HISTORIC LANDUSE PRACTICES AND BIODIVERSITY IN WALES

CCW Policy Research Report no. 01/2

Gwynedd Archaeological Trust /
North Wales Environment Services Ltd.

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North Wales Environmental Services Ltd

GAT project number G1674 Report Number 423.

March 2001

Carrying bracken, Beddgelert, Gwynedd

aur o dan rhedyn
arian o dan eithin
newyn o dan grug

gold beneath bracken
silver beneath gorse
starvation beneath heather

PREFACE - Contract specification

HISTORIC LAND USE AND BIODIVERSITY

Brief to consultants

The Countryside Council for Wales is the statutory adviser to the government on sustainable natural beauty, wildlife and the opportunity for outdoor enjoyment throughout Wales and its inshore waters. We manage National Nature Reserves and are responsible for section 15 (Sites of Special Scientific Interest) and agri-environment (Tir Cymen and Tir Gofal) scheme agreements. The Council advises government on habitat management and restoration.

Background

Historic farming and other land use practices, such as cutting reeds, bracken, gorse, heather and hay, coppicing, charcoal burning and water management were driven by economic needs, e.g. to produce thatch for roofing or to produce fencing hurdles. These traditional practices produced valuable habitats but by today most have ceased due to intensification of production and technological advances in agriculture and forestry.

Knowledge about these traditional management practices is in danger of being lost and forgotten. Having a record and understanding of such traditional management practices would assist modern land managers, particularly where detailed and specific management prescriptions are required, for example in Tir Gofal and SSSI management agreements.

The purpose of this scoping, desk study

The purpose of this scoping study is to produce a report recording examples of a range of different types of historical/traditional management practices that have sustained habitats rich in biodiversity in Wales. These records should be in as much detail as possible, and preferably linked to specific habitats and locations. The Report is intended for use by Tir Gofal, Wildlife Trust Officers, Nature Reserve Wardens and others who are involved with the application of habitat management techniques. The information provided will be used to develop and adapt prescriptions for the restoration and creation of habitats within the Biodiversity Action Plans and the Tir Gofal agri-environment scheme. The list of different traditional management practices should cover as wide a range as possible and could, for example, include coppicing, hay-meadow management, heathland management, management of the ffridd.

Outputs A report which lists traditional management practices in Wales with:

- where possible, case study examples of sites where the habitats created or sustained by traditional/historical practices may still occur today, e.g. Gwent Levels.
- a map of Wales showing the location, land use and habitat of each historic land use site (including grid references).
- tables of the habitats types together with the relevant traditional management practice.

- detailed information about the practices involved, e.g. number, type/breed of stock, grazing density, season and regime, dates for cutting, hay, coppicing, etc.
- identified benefits of the management to habitats & species
- recommendations on how these practices might be sustained/reintroduced using modern technology.
- reference to past and current economic benefits of these traditional management practices to practitioners.

The Report should be in **Word 2000** format (15 copies, for which CCW will provide covers) and the contractor should also provide a copy of the Report, in Word 2000, on a floppy disk.

Maps should preferably be digitised.

Tables should be presented in **Excel**.

The contractor must demonstrate an ability to address both the historical and wildlife management aspects of this project.

Suggested sources of information

The National Library of Wales, Aberystwyth
University libraries (PhD theses)
Agricultural Societies' reports
Journals
IGER
Oral sources of information where possible, given the contract's time limit.

Timetable

An initial meeting with the project officer, at which the successful consultant should present an outline of topics and sources, will be arranged in **December, 2000**.

A draft report should be presented to the project officer by **February 16th, 2001**.

The final report should be submitted by **March 9th, 2001**.

Mission statements

The **Countryside Council for Wales** is the Government's statutory advisor on wildlife, countryside and maritime conservation matters in Wales. It is the executive authority for the conservation of habitats and wildlife. Through partners it promotes the protection of the landscape, opportunities for enjoyment, and the support of those who live and work in, and manage, the countryside. It enables these partners, including local authorities, voluntary organisations and interested individuals to pursue countryside management projects through grant-aid. The Countryside Council for Wales is accountable to the National Assembly for Wales who appoints it and provides its annual grant-aid.

The **Gwynedd Archaeological Trust** was formed in 1974. It is one of four Trusts which operate across Wales. It is an educational charity as well as a limited company, governed by a board of Trustees who delegate the daily running of the Trust to a Director. The aim of the Trust is to advance the education of the public in archaeology. Using both its heritage management and consultancy services, the Trust offers information, advice and support to both public and private sectors, including local and regional government, schools and the public, as well as public utilities, developers and other consultants and environmental bodies. In particular, over recent years, it has built up an enviable reputation in Welsh archaeology and heritage management, notably in landscape, countryside and cultural matters. It also has experience of interpreting, presenting and promoting both its work and archaeological sites in the landscape to a wide public audience.

North Wales Environmental Services Ltd. is an independent environmental consultancy offering a high quality service following current best practice guidelines. NWES is a wholly owned subsidiary of the North Wales Wildlife Trust and was set up in 1990 to provide financial support for the charity. NWES provides a wealth of experience in wildlife issues, including protected species, familiarity with current policies and quick access to local wildlife information. Clients include Gwynedd Council, Dwr Cymru, the Environment Agency, Forest Enterprise, the Youth Hostel Association, Posford Duvivier and WS Atkins and other commercial and private clients throughout Wales.

Acknowledgements

This report was researched and produced by Chris Wynne (NWES) and John Griffith Roberts (GAT), with contributions from Anne Davies, Julian Thompson (both NWES), David Longley and Dr David Gwyn, with assistance from Jeff Spencer (all GAT).

The authors would like to thank Buddug Jones, Richard Kelly (both CCW), David Thompson and Andrew Davidson (both GAT) for their advice, comments and support.

They are also very grateful to everyone who responded as part of the consultation exercise.

Executive summary

This report comprises a scoping exercise and preliminary review of the extent to which knowledge of traditional land-use practices may be used to inform contemporary and future land management for biodiversity benefits. The project was commissioned by the Countryside Council for Wales whose duties include advising the National Assembly for Wales on sustaining natural beauty, wildlife and landscape. It has been undertaken as a collaboration between Gwynedd Archaeological Trust and North Wales Environmental Services.

Traditional practices have produced habitats of great ecological and landscape value. However, landuse intensification and technological change have led to the decline or cessation of many of them throughout Wales. This report looks at the extent to which this decline has impacted upon habitat sustainability and biodiversity. There is a great danger that the ongoing loss and erosion of this knowledge could impoverish future strategies for sympathetic management of the rural landscape.

An integrated approach to both the historical and wildlife aspects of the project has been developed by drawing on the results of a broad consultation exercise, extensive literature searches and the expertise of the two partner organisations. A wide list of traditional practices was drawn up, from which ten specific examples thought to have particularly high potential biodiversity value were identified for detailed research. The results have generated a substantial corpus of information, confirmed the potential of the approach and established a platform for further research. The work emphasises that it is important to avoid simplification or nostalgia when addressing the complex relationships between society, agriculture and ecology, and demonstrates that whilst agriculture has a great ancestry, the extent to which these various elements have harmonised has varied considerably through time. The project does not advocate direct wholesale reintroduction of landuse traditions. Instead it investigates how drawing on appropriate traditional techniques, either in their original form or in conjunction with aspects of contemporary practice, could greatly assist modern land managers, particularly where detailed and specific management prescriptions are required, for example within Tir Gofal and SSSI management agreements.

