land to be entered under the semi-improved/unimproved land use codes it could be specified that the parcels would not have been ploughed, reseeded or had inorganic fertilizers or biocides applied for the previous five years, removing the need for the landowner to be able to identify grassland habitats.

Additional land use codes for semi-natural habitats may also help when cross checking land declared on the SAF with agri-environment schemes, with cross-compliance and with Environmental Impact Assessments.

Similarly, the current arable codes do not indicate input use, particularly biocides, but low intensity arable codes could be incorporated into the SAF/IACS and linked into LPIS, for example, BA4, unsprayed barley with the retention of winter stubbles.

Further refinement of the land use codes and their definitions would be an important consideration, to enable data to be captured in LPIS- IACS that reflected the appropriate management of semi-natural farmland.

Farm features that make a significant contribution to HNV are not included in LPIS-IACS. Simple questions could be asked on the SAF to include these features, for example, the length of hedgerows on the holding managed traditionally each year.

Available data sources are currently inadequate for use as accurate indicators of HNV. Existing data sources on land cover and farming characteristics will give only an approximate picture of the extent of HNV farming.

Furthermore, significant areas of farmland of importance for biodiversity may be overlooked, namely HNV not registered on LPIS-IACS. Within East Carmarthenshire unregistered semi-natural land was picked up in all but one of the sample sites, with Mynydd Mawr containing the highest proportion of unregistered land. This land is of course by definition outwith the 'reach' of RDP measures.

Although more land is registered in Llansadwrn, there is still HNV farming which falls outside the LPIS-IACS systems.

9. Farming High Nature Value farmland in East Carmarthenshire – the socio-economic aspects

The way that agricultural production systems are managed is one of the most important factors affecting HNV farming and its sustainable use. The decisions on how to manage farm systems are in turn driven by socio-economic factors, such as the benefits and costs farmers and land managers realise in adopting different approaches. Government policies also affect the incentives and constraints farmers face in making their management decisions.

In order to gain a better understanding of the use and management of HNV farming and the factors influential in maintaining farmland biodiversity in East Carmarthenshire, four farms representing different farming systems were interviewed during the pilot study in February 2011. The case studies were:
    a) Hill Sheep and Cattle Farm
    b) Upland Mixed Organic Farm
    c) Smallholding
    d) Lowland Dairy Farm

These farms were visited and face-to-face interviews conducted. The interviews were semi-structured, and to ensure consistency and comparability they all covered the following themes:
1. History of farm business, current and possible future trends
2. Finance – subsidies, grants, other employment etc.
3. Management, costs and benefits of HNV farming
4. Market, direct sales, diversification etc.
5. Socio-economic impacts
7. Significance of the HNV farming to farm business
8. Personal motivation to maintaining the HNV farming

9.1. Analysis of management of HNV farmland in the four main farming systems present in the area

The costs and benefits of managing HNV Farmland within the four farm systems are summarised in Figure 44.

Use and Management of HNV farming	Cost to Farm Business	Benefits to Farm Business
Grazing	- Low carrying capacity - typically an average of 0.25 -0.4 LSU/ha/yr for unimproved pasture - Often restricted to summer months – need to rent land for winter grazing - Suitable low productivity and traditional breeds are smaller, slower to fatten – reduced competitiveness - low economic return	- Herb rich fodder - Unimproved wet land can still produce good grazing - critical in dry summers when improved grasslands may fail to produce enough forage
Hay Making	- Labour intensive compared to silage - Tir Gofal payment rate reduced post review from £145 to £90 (same rate as for pasture).	- Herb rich winter fodder - Limited inputs – FYM every other year - Social event – help from friends and neighbours
Heather Management	- Labour intensive - Cost supported by Tir Gofal capital payments	- Regeneration of heather - Reduced fire risk – old leggy stands targeted for management
Scrub/ Bracken management and control	- Limited potential for machinery use – inaccessible and dangerous on slopes - Hand cutting labour intensive - Cost supported by Tir Gofal capital payments	- Opens up more areas for grazing - Improved animal welfare - Decreased fire risk
Control of Soft Rush	- Wet ground can restrict the use of machinery – hand cutting, labour intensive - Restoration cutting allowed but no grant payment.	- Allows more palatable grazing - Enhanced grazing and spp. diversity in areas dominated by Molina and rush
Hedgerows	- Traditional management is labour intensive - Hedging contractor – costs offset c. 50% by Tir Gofal	- Provides wood fuel - Provides additional employment
Woodland	- Grazed woodland low Tir Gofal payment - £10/ha compared to £125/ha for stock excluded woodland.	- Grazed woodlands provide shelter for stock - Grazed woodland benefits lichens and certain bird species e.g. pied flycatcher
Organic Low Intensity Arable	- Total cost of organic spring sown cereals £700/ha/yr. Sold as whole crop for £480/ha/yr. Loss offset by Tir Gofal grant £390/ha. - Weed burden - limits value of crop	- Provides organic winter fodder, straw - Lower inputs - no biocides - Benefits to wildlife, notably farmland birds e.g. yellow hammer

Figure 44. Costs and benefits of HNV farmland within the various farming systems

9.2. Factors influential in maintaining HNV Farmland

9.2.1. Land use and trends

The farm case studies provided real examples of the changes in land use and trends for HNV farming systems within the study area and of the threats and challenges perceived by the farmers:

● Amalgamation – selling or renting land out to larger/more productive farmers

● Separation of the farmhouse from the land, with these farmsteads becoming essentially residential.

● Abandonment of small, difficult to manage fields, particular wet land that scrubs over quickly when grazing ceases.

● Increase in number of hobby farms and non-farmers, HNV farming being grazed with horses, rented out to neighbouring graziers or left ungrazed. On Mynydd Mawr some landowners run part-time businesses or leisure interests such as Welsh Cob breeding, harness-racing or livery stables, and so do not feel they are able to reduce their stock numbers. Many owners consider their land as an extension of their gardens, keeping it 'neat and tidy' by mowing and topping the pastures, flailing hedges and clearing scrub, often at inappropriate times of year.

● Rapid move away from the mixed family farm towards predominately one major intensive enterprise – intensification, particularly in the dairy sector, with high fixed costs they feel under pressure to compete in a global market.

● Increase in low input arable crops supported by the Tir Gofal Scheme, which encouraged mixed sustainable systems in areas of grass monoculture. It is feared that if these holdings (Type 2 HNV farming) fail to be selected for the Glastir Targeted Element, this trend in small scale arable along with the associated benefits will be reversed. The farmer selected for interview in this study reported he would be forced to return to an all grass system without ongoing agri-environment support, and was concerned about the impact on the farmland birds, such as yellowhammer.

● Reduction in hill sheep numbers, with replacement with hill cattle, which may reflect the market, the move away from headage payments and also participation in agri-environment schemes i.e. the requirement to reduce stock (preferably sheep numbers) to within a whole farm stocking limit for entry into Tir Gofal. Also, the Tir Gofal Scheme offers an added incentive for grazing with cattle, agreement holders can claim a Cattle Grazing Premium of an additional 10% on top of habitat grassland payments.

●Increased competition from new EU Members States and non-EU countries with low-cost economies.

●Ageing of the farming population, leading to the potential loss of knowledge of how to manage extensive systems.

● Low product prices threatening the sustainability of extensive farm systems, high vulnerability to price fluctuations and dependence on income from SPS and agri-environment schemes to be able to remain full-time on the farm.

● Low incomes within extensive systems leading to lack of succession within family farms; the dairy farm in this study was the only example where the progression from one farming generation to the next was evident, with the children from the hill and upland farms now working elsewhere or training in other fields.

● Increased pressure to adapt, to deepen and broaden the farming system in order to stay viable e.g. organic farming, shortening links between production and consumption by selling at local farmers markets or to organic box schemes, agri-tourism; environmental and landscape management though participation in agri-environmental schemes; and diversification – fruit and vegetable production.

● Personal motivation was a strong factor for the maintenance of the HNV farming in the case studies; *"Managing land of high nature value is a life choice not a business choice. If all you're interested in is maximum profit, you cannot give the natural environment the time, energy and input it needs."*

9.2.2.   Policy measures

Agriculture in Wales is affected by a wide range of policies at both regional and national levels, including strategic initiatives, environmental legislation and support under the EU. They are either aimed at obligatory site protection or based on voluntary measures in the wider countryside.

The main policy element currently relevant to high nature value farmland conservation is the voluntary participation in agri-environment schemes. The four existing schemes in Wales comprise the Tir Gofal Scheme, Tir Cynnal Scheme, the Organic Farming Scheme, and Tir Mynydd. From 1st January 2012 these schemes will be merged into a new single scheme, Glastir.

The project assessed the coverage of the current Tir Gofal and Tir Cynnal schemes within the sample sites, to determine the uptake of agri-environment agreements.   The two figures below represent the two ends of the scale within the study area where agri-environment schemes have been most (Figure 33) and least (Figure 41) effective in terms of coverage and delivery.

As holdings have entered the Tir Gofal scheme, the Brechfa area has seen an increase in small scale arable, supporting biodiversity and sustainable farming. These benefits may be lost if financial support is not ongoing through effective targeting of Glastir Targeted Element (TE).

On Mynydd Mawr, there is little agri-environment uptake; much of this land is not even registered on IACS, exemplifying the need for the 'locally-tailored project' approach.

The list below summarises some of the key issues relating to current policy brought to light during the case study;
●Uncertainty and concern over SPS and agri-environment scheme changes.
●Complexity of agri-environment scheme application pack and process; although open to all registered land holders in Wales, the scheme may not in reality be accessible for all farmers, e.g. for those unable to travel the distance to one of the three divisional offices for interviews.
●Concerns over increased paperwork, added bureaucracy, regulations/constraints, impact on SPS, once in an agri-environment scheme.
●Low financial incentive to join agri-environment schemes, e.g. a 10ha holding in LFA such as the one interviewed, would receive just £486 a year under Glastir All-Wales Element, AWE, (including the 20% premium for farmers within the LFA). There are holdings as small as 3ha currently participating in the Tir Gofal Scheme within Carmarthenshire.
●The regulatory requirements that agri-environment payments can only be made for cost incurred and income foregone is a major constraint to making measures for delivering environmental benefits financially attractive to farmers. This is most apparent on smaller farms with a high dominance of high nature value land, where there is a lack of financial recognition for existing habitats (existing environmental goods and services). To exemplify this, under Tir Gofal the payment for existing semi-improved grassland is £90per ha, compared to the option to convert improved land to semi-improved at £160 per ha. The effectiveness of the reversion options is questionable within the lifetime of a five year scheme.
●Applicants will not be told whether they will be selected for the Glastir TE until they have signed up to the AWE, making it very difficult for landowners to make informed business decisions from the outset. No financial information is currently available to landowners regarding Glastir TE.
●Many farmers have worked hard to demonstrate that food production and sound environmental management can be delivered. The presence of existing HNV farming on the holding should be better valued, if they are to be retained. Often these areas are managed at a lower intensity than the more productive land, but are nonetheless an important part of the whole farm system e.g. for dry cows or providing additional grazing, often critical in dry summers. *"Farming should be a mix of production and conservation working alongside each other"*.
●New rules relating to dual use of land, which will come in to effect on entry to new agri-environment schemes, could potentially impact on participation in these schemes. Many landowners in Wales claim agri-environment payments whilst their grazier claims SPS, the dual land use rule could potentially lead to more areas of HNV farming becoming under-grazed.