Crynodeb gweithredol

Mae'r adroddiad hwn yn cynnwys ymarferiad cwmpasu ac adolygiad rhagarweiniol i bennu i ba raddau y gellir defnyddio gwybodaeth am ddulliau traddodiadol o ddefnyddio tir fel sail ar gyfer rheoli tir mewn modd sydd o fudd i fio-amrywiaeth yn awr ac yn y dyfodol. Cafodd y prosiect ei gomisiynu gan Gyngor Cefn Gwlad Cymru ac un o'i ddyletswyddau yn cynghori Cynulliad Cenedlaethol Cymru ar faterion sy'n cynnwys cynnal harddwch naturiol, bywyd gwyllt a'r tirwedd. Ymgymerwyd â'r prosiect ar y cyd rhwng Ymddiriedolaeth Archeolegol Gwynedd a Gwasanaethau Amgylcheddol Gogledd Cymru.

Mae arferion traddodiadol wedi creu cynefinoedd o bwys ecolegol a thirweddol. Fodd bynnag, mae'r defnydd dwys a wneir o'r tir a newidiadau technolegol wedi arwain at ddirywiad neu ddiflaniad llawer ohonynt ledled Cymru. Mae'r adroddiad hwn yn edrych i ba raddau y mae'r dirywiad hwn wedi effeithio ar gynaladwyedd a bio-amrywiaeth y cynefinoedd. Os bydd y wybodaeth hon yn parhau i ddiflannu a dirywio mae perygl gwirioneddol y caiff effaith andwyol ar strategaethau'r dyfodol i reoli'r tirwedd gwledig mewn modd sensitif.

Datblygwyd dull gweithredu integredig ar gyfer yr agweddau hanesyddol a bywyd gwyllt o'r prosiect trwy ddefnyddio canlyniadau ymarferiad ymgynghori eang, trwy chwilota'n drylwyr mewn llenyddiaeth a manteisio ar arbenigedd dau gorff y bartneriaeth. Lluniwyd rhestr faith o arferion traddodiadol, a dewiswyd deg enghraifft benodol a ystyrid fel bod yn werthfawr o safbwynt bio-amrywiaeth er mwyn cynnal gwaith ymchwil drylwyr. Mae'r canlyniadau wedi arwain at gorff sylweddol o wybodaeth sydd wedi cadarnhau potensial y dull gweithredu yn ogystal â sefydlu llwyfan ar gyfer ymchwil bellach. Mae'r gwaith yn pwysleisio pa mor bwysig yw gochel rhag gor- symleiddio neu hiraethu am y gorffennol wrth ystyried y berthynas gymhleth rhwng cymdeithas, amaethyddiaeth ac ecoleg, ac mae'n dangos, er bod gan amaethyddiaeth hanes mor hen, i ba raddau y mae'r cytgord rhwng y gwahanol elfennau hyn wedi newid dros amser. Nid yw'r prosiect yn annog ail-gyflwyno'r hen arferion defnydd tir yn eu cyfanrwydd. Yn hytrach mae'n ymchwilio i'r modd y gallai arfer technegau traddodiadol priodol, un ai yn eu ffurf wreiddiol neu ar y cyd â rhai agweddau o arferion cyfoes, fod yn ddefnyddiol i reolwyr tir modern, yn arbennig lle mae gofyn am gyfyngiadau rheoli manwl a phenodol, er enghraifft o fewn Tir Gofal a chytundebau rheoli Safleoedd o Ddiddordeb Gwyddonol Arbennig (SSSI).

Contents

1 Introduction

Productive agriculture currently occupies approximately 80% of the land surface in Wales (Lovegrove *et al*, 1995). It varies from the horticulture of Pembrokeshire to the hill farming of Gwynedd to the dairy farming of Carmarthenshire. This variety is as true now as it was in the past (WLGA, 1998). That agriculture has been the main influence on Welsh and British vegetation for centuries is beyond doubt (Adams, 1996). For much of the past agricultural activities and other forms of rural production have produced complex and diverse habitats and landscape.

The dramatic declines in many species and habitats since the end of the Second World War are well documented (Shoard, 1980; Mabey, 1980). More recent work has highlighted the acceleration in this decline since the Common Agriculture Policy was introduced (Adams 1996; Harvey, 1997; Chamberlain *et al*,, 2000 for example). The roots of this change lie in the "Dig for Victory" campaign and the subsequent drive for production and intensification (Milton, 1994). Farming economies, particularly pastoral and mixed systems, have often been sustainable in terms of the management of natural resources over many centuries (Adams, 1996; Bignal and McCracken, 1993). However, the picture of agriculture as a harmonious balance between food production and ecological stability should not be overplayed, and the extent to which different practices allows biodiversity to flourish varies considerably. Many of the landuse practices now seen as 'traditional' developed during the eighteenth and nineteenth centuries with major changes in the scale and intensity of agriculture. This was particularly the case for arable farming with an increasing mechanisation and greater reliance on external inputs to the farm. These changes were often detrimental to wildlife diversity (Stoate, 1995). The extent to which past agricultural economies balanced production and long term sustainability of resources in the past should not be taken for granted. Indeed assumptions concerning the long-term sustainability of agricultural practice in prehistory have come under question in some quarters (see for example Kooijams, 1995).

The dramatic changes in agriculture during the mid to late twentieth century reflect socio-economic changes including a shift towards a more consumer based society (Adams, 1996). Perhaps more than any other economic activity, farming is highly rooted in the local community and environment (WLGA, 1998). The impact of the decline in rural industries on local communities and the changing relationship between people and their surroundings is well documented. The erosion of an organic 'community' with an intimate relationship to the rural landscape is widely lamented (including, for example Jenkins, 1976). The need to build, or to rebuild, community involvement in biodiversity is widely recognised (Mabey 1980; Adams, 1996).

The need for sustainability in current agricultural systems is addressed by Atkinson and McKinaly (1995 and 1997). Fundamental to this is a consideration of the balance between food production and biodiversity. Formal economic evaluations of agriculture fail to take into account non-monetary values. Today's landscape has developed through complex interaction between people and environment over time. Remains of the past including habitats formed through generations of management are fundamental to the character of the present day landscape. Ecological features are valuable for scientific reasons, and for

the health of the environment. They are also of broader importance, because like archaeological remains (traces of past human activity in today's landscape), they underpin the way that we identify with the places we live in (see Fairclough 1997 and Clifford and King 1993 discussions of local distinctiveness, sense of place and landscape character). Local Agenda 21 explicitly links community well being to biodiversity and to the quality of local landscapes (see Countryside Commission, English Heritage and English Nature nd).

2 Overall project objectives

This desk-based scoping study is a preliminary review of the extent to which knowledge of traditional land-use practices may be used to inform contemporary and future land management for biodiversity benefits. The project was commissioned by the Countryside Council for Wales whose duties include advising the National Assembly for Wales on sustaining natural beauty, wildlife and landscape. The aim of the work was to:

- establish the extent to which particular traditional land-use practices have created habitats of high biodiversity value;
- outline the nature of these practices and associated rural crafts and industries;
- assess the extent to which detailed knowledge of those practices yielding biodiversity benefits could inform future land management for biodiversity;
- suggest ways that these beneficial effects on biodiversity could be achieved through contemporary techniques.