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●Problems associated with managing small fields, often results in scrub and bracken encroachment. The Tir Gofal Scheme does offer capital works payments to manage encroachment of scrub or bracken where it impacts on valuable grassland habitats, e.g. unimproved marshy grassland. However, this work so often fails to be undertaken, since it is very labour intensive, often required to be carried out by hand, and there is little financial incentive to employ a contractor. This leads to issues of non-compliance with the management agreement, and often owners of small areas of land prefer to terminate their agreement at no great financial loss, rather than undertake the works required to stay in the Scheme.

●The issue of scrub habitat being excluded for eligibility under the SPS, causes considerable problems. There is a confused message from government to landowners, in that scrub is valued under one payment scheme (agri-environment) and disregarded and liable to penalty if not declared as ineligible for payment under another (SPS). Often the administrative burden of resolving issues during validation of the SAF against agri-environment payments causes delays in payments; whilst landowners are threatened with potential penalties for under/over declaring areas of scrub. All this could be avoided if scrub vegetation was reconsidered to be included eligible for SPS. The Glastir AWE scheme currently offers no option for continuing to manage scrub, something which was paid for under Tir Gofal.

● Outside of agri-environment schemes, cross-compliance regulations do not hold any sway on holdings that are not claiming SPS. EIA regulations are difficult to implement and remediation of damaged semi-natural land impossible to enforce if the land has not previously been recorded as habitat. For example, as seen in this study, semi-improved grasslands are difficult to classify, pick up through aerial photography and are under-recorded in Phase I. Further, many landowners are simply unaware of the EIA regulations, are unable to identify or see the value of semi-natural grasslands, which are often perceived as *"wastelands"*.

●CAP rules to limit the decline of permanent pasture are ineffective at protecting semi-natural grasslands for a variety of reasons, primarily because they do not apply at the farm level and also because the definition of permanent pasture includes intensively managed grasslands. Also, owners of small areas of grassland which may be of significant value (as seen at Mynydd Mawr) are not registering their land for Single Payment. Therefore, this land is not included in the overall amount of permanent pasture.

Outside protected areas, conservation of HNV farming currently depends mainly on the application of instruments within the CAP, notably agri-environment schemes. These instruments, however, do not appear to be well targeted at high nature value farmland areas. Within this study HNV farming areas and in particular smaller holdings get relatively little recognition and financial incentive and where semi-natural land was seen to be managed in favourable condition, personal motivation and a sound knowledge in extensive farming was a key factor. A change to the EC regulations governing agri-environment payments would be required which introduces the allowance for an incentive element to environmental delivery.

It is widely recognised that a proportion of HNV farmland lies outside management by agri-environment schemes or of designated sites. There are also farms and landowners that are not part of whole farm schemes for a variety of reasons. In the past various grants have been available for biodiversity projects on such land, including:

• Local Authority and CCW's Landscape and Nature Conservation Grants that were administered by local authorities across Wales until 1995. CCW holds data on their results. In Carmarthenshire this included small woodland and tree planting, hedgerow management, creation of ponds. Capital works attracted a grant of about 50%.
• CCW's Hedgerow Renovation Scheme
• Various RSPB projects that included hedgerow management

- Tywi Afon yr Oesoedd – A landscape partnership project funded by HLF, CCW, National Trust, and Carmarthenshire County Council in the Tywi Valley that ran for just under three years ending in March 2011, and worked with 41 landowners and 10 community groups and achieved the management of 3.5km of hedgerow, and the planting of 400 hedgerow and field trees, as well as restoring ponds, and planting 240 fruit trees in 18 traditional orchards. Grants were rarely more than £7500 per holding, and were based on fixed costs very similar to those in Tir Gofal.

Given the considerable achievements of these grant schemes for capital works, it is concluded that in order to support HNV farmland wherever it occurs, financial support needs to go beyond what has developed to be the 'traditional' scope of agri-environment schemes, for example, offering support to those who are not strictly farmers but none the less are landowners managing their land to conserve and enhance its biodiversity, and as a result are ensuring the delivery of the ecosystem services that HNV farmland can provide. Such capital works schemes could be provided under Axis 4 (Leader), but WG, like many other administrations, has decided not to use Leader to deliver Axis 2 objectives. It must be stressed however that Axis 4 as currently devised is not allowed to pay for area-based measures.

10. Towards HNV farmland indicators

10.1.   What must indicators do?
Indicators are, or should be, involved at all stages of the policy process:
- they are used for assessing the *ex ante* position, both qualitatively and quantitatively (providing a baseline) and, in the light of budgetary and other constraints, to decide on the appropriate suite of actions. In reality they will, given the limitations on current knowledge, also increase understanding of the baseline situation.
- they are used to direct the targeting of measures to ensure value for money against policy objectives.
- they are used to show how the qualitative and quantitative position changes over time.
- they should help understand the relative impact of policy measures in the context of wider natural and social pressures, providing useful information for the improvement of measures and their targeting.