It has been undertaken as a collaboration between Gwynedd Archaeological Trust and North Wales Environmental Services. The project is rare in its joint approach - historical and ecological - to determining land management prescriptions. The combined experience and expertise of the two organisations in their respective fields allows for an integrated and authoritative approach to both the historical and wildlife aspects of the project.

The report is intended for use by Tir Gofal, Wildlife Trust Officers, Nature Reserve Wardens and others who are involved with the application of habitat management techniques. It is intended that the information provided will feed into the management, restoration and creation of habitats through various mechanisms including Biodiversity Action Plans and the Tir Gofal agri-environment scheme.

3 Methodology

A provisional list of over twenty broad traditional management practices with biodiversity implications were identified through an initial, broad brush literature survey in combination with the professional knowledge of the two partner organisations.

During management meetings between CCW and the partner organisations, it was decide to adopt a two-stranded approach to further research into aspects of this 'long list' of practices. The main focus of the work was to undertake detailed assessments of ten landuse practices thought to be of particularly high biodiversity value. The selected practices are:

1. Hay meadow
2. Water meadow
3. Small scale mixed arable
4. Coppicing
5. Peat cutting
6. Ffridd pasture
7. Water power
8. Reeds
9. Marram grass cutting
10. Bracken cutting

Work was to continue on the long list, as project scope and timings allowed, with the aim of establishing a generalised gazetteer of practices and their biodiversity potential. Information gathered has been incorporated into an Excel spreadsheet under a series of heading devised by the partner organisations. These are:

- Broad land-use type
- Land-use management type
- Land-use management practice
- Rural industry / product

The substantial findings of the research into the ten practices investigated in detailed precluded comprehensive coverage of the full range of themes for each subject. An abbreviated version of the spreadsheet appears as Appendix 1. As a scoping exercise the project has shown the potential of this approach, and recommendations are made that the gazetteer is extended through further research. A substantial corpus of information has been gathered for a broad range of practices, which would allow for more extensive development of the spreadsheet content. The extant information also acts as a platform to guide the selection of further topics for more detailed research (in the manner of that carried out for the ten practices selected for this project) likely to yield useful information and data relevant to biodiversity objectives.

4 Research

As part of the information gathering exercise a range of organisations were consulted to locate sites which demonstrate one or more of the traditional practices, and to establish a platform of known historical and ecological context for each practice. These organisations included:

- the Welsh Wildlife Trusts;
- the Regional Welsh Archaeological Trusts;
- National Museum of Welsh Life, St Fagan;
- School of Agriculture and Forest Science (SAFS), University of Wales Bangor;
- Palaeo-environmental specialist, Department of Archaeology, University of Wales Lampeter;
- Institute of Geography and Earth Science, University of Wales Aberystwyth;
- Institute of Grassland and Environmental Research (IGER);
- Centre for Advanced Welsh and Celtic Studies, Aberystwyth;
- Rural History Centre, University of Reading

Reference material included the following primary and secondary sources:

- The full range of available habitat management manuals e.g. Heathland Management Manual;
- Site Nature Conservation Management Plans;
- National, regional and local habitat and species surveys;
- Antiquarian topographic descriptions, travel accounts and other writings;
- Historical agricultural reviews and treatises on agriculture and improvement in Wales (*e.g.* the Board of Agriculture accounts);
- Archival records of selected County / Regional Public Record Offices and of the National Library of Wales, Aberystwyth;
- University libraries (PhD theses);
- Selected journals;
- Selected Agricultural Societies' reports;
- Relevant volumes of the Annals of Agriculture;

Extensive searches for relevant reference material were made through the catalogues of the Reading Rural History Centre [http://www.ruralhistory.org/index.html] and the Web of Science [an academic resource combining science and social science citation indices - http://wos.mimas.ac.uk/]. A substantial resource of references was produced through this exercise; the implications of this resource for further research is indicated in the recommendations for further research made at the end of this report.

5 Collation of results of research

The information derived from the consultation and research exercises was synthesised for each of the specific practices. The findings of this process are presented in the body of this report, with the information being structured in a consistent proforma approach:

1. Definition
2. Associated habitats
3. Associated species
4. Chronology and historical synthesis
5. Former geographical distribution
6. Case study examples
7. Ecological aspects of the practice
8. Nature of the practice
9. Sites where the practice still occurs
10. How the practice may be sustained
11. Potential for re-introduction using modern techniques:
12. Potential economic benefits as a basis for the sustainable management of biodiversity:
13. References

5.1 Hay Meadow

Definition

Grasslands laid up for hay from April to July or August or later depending on the weather; the crop is then cut and is mainly conserved as fodder for the winter months when there is little or no grazing available. The fields are used as pasture for the rest of the year.

Associated habitats

Mostly found on moist mineral soils of pH 5-6.5 i.e. neutral conditions that occur across a wide area of Wales. The low nutrient levels maintained in hay meadows encourage a diverse community of plants to develop and a corresponding wide range of food plants and micro-habitats for invertebrates.

Hay meadows are particularly associated with the National Vegetation Classification communities MG 5 *Cynosurus cristatus – Centaurea nigra* (Rodwell, 1992). The fields are often small, with few sites bigger than 20 ha with hedges, drystone walls, cloddiau often forming the boundaries. Fen meadows and flood meadow are also subject to similar management.

Lowland hay meadows are a priority UK BAP habitat (UKBG, 1998).

Associated species

The origins of the flora may lie in the woodland glades and floodplains of rivers where wild animals congregated. They are naturally grown communities that provide mankind with a regular harvest while retaining much of their natural composition. The dominant plant species are grasses such as crested dog's-tail *(Cynosurus cristatus),* red fescue *(Festuca rubra)* and Yorkshire Fog *(Holcus lanatus).* Typical flowering species include bird's-foot trefoil *(Lotus corniculatus),* black knapweed *(Centaurea nigra)* and yarrow *(Achillea millefolium).* A detailed analysis of the species associated with the NVC community is given in Rodwell (1992). Scarce and declining plant species associated with this habitat in Wales include dyer's greenweed *(Genista tinctoria),* green-winged orchid *(Orchis morio),* greater butterfly orchid *(Platanthera chlorantha),* pepper saxifrage *(Silaum silaus)* and wood bitter vetch (*Vicia orobus).* A comprehensive list of all known nationally rare and nationally scarce vascular plants found within grasslands for the UK is given in Crofts and Jefferson (1999).

A wide range of bird species may be associated with hay meadows, a critical factor being the water levels. The dry lowland meadows and pastures described here support few breeding bird species, although skylark (*Alauda arvensis*) may be present (Crofts and Jefferson, 1999). Wetter meadows may support a wider range of species notably corncrake (*Crex crex*), lapwing (*Vanellus vanellus*), snipe (*Gallinago gallinago*) and curlew (*Numenius arquata*). The critical issue for many bird species is grassland structure as opposed to species composition.

For the corncrake, hay meadows form one part of a mosaic of habitats required to support the bird (see Green, 1996).

Ground nesting birds such as lapwing (*Vanellus vanellus),* grey partridge *(Perdix perdix)* and skylark *(Alauda arvensis*) benefit from the relative lateness of the hay cut compared to modern silage techniques. It is these species which have undergone some of the most serious declines in Wales and the UK as a whole in recent years. This is due to the loss of mixed farming and the intensification of farming in the remaining arable areas (Lovegrove *et al* 1995*)*. The loss of habitat has being exacerbated by declining breeding success as a result of trampling caused by increased stock densities. In North and mid-Wales, the change in grassland structure has also increased vulnerability to predation (Lovegrove *et al* 1994*)*. Fewer than 1700 pairs of breeding lapwing may remain in Wales (CCW and FC, 1999), this may represent a decline of 97% on the 1930-1959 population (Lovegrove *et al* 1995*)*.

Semi-natural grasslands are of considerable interest for invertebrates although broadly speaking neutral grasslands, such as hay meadows, may not show as greater species richness as calcareous grasslands. The impact of hay cutting is to considerably reduce the structural diversity important for many invertebrates. However, plant species richness is one of the important factors (Crofts and Jefferson, 1999; Kirby, 1992). No UK BAP priority invertebrate species in Wales show a strong association with lowland hay meadows (Simonson and Thomas, 1999). Grasslands, hay meadows included, can form part of the mosaic of habitats used by great crested newts (*Triturus cristatus*) and brown hare (*Lepus europaeus*) - UK BAP priority species (Anon., 1995) and several bat species.

Chronology

Pollen analyses of palaeoenvironmental samples taken from archaeological sites, together with items of material culture such as sickles and hay knives show that hay has been produced as stored fodder for stock in Europe since as early as the Neolithic period (Barker 1985). Incidental evidence for hay is discussed in the report of excavations at Cefn Graeanog, Gwynedd (Fasham et al 1998, 50). Hay meadow is a vital component of any mixed economy farming enterprise and is likely to have been a major feature of the landscape of Wales from later prehistory until decline of the practice in the second half of the twentieth century. The amount of land given over to hay production would have increased through time in relation to the extent of arable cultivation practised, because greater quantities of fodder would have been required to maintain draught animals through the winter months. There would have been a fine balance between the need to expand the total area of arable cultivation against the necessity of conserving good meadow land (Barker 1985, Rackham 1986). The Medieval Welsh law books refer to hay meadow practice: 'Meadow, defined as land appropriated for hay only, was enclosed by a fence from the feast of St Patrick (17 March) to the Kalends of Winter because it was mown twice in a year' (Jones 1973, 438).

Rackham (1986) notes that the best land tended to be reserved for hay and that in some cases (where topography and land allowed) farms specialised in hay production because it was such a valuable commodity. Hay meadows were an especially important part of

agriculture of Snowdonia during the Early Modern period because of the cattle economy associated with droving to markets in England (Campbell, North and Scott 1949, 373). Whilst some travel writers produced pejorative reports of the value and size of hay harvest in upland Wales, there are also eighteenth and nineteenth century accounts of good yields, even from within the heart of Snowdonia (Campbell, North and Scott 1949, 385, Davies 1810, 212). Davies (1810) includes a detailed discussion hay production in north Wales, including practices and techniques, storage, dates of meadow closure and mowing, and the high value placed on meadows and old pastures by farmers.

Former geographical distribution

Refer to the discussion above under 'Chronology'

During the 20th century, and particularly since the Second World War increased food production powered by changing agricultural practice resulted in a rapid decline in old hay meadows and neutral grasslands. It is estimated that by 1984 in lowland England and Wales, semi-natural grassland had declined by 97% over the previous 50 years to approximately 0.2 million ha. Losses continued during the 1980s and 1990s, and have been recorded at 2 -10% per annum.

Case study examples

Caeau Tan y Bwlch, Clynnog Fawr, Gwynedd is a SSSI and North Wales Wildlife Trust nature reserve (see Appendix 3). Its history is typical of many "hay meadows" in Wales.

The area of hay meadow is approximately 2.9 ha and as described above is assigned to the National Vegetation Classification communities MG 5a *Cynosurus cristatus – Centaurea nigra Lathyrus pratensis* sub-community (Wales Field Unit, unpublished; (Rodwell, 1992). The rest of the reserve consists of areas of mire and scrub.

The site has undergone some small changes in the management but verbal evidence from previous occupiers indicates that until the 1950s cattle (5) and sheep (25-30) grazed the 6.4 ha site. Some of the fields were cut for hay, some fields were also ploughed for arable use. But not all of the fields would have been affected as access is too narrow for anything but stock (NWWT, unpublished).

Current management relies on winter grazing by up to 7 cattle for the whole of the site (6.4 ha). Since acquisition by the WT a hay crop has not being taken. This may be partly responsibly for the spread of bracken and the decline in the diversity of some of the fields at the site (NWWT, unpublished; Neil Griffiths, NWWT Reserves Officer, pers. comm).

Ecological aspects of the practice

In the absence of grazing or cutting management grasslands will undergo successional change over time. Generally this tends to lead to the development of scrub and woodland. The rate of change will depend on local environmental factors. By removing vegetation, by grazing or cutting, soil nutrient levels can be kept low and the competitive species prevented from dominating the sward. Those species which have life history strategies

that can tolerate such management are the ones that will benefit. Variations in the position of the growing point, palatability, tillering in grasses and reproductive and regeneration strategies are all important in determining species composition. Trampling and manuring and nutrient cycling are also factors affecting the structure and composition of grasslands (see Crofts and Jefferson, 1999).

Nature of the practice

The basic principle of hay meadows is that the fields are grazed from just after the hay cut through to April. They are then laid up for hay from April to July or August or perhaps later depending on weather; the crop is then cut for fodder. This would original have been done by hand (see Jenkins, 1992) before the advent of machinery. As late as 1992 the hay crop on Bardsey Island was cut by hand (Walker, 1992).

Periodic dressings of farmyard manure and occasional applications of lime may also have been applied to fields and may have helped maintain plant diversity (see above).

Sites where the practice still occurs

Pentwyn Farm is a Gwent Wildlife Trust reserve and SSSI. The site was acquired by the GWT in 1991. Prior to that it had been with the same family since the 1920s. During World War Two, part of the site had a potato crop grown on it. An annual hay crop was taken (Nicola Hutchinson, GWT Conservation Officer, pers, comm; GWT undated). Historically the site had low levels of organic manure applied to it and it is thought that this may have helped to maintain floristic diversity on the site (Richard Jones, CCW District Officer, pers. comm). The Grassland Institute are currently looking at the effects of organic fertiliser applications at the site. The WT are continuing with the annual hay crop and aftermath grazing by cattle management. This site would warrantee more detailed examination as part of any further work.

Hafod Wennol Grasslands SSSI in West Glamorgan includes the third largest example of lowland neutral grassland in the county and has long been managed on traditional lines. The site is currently covered by a Management Agreement with CCW (Tony Jenkins, CCW District Officer, pers. comm). The site includes several notable plants species e.g. greater butterfly orchid (*Platanthera chlorantha*) and the marsh fritillary *(Eurodryas aurinia*) has also been recorded from the site.