10.2.   Identifying semi-natural farmland
At the heart of the HNV farmland concept is semi-natural farmed vegetation. Identifying this correctly and reliably is a key first step in the development of policies to support biodiversity in the wider countryside on the one hand and the socio-economic systems linked to high levels of biodiversity on the other.

After initial discussions with CCW, the concept of a rule-based formula using 'synonyms' to define HNV farmland was considered. This approach assumes that due to imperfect knowledge and flawed techniques, the same question can be approached from various complementary directions. If semi-natural habitats are not accurately or precisely mapped, then it might be possible to look for areas with:
- Greater than x% of semi-natural habitats *excluding* semi-improved (on the basis that semi-improved causes most identification issues)
- Greater than x % wet habitats (wet habitats least likely to have been improved)
- Greater than x% of broadleaved woodland on the farm
- Greater than x degrees slope (too steep to improve)

In theory, the 'Nature Value' could be measured directly, through the presence and frequency of species, either in total or using indicators. If this were possible, it would in fact be 'semi-natural vegetation' which was the surrogate! But there is no obvious choice of species that can be used across the study area, nor is there a comprehensive record of the frequency of more or less any species in either the study area or at a wider scale over the whole of the country.

Fortunately, the project coincided with a major development in land cover mapping in Wales – the release, in sections, of the first draft of the HIW. A major element of the project resources were spent on analysing its potential utility, while being cognisant of the fact that ground truthing and the improvement in quality which will result is still ongoing and had not in fact occurred to a significant degree as yet in the area covered by our work.

Of all the data sets examined, only the HIW appears to offer a way forward for both identifying and monitoring the extent of HNV in the study area and probably across Wales. It can do this on a field by field scale without the necessity for field by field survey. Although the system is still in development, it clearly has this potential. Identification and monitoring of HNV using HIW should be supported by field work so as to:
- develop confidence in the system
- identify any irregularities
- improve in its accuracy
- add information that it may not be possible to discern from the map, such as key species.

The HIW is considered to be about 75-80% accurate in terms of identifying habitats (CCW personal communication). In this study it was found that the HIW identified 84% of the HNV habitat in six of the eight sample areas. It did not identify any land as being HNV that was not. While it makes errors in classifying some HNV habitats, it is very probable that this level of accuracy will improve as HIW is developed. The use of 'surrogates' or 'synonyms' on a broad scale is not necessary, at least as far as semi-natural vegetation is concerned. However this highlights the need for any system that supports HNV to include field work if a higher level of accuracy is required.

10.3. Context and scale

As Latham and Gillespie (2009) set out, nature value is something which is dependent not just on the characteristics of a particular patch of vegetation, but on the spatial context of that patch in the wider landscapes – its connection or proximity to other patches of both similar and different habitats. Furthermore, the spatial scale at which interactions take place themselves vary with the species in question. Different species require different degrees of habitat uniformity or heterogeneity at those key scales. This requires consideration of needs and policy responses at a variety of scale, which in itself must be cross-referenced with the priorities for public spending. Latham and Gillespie (2009) set out a table illustrating this (Figure 45), in this instance giving designated sites the highest priority.

The difficult task is to separate out in the policy process, but at the same time to integrate, the ecological aspects of targeting from the practical and political, in the wider sense. Latham and Gillespie (op. cit.) illustrate how at a landscape scale their methods can suggest places where maintenance actions on the one hand and enhancement measures on the other could be targeted, but they themselves admit that there is not only not only one 'right answer', but that that to bring such an approach down to an ever-finer level might be to suggest a finesse which is not actually claimed to be present in the method.

Not having one 'right answer' seems to us to accord well with the realities and complexities of HNV farmland at the landscape scale, with its plethora of individual integrations of environmental, social and economic factors by many different individuals on a field and farm scale. However, that is not to say that *all* answers are equally 'right' and the challenge is in part to define an envelope in which we are most likely to find the range of answers which deliver the public policy goals.

The dilemma can be illustrated by comparing HIW and the landscape habitats layer of Landmap. The latter indicates landscapes where there is likely to be more HNV (i.e. those evaluated as being of high, or outstanding quality), and where there is likely to be less. However the samples demonstrate the limitations of such a basic assessment in distinguishing between HNV and non HNV areas. There are good examples of HNV in Llansadwrn, and examples of far less HNV in Llanllawddog, yet both areas are evaluated as medium. Llanllawddog has significantly less HNV farmland; its landscape habitats are largely a function of the extensive woodland edge in this area, not the farmland per se.

Analysis of HIW, on the other hand, suggests that accurate information on HNV land cover can, and therefore should, be carried out using its field by field analysis of individual holdings, especially if LPIS data is also integrated into the process. This would be a mainly desk-based exercise. Providing that HIW can be further developed to meet the needs of HNV recognition outlined above with particular reference to poor improved grasslands, which seems likely, there is no need to work at a larger, essentially less accurate, scale if the main and only issue is the identification of semi-natural vegetation. However Latham and Gillespie's work shows that an ecologically meaningful middle way *might* be possible, combining ecological meaningfulness with ease of operation.

We must also ask at what scale the finesse of the technique is lost – it is at the farm level (or below) or at some larger landscape or sub-regional scale? If it is possible at a small scale, then this approach has a real potential within the RDP process; detailed consideration of this question is well worthy of attention within the Welsh Government and its agencies.

Landscape level	Description	Biological function	Actions required
1. Sites	SSSIs and other designations	Biodiversity hotspots with good chance of persistence in the face of climate change; sources for dispersal	Management to achieve favourable condition; completion and review of series
2. Buffers	Land in the neighbourhood of sites	Support and protection for biodiversity sites; opportunities for local movement in response to climate change	Targeting grants and incentives to these areas to provide appropriate management; use of heterogeneity maps to inform planning; recognition in Local Development Plans
3. Habitat networks and permeability	Series of habitat patches and intervening land that form functional systems	Support biodiversity sites by increasing effective area; enhanced metapopulations; opportunities for species movement in response to climate change	Use of network maps to inform land use; targeting of grants and incentives for appropriate management; agri-environment measures to improve permeability; recognition in Local Development Plans
4. Large landscape areas	Large, heterogeneous landscapes with good connectivity for a wide spectrum of biodiversity. Examples include: coastal zones; ffridd zones (upland fringe); upland ranges; and some river corridors	Resilient framework of seminatural habitat at a regional scale; long-term population persistence and movement of taxa in response to climate change. Convergence with environmental services (as a product of all levels)	Recognition within planning policies (*e.g.* Wales Spatial Plan) for protection; targeting of schemes to aid development

Figure 45. An outline policy framework for action to improve ecological connectivity in Wales (Latham & Gillespie, 2009)

What might a simpler approach entail? It could involve assessment of grid squares (or larger regular units) using similar criteria proposed below at the farm scale. 'Similar' but not identical because the landscape is rather different from the farm, containing land uses and land covers which are not farmland, many of which are not even semi-natural vegetation (urban and industrial, brown field, conifer plantations).

The question of threshold % semi-natural vegetation cover raises interesting issues. Most of the farmland described above as interesting has at least 30% cover of such habitats (as judged by eye); significantly higher in most cases (especially if semi-improved is included).

An 'inclusion rule' could be developed for areas with low % semi-natural vegetation or where semi-natural vegetation consists mostly of semi-improved pastures, e.g. if a square kilometre meets the threshold for 3 other 'synonyms', it is included as HNV farmland. In these cases an area would be excluded if it met only one other criterion. The more synonyms incorporated, the less certain each one needs to be in theory, but the more the possibility of confusion in practice.

The question of broad-leaved woodland is quite difficult – how should its significance be recognised? The conviction that a high density of traditional hedges should count towards recognition of farmland as being HNV only serves to illustrate that excluding woodland completely is ecologically nonsensical. However, the prospect of rewarding farms on the basis of land outwith their management also raises difficult issues. For HNV farm identification, we opted for compromise position of including only woodland on the farm and then only as a secondary consideration. However, we recognise that the integration of the farm with other semi-natural habitats in the same landscape is an important question and one which is key when it comes to the placing of the farm-level policy context into the wider farmed-landscape policy framework.

10.4.   More than semi-natural vegetation?

It seems clear to the project team that the farming system and the suite of farming practices within it is a key factor in the existence and quality of HNV farmland. It is a separate question whether information on farming systems at a scale at which information is readily available can add anything useful to the process of identifying HNV farmland and whether it is rather most appropriately brought to bear in assessing questions of quality rather than presence/absence.

Logic suggests that farms which have very high levels of semi-natural vegetation must be managed at an overall intensity which allows such land cover at least to survive. Similarly, the survival of an individual semi-natural field on an otherwise improved farm could result from such a wide range of scenarios at farm level, almost all of which could equally have resulted in its destruction, that it can only be understood at the level of farming practice at the scale of that field.

In between, farm-level indicators which offer added value seem to us to be possible. These are the farms where the easily-identified habitats are most likely to be linked by less-easily recognised semi-improved fields, or be set in a more traditional framework of field boundaries and small parcel size. Beneficial farming practices not only imply the existence of such habitats, but add to their quality. They are not 'synonyms' for semi-natural vegetation, but complement it and, if and where it is difficult to recognise, can be used as a poor surrogate for it. As such they bridge the gap to some extent with questions of habitat quality (see below).

Examples of farming practices which, when present at the farm scale, could contribute to or indicate such HNV systems in cases of dubiety, include:
- Stock numbers of each breed on the farm

- Grazing diaries – information on the stocking levels in each field during the year
- Hedgerow management - proportion of hedges cut on one, two and three year rotations
- Length of hedge laid in a year.
- Greater than x number crop codes (indicating mixed farming system)
- Application of NPK fertiliser in each field
- Application of farm yard manure, number treatments applied per field
- Area cut for silage each year – this should not increase without good reason
- Area cut for hay or haylage each year and date of cut
- Area cultivated p.a.
- Length of permanent grassland headland
- Habitat management aimed at increasing its nature value e.g. fencing out of water courses, fencing out of woodlands, woodland planting on improved grassland, encouragement of scrub regeneration/ management, woodland management.

The question of whether and how small field size adds value to semi-natural vegetation and how this should be taken into account when identifying HNV farmland also raises difficult issues. Small fields provide a high ecotone density, are more likely to exhibit a wide range of management practices and therefore structural diversity in a given area than large fields, cause fewer or smaller breaks in habitat connectivity even when they themselves are not semi-natural and are less amenable to the use of machinery (not just in terms of ease of access, but in whether the effort is financially-justifiable). In addition, small fields pose additional difficulties for HIW (with large hedges shading out the in-field habitat, often preventing its correct interpretation), necessitating additional consideration of how to deal with fields which are small and semi-natural, but which could easily be misclassified as woodland, for example.