How the practice may be sustained

Today hay meadows can supply sweet hay for dairy calves and racehorses, pasture for ponies and traditional livestock breeds and more recently supplies of wild flower seeds. Their main significance however may lie in "the more spiritual areas of nature conservation and heritage" (Marren, 1995). They are no longer economic when compared to the high yields and low labour costs of agricultural improved fields.

In terms of financial support, there is provision for hay meadows adjacent to or within SSSI sites through CCW's annual grant-in-aid programme for key sites which are managed by NGO or through Section 15 Management Agreements (under the 1968

Countryside Act). Local non-statutory sites (Wildlife Sites) should be targeted by liaison with Wildlife Trusts or Local Authorities. The Tir Gofal scheme may provide opportunities on other sites. The scheme includes a mandatory habitat prescription for semi-improved meadows / hay meadows. The voluntary option for grassland restoration may provide further opportunities on land currently of poor biodiversity (NAW, 2000).

The Organic Farming Scheme launched in 1999 in Wales may also provide opportunities for the re-introduction of hay meadow type management. This would be particularly beneficial to the bird species described above. It is likely that organic hay would also sell at a premium on a local basis.

Potential for re-introduction using modern techniques

Changes in agriculture, particularly since the 1970s, have resulted in a great decline in the area of land given over to hay production. Silage making and farm specialisation have been particularly instrumental in this decline. Silage production avoids the weather constraints associated with hay making as well as allowing for a number of cuts to be taken from a meadow in a single year. Agricultural statistics demonstrate that silage hectarage in Wales surpassed that of hay in 1985, and has continued to expand since then (H.M.S.O. 1974 - 1995). The switch to silage has a number of detrimental consequences for wildlife, including the disturbance of young birds and of ground nesting birds due to cutting earlier in the year, as well as the potential pollution problems caused by liquor from silage. Hay production used to form a key element of agricultural system of a mixed farm. As farms have become increasingly specialised so the number of mixed farms has fallen dramatically. Hay production does not form a component of these specialised farms, and in pasture systems, winter fodder for livestock tends to be bought in as conserved forage.

The use of modern efficient harvesting machinery could improve the economics of a practice which is otherwise laborious and time consuming. The application of meadow type management on modern farms is discussed by Andrews and Rebane (1994). However, other positive strategies need not necessarily rely upon costly technological investment. Strategies could be developed to support greater numbers of mixed and less specialised farms who produce their own hay. For example, local machinery rings, providing baling equipment would enable smaller farms to cut hay without the cost of buying in machinery.

At the time of writing this report, and in the light of the 2001 Foot and Mouth Disease outbreak, the importance of being able to produce animal feed locally should not be underestimated. There are obvious benefits: for animal welfare i.e. known source of food and inputs to feed; for the environment by avoiding transportation of feed from other parts of the country; and for the creation of local employment possibilities.

Potential economic benefits as a basis for the sustainable management of biodiversity

Agri-environment payments for the management of hay meadows as part of extensive or organic farm systems would help re-build or maintain farm incomes. At a general level,

the broad economic consequences of sustainability in agriculture are unclear. Although there may be an increased demand for labour it is likely to be of a seasonal or causal nature (Webster, 1997). However, at a specific level, on-farm production of hay through meadow management would remove the cost of both purchasing in and transporting hay to the farm. These benefits would have to be weighed against the cost incurred by production of hay on the farm, such as machinery and labour costs to evaluate the extent to which they could be seen as sustainable in economic terms.

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5.2 Water Meadows

Definition

Meadows watered and drained under human control as opposed to the natural situation with flood meadows. Flood both insulates the ground over winter, stimulating a strong flush of grass growth in spring, and deposits minerals and nutrients on the ground surface.

Associated habitats

Unimproved seasonally-flooded grasslands may include National Vegetation Classification communities MG 4 *Alopecurus pratensis - Sanguisorba officinalis* flood meadow but more often it is MG 8 *Cynosurus cristatus - Caltha palustris* flood-pasture (Rodwell, 1992). The latter is the classic habitat produced by water meadow management. The fields may be bounded by hedges. Permanent or seasonal ponds, ditches or streams may also be associated with water meadows.

Habitat type affected or produced by the practice

The permanent or seasonal ponds, ditches or streams associated with water meadows also provide valuable habitats for a range of species.

Associated species

Generally no single grass species dominates but meadow fox-tail (*Alopecurus pratensis*), crested dog's-tail (*Cynosurus cristatus)* and red fescue *(Festuca rubra)* may all be abundant. Typical flowering species include great burnet (*Sanguisorba officinalis)* and meadow-sweet (*Filipendula ulmaria*). Sedges frequently occur, particularly in the flood-pasture communities. Marsh marigold (*Caltha palustris)* is also an important component of this community. A detailed analysis of the species associated with the NVC community is given in Rodwell (1992). Rare species associated with wet grasslands throughout the UK are given in Crofts and Jefferson (1999) and RSPB *et al* (1997).

Wet grasslands support a wide variety of invertebrate species (see RSPB *et al,* 1997).

A number of breeding bird species are characteristic of inland flood meadows including snipe (*Gallinago gallinago*), redshank (*Tringa totanus*) and lapwing (*Vanellus vanellus*). The latter has undergone one of the most serious decline of any breeding bird in Wales with less than 1000 pairs present. This is particularly associated with the switch from Spring sown to Autumn sown cereals so that by Spring the vegetation is too tall (Lovegrove *et al*, 1995). In winter the flooded grasslands can attract flocks of these and other wildfowl species including wigeon (*Anas penelope*) and teal (*Anas crecca*).

Of the other vertebrates found in water meadows or their associated features, the water vole (*Arvicola terrestris*) is important. This species has undergone dramatic declines - - possibly by as much as 97% - right through the 1990s (Anon., 1995; Strachen, 1998).

Chronology and historical synthesis

The earliest reference of the use of water meadows is in Dorset in 1607 (cited in Thomas, 1995). The practice reached its peak between 1700 and 1850. The increased used of fodder crops and fertilisers in second half of the 19th century resulted in a decline in the practice. This decline continued into the 20th century, exacerbated by loss of skilled labour as a result of the two World Wars (Thomas, 1995). In England water meadows were often associated with Lammas meadows (Brian, 1993 and 1999).

Clearly the term 'water meadow' has a specific definition and in this sense they are a relatively recent phenomena (Cook and Williamson 1999). No certain references were found for the practice in Wales, although management of wetlands in the south east, including the Gwent Levels, which utilises ditches ('reens') and sluices, may have followed similar arrangements (Rippon, 1996 and 1997; Sylvester, 1958). However, a broader series of practices involving the flooding of pasture land to protect the grass from frost, to encourage growth, and to spread nutrients over the fields were common practice throughout Wales. References to 'floated meadows' are common on land schedules accompanying eighteenth century estate surveys, as seen for example in the Vaynol Estate (Caernarfonshire) papers (see for instance Roberts 1973, 14).

A practice common on steeper land was to flood pasture slopes from a leat running on a gentle gradient and blocked at the far end. Few examples of this technique are recorded, but it is thought to have formerly been fairly common throughout hilly areas of Wales. A late eighteenth century example known from the antiquarian literature for Cardiganshire and follow up field survey work identified features thought to represent the remains of this specific example (Ken Murphy, Cambria Archaeology pers. comm.). An example of a similar system, known as a 'catchwork system' operating in the south east of England in the nineteenth century is given in Cook (1994, 61). Davies (1810, 212-220) includes a discussion of the maintenance of meadow land, including the benefits of flooding / floating. There is a discussion of late eighteenth century attitudes amongst the surveyors and estate managers of the Vaynol Estate (Gwynedd) and tennants of the estate on Llyn in Roberts (1973).

The inverse of these systems of flooding is seen at the low lying Gwent levels, where water management systems based around networks of large ditches (reens) drained water away where necessary, or maintained levels on meadow land where needed (Rippon 1996, 1997; Davies 1973).

Former geographical distribution

Water meadows developed in areas of poor soil particularly associated with the chalk areas of southern England.

Flood-meadow has a current total cover of <1500 ha and is found in scattered sites from the Thames valley through the Midlands and Welsh borders to the Ouse catchment in Yorkshire. Flood pasture is also now scarce and localised, with probably <1000 ha cover in England and Wales (UKBG, 1998). There may be as little as 500 ha of the NVC

community MG8 left in the UK. Only one or two working water meadows may remain (Scholey, 1995).

The more informal arrangements for flooding areas of land, including the 'catchwork' technique for undulating ground, appear to have been formerly widespread throughout Wales as discussed above, although details are unclear and further research is required in this area.

Case study example

Sherborne Water Meadows, Gloucestershire is an example of an attempt to re-instate a water meadow management infrastructure and regime on a former site (see RSPB *et al*, 1997 and Scholey, 1995). This project revealed no known sites of formal sluice-based water meadow systems in Wales.

Example of 'catchwork' systems are thought to have been common throughout Wales, but further research is needed to identify specific examples.

Ecological aspects of the practice

In the absence of grazing or cutting management grasslands will undergo successional change over time. Generally this tends to lead to the development of scrub and woodland. The rate of change will depend on local environmental factors. By removing vegetation, by grazing or cutting, soil nutrient levels can be kept low and the competitive species prevented from dominating the sward. Those species which have life history strategies that can tolerate such management are the ones that will benefit. Variations in the position of the growing point, palatability, tillering in grasses and reproductive and regeneration strategies are all important in determining species composition. Trampling and manuring and nutrient cycling are also factors affecting the structure and composition of grasslands (see Crofts and Jefferson, 1999).

The crucial factor for water meadows is the flooding in winter which provides a supply of water to warm and enrich the soil in spring and so stimulate an early bite from the sward.

Nature of the practice

Water meadows require a series of sluices and leats to enable control of the water levels and to ensure a moving film of water over the vegetation without completely covering it. A weir would control the water flow into a deep channel or carriage which supplied smaller "drowners" spaced at about 10 m intervals. Water spilled from these onto the adjacent land or "panes" and was collected in drains to return to the river (Thomas, 1995; Rodwell, 1992).

The season began in October after cattle had grazed the grass down. The land was flooded for approximately two week and then watered a week at a time through the winter. By March a rich, early growth of grass was ready for grazing after draining. This provided an important supplement for the stock, usually sheep, over a period of about six weeks. The animals would often be turned into less fertile land over night to provide manure. The

fields would be irrigated through May and June until ready for hay making. Finally the fields would be grazed until the end of September (Thomas, 1995).

Sites where the practice still occurs

There are no known sites in Wales however, various types of flooded meadow and pasture were formerly common throughout the country (see Chronology section)

How the practice may be sustained

As highlighted above this practice demonstrates the considerably biodiversity benefits which can be obtained by careful management of water levels. Although water meadows as such may not have been found in Wales, the principles of water control could be applied elsewhere particularly as part of habitat creation projects.

Tir Gofal may provide opportunities through its voluntary options for establishment of new habitats and features and also for grassland restoration on land currently of poor biodiversity value (NAW, 2000).

Larger projects may also attract funding from the Heritage Lottery Fund or other sources.

Potential for re-introduction using modern techniques

There is a growing body of case studies for the creation and recreation of wetland habitats e.g. the new wetlands created as part of the Cardiff Bay barrage mitigation, Morfa Madryn , Gwynedd; A55 mitigation, Anglesey. This is backed by a wide range of literature on the subject (e.g. RSPB *et al*, 1997 and Scholey, 1995 and Adams 1996). Any new proposal should be treated as unique with its own detailed plans developed.

Potential economic benefits as a basis for the sustainable management of biodiversity

The introduction or re-introduction of water control on a site may attract Tir Gofal or other funding especially for any capital outlay. However the long term sustainability of such schemes is more questionable. The vast differences between such management practices and current practices and the lack of sufficient compensation, as was the case with Tir Cymen, often discourage farmers (see Entec, 1998). Similar questions may be raised over the long term sustainability of projects carried out by conservation NGOs.

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5.3 Small Scale Mixed Arable Farming

Definition

An integrated, non-intensive, system of farming. By alternating or rotating cereal crops with other crops and grazing it is possible to maintain soil fertility, to control weeds and crop diseases, and maximise returns. With low levels of inputs from outside the farm, such farms are almost self-supporting.

Associated habitats

The habitats associated with small-scale mixed farming can be broadly described as grassland. Ecologically, however, the key to this land use practice is the variation in habitat structure produced throughout the year as crops are sown, weeded, harvested or over-wintered as stubble. This produces a range of habitats valuable as cover for nesting birds or the correct conditions for arable weed plant species. The mixture of crops also provides a wide range of nutritious foods. The key biodiversity benefits for the most part relate to the broad range of bird species that can thrive under such a land-use practice.

A wide variety of other habitats may be associated with small-scale mixed arable farm including hedgerows, dry stone walls and *cloddiau* (stone-faced earth banks), ponds and water courses and bodies of standing water.

Cereal Field Margins are included as a priority habitat in the UK Biodiversity Action Plan (Anon., 1995) and in the Countryside Council for Wales' *Action for Wildlife* document (CCW, 1995). There is however a relatively small area in Wales and it is not a high priority BAP habitat.

Associated species

The habitat features described above can support a wealth of species up through the food chain.

Various species of butterflies, grasshoppers, and beetles are associated with arable fields. Many polyphagous invertebrates (i.e. feeders on a range of foods) breed in crops, spending the winter in grassy banks and at the interface of crops, hedges and other features. Butterflies such as the orange-tip (*Anthocaris cardamines)* and 16 other species selectively use arable fields and adjacent habitats but do not breed in the crop. Many species of Orthoptera, Hemiptera, Hymenoptera and Coleoptera also utilise these habitats in a similar way. Over 2000 species of invertebrate are commonly found in cereal fields. (Anon., 1995)

The availability of prey such as field voles (*Microtus agrestis*) provides food for a number of predators such as kestrel (*Falco tinnunculus*) and barn owl (*Tyto alba*).