To some extent field size is a surrogate for hedge density - they are often surrounded by hedges that may well be important for biodiversity (ancient and species rich hedgerows are considered as BAP habitats, and the majority of those in East Carmarthenshire are both). But this is most true in lowland landscapes (not, for example, in some 19th century upland enclosure landscapes). It can also lead to a greater diversity of land use practice within a given area, but again this might not be the case in areas dominated by relatively intensive sheep-keeping, for instance. The main effect may in fact be that small fields are not worth improving by reseeding or likely to have been subject to many other mechanical operations (fertilising, for example). To what extent field size should over-rule low proportions of semi-natural pasture, particularly in the absence of a dense network of non-fence boundary features (hedges, banks, dry-stone walls, ditches) is a matter for further investigation, should it emerge as a common situation.

Our feeling is that whereas field size can be used as an indicator, it is not suitable to be used on its own and should be accompanied by other, rather conservative, criteria. It has the benefit of being easily measured and monitored from both remote sensing and LPIS and other GIS. The size threshold chosen for a small field could be varied from one landscape to another to reflect local needs, but there would need to be a very strong justification for adding such complications.

10.5.   Measuring quality
The availability of HIW and LPIS data allowed the team to focus on this aspect and to produce some new and potentially valuable results on the question of identifying and quantifying HNV farmland. However, we are aware that qualitative aspects are also crucial and that our work did not address this key aspect in any detail.

Habitat quality assessments are a standard procedure in nature conservation management, for example the monitoring of Conservation Status for Natura 2000 sites. However, quality in HNV

farmland has to consider not just the status of particular habitats, but the balance between habitats in the landscape. HNV farmland is about more than designated sites and their features of interest - HNV farmland quality is certainly concerned to ensure that not all habitats are managed at high intensity, especially if there has been a recent increase in agricultural pressure, but it should also allow species which depend on more intensive management (such as waxcap fungi) their place in the landscape.

The habitat networks approach has the potential to give indications of quality on a landscape scale. The fact that networks are analysed separately for different habitats is itself a helpful tool for the policy makers.   The networks can be 'stacked' (Latham and Gillespie give examples), though interpreting such a map must be done with care - a core area for blanket bog might be important for nothing else, whereas a lowland mosaic landscape important only for one habitat would be a cause for concern! However, whether the results of habitat network analysis are quantifiable, in a way which would allow their use in an RDP-orientated 'basket' of indicators, is not clear.

Quality must be related in some way to biodiversity – what is the number of species present and how is the number of individual organisms distributed between those species? Are any of them of conservation concern due to rarity or rapid population decline? Current datasets are inadequate for carrying this out on a county, let alone a national, scale.

A possible solution is along the lines of the German HNV monitoring scheme, which is itself based on the UK Countryside Survey (CS).   It involves the mapping of habitats within sample squares, and the assessment of the habitats using a list of indicator species. While it is possibly too focussed on one species group – higher plants – it enables the monitoring of national and regional trends at very low cost. We recommend that access to the confidential CS sample square datasets is permitted to allow an assessment of the potential of this dataset to provide a *qualitative* assessment of the habitats mapped quantitatively. Even if the present CS data gathering exercise is not detailed enough (or there are insufficient squares sampled – a perceived problem in Germany), any additional data gathering should be compatible with the CS and incorporate at least its sampled squares to maximise value for money.

10.6.   A draft model for field testing

It is clear that HIW provides a sound basis for starting to identify HNV farmland on a field scale and that any delivery mechanism would and should in any case involve some level of on-the-ground assessment. It is clear also that, whatever the merits of the habitat networks approach, it does not appear to be easily suited for use as the *sole* means of targeting and delivering policy measures, since that occurs at a farm scale. Is there some way we might bridge the gap between these two approaches at a *farm* scale? On the basis of the considerations outlined above we propose a *draft* model for identifying HNV farming *at the farm scale,* intended to complement (to a degree which we recommend should be ascertained more fully) landscape planning and policy targeting tools such as habitat networks*.* This approach recognises that 'Type 1' and 'Type 2' are actually just a conceptual way of dividing the spectrum of farms which use semi-natural vegetation and that as the proportion of such vegetation decreases in the farmed area, so the significance of other features increases. It also builds in, and attempts to circumvent, the finding that HIW, at present at least, has most difficulty in correctly identifying semi-natural vegetation in small hedged fields.

Our conceptual framework is that:
-    At the farm level, farms should be rewarded for features/activities within their control in the first instance, and only subject to further reward or penalty in the light of their landscape context within clear and unambiguous policy guidelines

- Semi-natural pastures and meadows and the field boundaries associated with them are the basis of HNV farmland. Agricultural landscapes in Wales where these habitats exist alongside semi-natural woodland and wetlands (including rivers and streams) are those landscapes that are likely to provide ecological connectivity and be of greatest value to biodiversity. The uncertainty in recognising semi-natural pastures is greatest for semi-improved grassland
- grazing density can be used with justification to overcome uncertainty at the margins, but is not a good guide on its own to Nature Value, especially at higher stocking densities, which could be appropriate for more productive habitats but wholly inappropriate for others
- semi-natural woodland adds to a farm's Nature value, and while it does not directly reflect the farming system itself, it is nonetheless indicative of the ecological "health" of an area. Landscapes that feature species rich grasslands, woodlands and wetlands (including rivers and streams) are likely to be some of those that are of greatest importance for biodiversity.
- hedgerows and field size can be associated with HNV farmland and should in any case be included to make up for deficiencies in the HIW for these landscapes, but they should be included conservatively (i.e. should only result in a small increase in the area of HNV farmland) and should be associated with relatively *low* intensity systems.