Ground nesting birds such as lapwing (*Vanellus vanellus),* grey partridge *(Perdix perdix)* and skylark *(Alauda arvensis*) benefit from the combination of cultivated fields for nesting and grazed areas which are a source of invertebrates for feeding chicks. It is these

species which have undergone some of the most serious declines in Wales and the UK as a whole in recent years (Lovegrove *et al* 1995; Chamberlain *et al*, 2000). This is due to the loss of mixed farming and the intensification of farming in the remaining arable areas – in south Wales the switch from spring-sown to autumn-sown cereals is particularly responsible for this decline, elsewhere increased stock densities have been a contributing factor (Lovegrove *et al* 1994). Fewer than 1700 pairs of breeding lapwing may remain in Wales (CCW and FC, 1999), this may represent a decline of 97% on the 1930-1959 population (Lovegrove *et al* 1995). The former distribution of these birds is described in Lovegrove *et al* (1994).

The weed species among over-wintered stubbles provided seeds for a wide range of species including linnets (*Carduelis cannabina)*, goldfinches (*C. carduelis)* and greenfinches (*C. chloris)*. Yellowhammers (*Emberiza citrinella)* collect cereal grains from the same fields. During the breeding season the seeds of unripe weeds and the invertebrates associated with them, were important food sources for linnets, greenfinches and turtle doves (*Streptopelia turtur)*.

The range of food available is also utilised by brown hares (*Lepus europaeus)* and other mammals.

Various "arable weeds" can thrive under the conditions offered by this type of mixed farming; particularly important is the timing of ploughing which allows species to set seed or germinate (Stoate, 1995). Arable wild flowers are of conservation concern because of enormous national declines in their distribution and abundance. These declines are due to developments in farming practice notable among which are increased use or fertilizers, herbicides, improved seed cleaning and changes in the crop growing cycle (Wilson, 1992). Threatened and important species include pheasant's eye (*Adonis annua)*, cornflower (*Centaurea cyanus)*, broadleaved spurge (*Euphorbia platyphyllos)*, corn parsley (*Petroselinum segetum*), shepherd's-needle *(Scandix pecten-veneris),* corn gromwell (*Buglossoides arvensis*), red hemp nettle (*Galeopsis angustifolium*) and narrow-fruited cornsalad (*Valerianella dentata)* (Anon., 1995). Overall in the UK, some 300 species of plants can occur in arable fields (Anon., 1995). A list of scarce arable weeds in Wales is given in Appendix 2. The distributions of these plants are shown in Ellis (1983) and Perring and Walters (1982)

Chronology

Farming in rotation or "mixed farming" became an efficient integrated system in the late nineteenth century (Stoate, 1995). Robust discussions of the value of different rotation regimes occur considerable space in the agricultural writers accounts from the eighteenth and nineteenth century (see for example Davies 1810, 150-164). A series of events from the 1880s onwards resulted in decline of the practice and its metamorphosis into today's modern intensive arable farming. Key events include: the repeal of the Corn Laws (in 1846); falling cereal prices in the 1880s; increasing use of artificial fertilizers from the 1880s onwards; the expansion of dairy farming; the Second World War and the "Dig for Victory" campaign; and increasing arable subsidies culminating in the Common Agriculture Policy (summarised from Stoate, 1995).

The changing fortunes of mixed farming are shown by the changes in the area of land under tillage in Wales. This was at its peak in the mid to late nineteenth century with approximately 20% of agricultural land under tillage. As a result of the events outlined above the area of tillage declined steadily until the 1930's. During the Second World War the levels recovered but then declined for the following thirty years through to the 1970s (Lovegrove *et al*, 1995). In 1970 arable farming accounted for 18% of the agricultural land in Wales, by 1995 this had further declined to 12% (CCW and FC, 1995). This is concentrated in Pembrokeshire, the Vale of Glamorgan, Monmouthshire, the Vale of Clwyd and Anglesey.

Further illustration of this decline can be seen on Anglesey. Estimates of the area of arable land at the end of the 19th century vary from approximately 29000 hectares (Roberts, 1958) to 15269 hectares (Digest of Welsh Historical Statistics, Vol. 1 J. Williams, 1985 cited in Williams *et al*, 1993). By 1994 this was down to 10, 260 hectares (statistics quoted on Isle of Anglesey Council website: http:// www.anglesey.gov.uk/english/facts/agriculture.htm) and by 1997 to 7, 670 hectares (National Assembly for Wales 2000). It should be noted that variations in the definitions of "arable" and "tillage" used in the compilation of statistics such as those quotes above vary potentially making comparisons problematic. The figures are included here because they give a rough indication of the dramatic changes in this practice over a relatively short time period.

The findings of this scoping project suggest that there is a substantial amount of documentary information available relating to eighteenth through to early twentieth century mixed arable regimes in Wales. Time constraints and the remit of this project do not allow for a full review of this material here, but given the importance of the practice in biodiversity terms, it is recommended that further work is carried out in this area in future.

Former geographical distribution

Although still a widespread practice, arable farming,and in particular mixed arable farming, was formerly much more common than it is today. It has undergone economic cycles but is currently at its lowest levels for over 150 years (see above). The most important areas, by % under tillage, are Pembrokeshire, the Vale of Glamorgan, Monmouthshire, the Vale of Clwyd and Anglesey (Lovegrove *et al*, 1995).

Case study examples

Denmark Farm, Lampeter is owned and managed by the Shared Earth Trust (www.naturebureau.co.uk/pages/floraloc/homepage.html). The Trust acquired the 40 hectare farm in the late 1980s. Until the mid 1970s the farm, then a much larger unit, had been managed as a traditional small scale mixed farm. After this the farm was sold, broken up and management intensified. Since the Trust acquired the site its has been using non-intervention techniques to restore the pasture and meadows and has undertaken an extensive monitoring programme (Angie Polkey, Shared Earth Trust, pers. comm.).

The oral history of the site is currently being explored by Dominic Carmichael at the Trust.

As stated above small-scale arable farming was formally far more widespread than it is in the modern landscape of Wales. In some areas older farmers will have worked regimes of this kind in the past, or will have heard about them from the previous generation. Whilst the initial findings of this project have indicated that a substantial amount of documentary information is available relating to mixed arable regimes over the past three or four centuries, oral history could prove an important source for details of late nineteenth and early twentieth century practices. This is an area which would warrant further study.

Ecological aspects of the practice

Rotational farming developed at a time when the means to promote the growth of financially worthwhile crops depended on the waste products from stock (manure) and on the growth of green crops to fertilize the soil. It therefore manipulates that fundamental ecological process - the recycling of nutrients in the environment.

By combining knowledge of the properties of leguminous plants to improve soil condition (through their ability to fix nitrogen) with animal husbandry and crop cultivation (e.g. the ability to weed or "clean up" by growing crops, such as turnips or mangolds, drilled far enough apart to allow manual weeding) it is possible to maintain soil and plant nutrient levels on a long term basis.

Nature of the practice

Farming in rotation or "mixed farming" is described in Stoate (1995). Although the crop rotation varied from region to region the standard four course rotation consisted of: a root crop in the first year, followed by cereals, then a "seeds" stage of grasses or legumes and finally cereals again. A key feature of this rotation is that crops were sown in spring and stock grazing densities were low. This provides cover for ground-nesting birds in the spring and early summer and thereby reduces predation and has an acceptable level of nest or egg destruction through trampling (Lovegrove *et al*, 1994).