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1. Is there >66% semi-natural pasture or meadow on the farm's *SPS-eligible* IACS area OR does the farm have an IACS livestock density of <0.4 LU/ha?
   If yes, HNV
   If no, go to 2

2. Is there >20% semi-natural pasture or meadow on the farm's *SPS-eligible* IACS area?
   If yes, go to 3
   If no, go to 4

3. Is >33% of the farm's *total* IACS area semi-natural pasture or meadow (excluding semi-improved) or semi-natural woodland (including young broadleaved plantations) AND does the farm have an IACS livestock density of <0.8 LU/ha or <1 LU/ha where 2/3 or more of the livestock units are cattle?
   If yes, HNV
   If no, go to 4

4. Is median field size <2 ha or is the density of hedgerow in good condition* >200 m/ha AND does the farm have an IACS livestock density of <0.6 LU/ha or <0.8 LU/ha where 2/3 or more of the livestock units are cattle?
   If yes, HNV
   If no, not HNV at farm scale

good condition implies the presence of hedgerow trees (in unexposed areas); may be laid; fenced on one or both sides if appropriate and, excluding roadside hedgerows, be cut no more than once every 4 years with a flail. May also consist of a mature line of woody trees and shrubs which have not been managed for at least 10 years. Hedges will not show signs of significant damage by stock

Figure 46. Possible decision table for determining HNV status at farm level

It is strongly recommended that any use of this table be on an experimental basis, with adjustments to values being made in the light of results in known HNV and non-HNV farms. The % of farmland and farms being made eligible in Qs 1, 3 and 4 respectively should be monitored – high levels of *farmland* entering at Q4 is not desirable, given the speculative nature of the values given and the lack of a clear link to semi-natural habitats.

We show above how the rather detailed crop codes available for use in the Welsh IACS are potentially very useful as a way of operationalising the integration of semi-natural vegetation into policy delivery mechanisms (in contrast to many other countries, for example England). It is difficult to see how such integration can be avoided. How and when the link to HIW would be made is up for discussion. It would however be interesting to determine, on a sample basis (perhaps using our sample squares) to what extent they are fully used and to what extent the boundaries between the apparently-relevant classes correspond in practice to a definition of semi-natural vegetation which together we would see as central to the identification of HNV farmland. It seems possible at least that they are only fully or potentially fully used in cases of higher level agri-environment participation.

10.7. Monitoring trends in HNV farmland

Monitoring of HNV farmland could be based either on ecological monitoring or on farming practice (using the indicators at 10.4 above), or a combination of both.

Ecological monitoring of HNV farmland could be carried out for individual farm holdings or at a landscape scale using GIS data such as a periodically updated version of the HIW, assuming that the map can be produced for sample areas or individual holdings every 3-4 years. While there are inaccuracies in this map, a reduction of these errors would make the system sufficiently accurate for the quantitative monitoring of HNV, even at the level of an individual agricultural holding. Being digital, it would enable the results to be quantified with relative ease. At present it appears that HIW needs to be able to distinguish more accurately between the different grassland habitats, particularly where it identifies poor improved grassland – sometimes this has been observed to be improved grassland and in other locations, and within the same sample area, semi-improved grassland(e.g. Llystyn, Brechfa). This is complicated by the fact that the nature of this habitat can be changed with relative ease, e.g. by cutting and spraying rushes the field may change from being poor improved to improved.

Once a baseline for a farm entering a HNV scheme is established and its HNV areas identified and agreed, it should be possible to monitor habitat change adequately from repeat aerial photos, and the HIW. There would also have to be some ground-truthing in order to verify interpretation, to provide more qualitative information and to ensure confidence in the scheme. In some cases the aerial photos might give the monitor as much if not more information than the HIW in terms of vegetation, but on their own they would not provide the basis for quantifying change. While it is relatively easy to identify clearance of scrub, or new drainage form an aerial photo, other more subtle changes, such as an increase in the fertilising of a field resulting in its agricultural improvement over a number of years, may be hard to identify from aerial photos, but these practices would be picked up by remote sensing. There will be limitations to the monitoring that could be achieved with aerial photos alone.

Essentially HIW can identify HNV farmland, and it is considered that with appropriate resources it could be used to monitor HNV. But on the ground monitoring of individual holdings would look to demonstrate that the habitats identified as initially making the farm eligible for HNV payments remain in, or continue to approach, favourable condition for biodiversity conservation. Monitoring would need to take account of both species composition and structure of the habitats. It would also have to take on board the dynamics of habitat change, and the fact that habitats may not remain identical year by year - they evolve - scrub may encroach in one area while elsewhere it may be lost. Identification of key species and habitat condition is recommended.

Follow-up work to this study could fruitfully investigate the compatibility of the HIW data with Countryside Survey (CS) sample plots, with a view to using the CS (or at least the CS sample) as a

basis for qualitative monitoring in parallel with the HIW-based quantitative monitoring exercise. This is the model which has been used in Germany and, for this aspect of ongoing monitoring, it would seem most useful. It must however be stressed that the German model leaves open the link not only to policy, but even to the farm and the farming system – it is purely a systems of ecological monitoring linked to regionally-set thresholds of plant indicator species presence or absence.

10.8. Suggested further work

- Further trials in areas where there is a moderate amount on HNV are recommended e.g. areas similar to the Llanllawddog sample.
- Develop the accuracy of HIW identification of grassland habitats by cross-reference to CCW's Phase 2 grasslands surveys
- Develop parameters to assist HIW in accurately recognising poor improved grassland that actively contribute to HNV.
- Further integration with Habitat Network work, in particular to find a balance between appropriate techniques for policy targeting at the landscape and at the farm scale
- Investigation of appropriateness of Countryside Survey sample areas as a monitoring tool alongside HIW
- Investigation of the degree to which potentially useful IACS crop codes are fully and correctly used and the extent to which they could be used to designate *all* semi-natural farmland.

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Appendix: Habitat Inventory for Wales

The Habitat Inventory for Wales is a new mapping project developed by Environment Services and Aberystwyth University on behalf of CCW. It is designed to be consistent across Wales and over time. It takes a 'bottom-up' approach to satellite-based mapping, as a collaboration between field ecologists and remote sensing experts

> *'to help monitor landscape-scale biodiversity, habitat connectivity, ecosystem function and the green infrastructure of Wales. A key principle is to maintain continuity with traditional field-based survey methods while allowing future use of the enormous power of satellite-based measurements of productivity, habitat structure, soil moisture, biomass and seasonal patterns in phrenology'.*

The new methods are designed to work with and increase the effectiveness of field observations, not to replace them.

Remote sensing data are integrated into a single classification scheme to produce detailed habitat maps of Wales. The maps are created from a combination of satellite imagery which, in addition to the measurements listed above, can also:

- measure morphology and surface roughness (such as tussocky-ness);
- distinguish between dead and live biomass;
- interpret according to context within the landscape (e.g. a wet area is likely to be a bog if on flat land, a flush if on a slope):
    - GIS data, e.g. height, slope, aspect
    - Aerial photography
    - Original Phase 1 maps
    - Feedback from field surveys & local experts

All of this information is analysed by a trained expert system to produce the maps. This method replaces the surveyor's subjective judgement with 'fuzzy logic'. A field expert trains the expert system to map small areas (a few 10s of square kilometres) using ecological rules based on field observations. This is then tested on new areas, and the rules are adjusted to give the best fit between field observation, aerial photos and the map. This is then extrapolated across the entire landscape, making efficient use of a relatively small amount of field work.

The new methods are able to create and classify a larger number of small objects (using 'segmentation algorithm' software) by identifying pixels of similar colour values. These objects are typically smaller than an individual stand of vegetation. At a later stage of analysis, all similar pixels are joined together as one habitat. Habitats can also be mapped at different scales (e.g. individual crowns of trees or entire woodlands). This process produces more detailed maps than a Phase 1 surveyor can do, and also eliminates the time-consuming process of digitising polygons and boundaries, which usually feature a degree of error.

The expert system can evaluate a much greater range of information and imagery than an individual. It evaluates the appearance of habitat in images taken at several different times of year, using parts of the spectrum that a person cannot see. For example, infra-red and near infra-red contain a great deal of information about the amount of photosynthetic tissue unseen by the human eye. Additionally, satellite images are more consistent over a large area than aerial photos, which can vary in colour across a landscape, leading to potential errors in distinguishing habitats.

In contrast to the new mapping system, Phase 1 maps 'summarise' a surveyor's observations. The surveyor must simplify and abstract the objects they see on the ground, in the limited time available.

Mosaic habitats and intermediate types of vegetation can be 'lost' from the map. Where the picture on the ground is ambiguous or too complex to map, the surveyor should make target notes, for example estimating the amount of each type of habitat within a mosaic. But making target notes is very time-consuming, can be inaccurate, and may not be read by users of the Phase 1 map.

Quality Control
Phase 1 maps are rarely verified or quality controlled by repeat survey and mapping by different surveyors. Therefore, the amount of error they contain is unknown. The new maps incorporate a new approach to spatial data, which recognises that there are errors and uncertainty. The sophisticated 'geoinformatic paradigm' judges the degree of confidence in the classification, and combines a number of data sets to reduce the effect of errors in any one set.

Rules and accuracy
The rules used by the expert system are based on real ecological knowledge, such as differentiating between trees and bracken based on the fact that they produce a canopy at different times of the year. Differences in temperature, rainfall and oceanicity across Wales are included in the model. At a more local scale (e.g. the eastern third of Carmarthenshire), the rules are further fine-tuned, by training them on samples spread across each area. The centre of each area will be more accurate than the edges, reflecting local climatic variation, as a compromise between accuracy and the time needed to produce the maps. These climatic variations can be fine-tuned over time, increasing the maps' accuracy.

Updating
One of the key advantages of this system is that it is a method of producing maps, not the production of a one-off map. On the other hand, Phase 1 can only be updated by repeating the survey; it cannot re-use the original survey data. The satellite maps can be reproduced whenever new images become available, by re-running the expert system.

The system's accuracy will improve as it uses more training information and data sets to produce updated and post-dated maps. The initial maps are based on 2006 aerial photographs, but can be updated. Future data sets may include data measuring vegetation height, biomass and surface wetness, which will refine the system's ability to map, for example, hedgerows and rushy pastures. At the same time, feedback from field surveyors and local experts will also be incorporated to improve accuracy of habitat classifications.

The new methods are designed to complement field survey and monitoring, making more efficient use of field information. They update rather than completely replace the original Phase 1 maps. Individual errors such as mistaking cloud shadow for conifer plantations will be corrected. Overall accuracy of maps can be improved using the rule base. And habitat specialists will help revise the mapping of entire habitats, such as bracken, blanket-bog or semi-improved grasslands, in conjunction with new images and data. Corrections and improvements in one area can be incorporated into the rule base and thus rolled out across Wales. Earlier maps can also be revised, which will greatly improve the ability to monitor change over time.

This description is a summary of:
Alan Brown, Nov 2010, Ecologists' Explanation, Habitat Inventory for Wales (Environment Systems for CCW) www.gwylio.co.uk