For example in 1897 a farm of 145 acres (59 hectares) in the parish of Llangrannog, Cardiganshire grew: 35 acres of corn, 15 of barley, 12 oats, 5 of wheat and 3 of rye. In addition there were 10 dairy cattle and 35 calves; 15pigs, 5 horses and poultry.

A further example is given in the life story of J.R. Rowlands (Gwynedd County Council, 1992). Hendre Hywel (Talwrn, Anglesey) was a 125 acre (50 hectare) farm. Three of the farm's fields were ploughed each year throughout the 1920s. The following sequence was followed. In the first year a field was ploughed out of grass and oats were sown. The following year a green crop was grown along with potatoes, mangolds and swede to "clear it out". In the third year corn was under-sown with grass for hay and grazing. This practice all but ceased with the introduction of the farm's first tractor, supported by corn subsidies in 1947. The All Wales Habitat Survey Maps for Anglesey (Williams *et al*, 1993) records all the fields surrounding this farm as "improved".

Sites where the practice still occurs

The research for this study revealed that in a number of locations conservation organisations are proposing to trial arable farming on a small scale specifically aimed at providing biodiversity benefits. At Gilfach Farm, Radnorshire and Cors Goch, Anglesey the respective Wildlife Trust (WT) hope to carry out such plans in the near future (Julian Jones, Conservation Officer, Radnorshire WT, pers. comm.; Chris Wynne, Conservation Officer, North Wales WT, pers. comm.)

During 2000 the RSPB ran a small trial involving an oats crop at its Valley Lakes site, Anglesey and similar trials have taken place at their Inner Marsh Farm reserve, Deeside (Ian Simms, RSPB Anglesey, pers. comm.).

A more detailed agricultural perspective may be provided through by the demonstration farm network run by the Organic Centre Wales. Further research in this area is recommended.

How the practice may be sustained

Tir Gofal includes a number of voluntary options which may provide opportunities for financing arable farming methods with a wide range of biodiversity benefits. Importantly these benefits will come from land that has little current ecological value. The options are: unsprayed crops; winter stubbles; spring cereals or oilseed rape under-sown with grasses and legumes; unsprayed root crops followed by winter grazing; rough grass margins; uncropped fallow margins; establishment of wildlife cover crop and conversion of arable to grassland. Payments vary from £80 per ha per year for winter stubbles after a conventional crop to £450 per ha per year for uncropped fallow margins (NAW, 2000).

The Organic Farming Scheme launched in 1999 in Wales may also provide opportunities for a whole range of arable and other farming practices to benefit biodiversity. The scheme provides direct financial support for conversion to organic production. The potential benefits derive from an overall aim to create an integrated agri-environment production system that is self-regulated in terms of pest and disease control and conservation of wildlife and landscape (Lampkin and Measures, 1995; Stockdale et al 2000).

At the time of writing this report, and in the light of the 2001 Foot and Mouth Disease outbreak, the importance of being able to produce animal feed locally should not be underestimated. There are obvious benefits: for animal welfare i.e. known source of food and inputs to feed; for the environment by avoiding transportation of feed across large distances; and through the creation of local jobs.

Potential for re-introduction using modern techniques

Changing technologies and the application of modern machinery to arable farming is not the critical issue in terms of the ecological benefits. However, the intensification and specialisation of arable farming since the 1970s, with attendant increases in inputs of pesticides and chemical fertilisers, have had a high cost in environmental terms. The clear ecological benefits of arable systems based on rotations of a range of crops is outlined

above. However, the potential benefits are greatest when arable rotation is combined with stock husbandry on mixed rather than specialised enterprises. The successful promotion and extension of mixed enterprises which include rotation systems in the English West Country suggest potential for re-introduction in areas where mixed systems have declined in number at the expensive of specialisation.

Through a process of agricultural extensification assisted by Tir Gofal or the Organic Farming Scheme the biodiversity benefits of traditional small scale arable farming could be harnessed. The development of integrated crop protection practices, as a drive towards greater sustainability within mainstream agriculture, should also yield positive biodiversity benefits (Atkinson and McKinlay, 1997).

Potential economic benefits as a basis for the sustainable management of biodiversity

Data for the UK does suggest it may be possible to reduce input (pesticides and chemical fertiliser) levels and to bear reduced crop yields without compromising gross margin levels. Webster (1997) has stated that increased demand within for labour extensified systems is likely to be of a seasonal or causal nature, which may have attendant implications for the economic, and therefore social, sustainability of rural communities (Webster, 1997). The development of machinery rings and co-operatives is well suited to the reintroduction of balance mixed enterprises and would allow costs to be shared. Other benefits include: local production and marketing; reduced food miles and transport and input costs; and a possible contribution to environmental tourism through wider benefits to the welfare of the natural and historic landscape.

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5.4 Coppicing

Definition

Almost all British broadleaved tree and shrub species are capable of vigorous regeneration after felling, by sprouting from the cut stump or 'stool' (eg. hazel, oaks, ash, wych elm, willows, sycamore, sweet chestnut) or by suckering from the root system (eg. elm, aspen). Coppicing exploits this natural propensity by regularly and repeatedly cutting trees to near ground level to create a recurring crop of relatively small, uniform material or underwood. The term "coppice" may be applied either to the woods or woodland compartments which are managed to produce such underwood, or to the crop of underwood itself, or as a verb describing the management practice. Historically, it has also occasionally been used, as 'incopse', meaning the fencing of woodland compartments after felling, to convert to coppice (Rackham 1989).

'Underwood' has historically been distinguished from 'timber', which comprised the standing or felled crop of large trees suitable for planks and beams. Coppice woodland, for underwood, has often been combined with timber production in the practice traditionally known as "coppice-with-standards".

Coppice which has been left uncut beyond its normal rotation may be termed 'stored coppice' because, for many species, this has the potential to develop a timber crop if managed. However, more often, especially for shrub species such as hazel which will never develop real timber, it is simply regarded as derelict or neglected coppice.

Other woodland practices are akin to coppicing. 'Pollarding' is similar to coppicing but the boll is cut, not at ground level, but at about 2 - 3m, so that the regenerating sprouts are above the reach of grazing animals. Pollards are often associated with ancient wood pasture.

'Shredding' entails the cropping of side branches from a tree leaving only the topmost branches uncut (Rackham 1986). This may have yielded underwood and yet retained the timber value of the tree. Lopping was essentially similar but perhaps less systematic. Lopping provided a supply of fuel and fodder without killing the tree.

Associated Habitats

Coppicing was once so ubiquitous that it has affected probably every type or class of deciduous woodland in England and Wales.

The archetypal flowery, lowland hazel coppice or coppice with standards occurs especially in NVC W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* woodlands and NVC W10 *Quercus robur- Pteridium aquilinum- Rubus fruticosus* communities. Coppicing was once the most important and ubiquitous silvicultural practice in these woodland types throughout England and Wales. In many sites, centuries of coppice management in these woods has blurred the natural distinction between different NVC communities and sub communities, resulting in canopy species which would not otherwise be associated with the soil, ground flora and bryophyte layer

beneath. In particular, hazel has often become unnaturally superabundant in response to coppicing, both because hazel responds so well to coppicing, and because it has been favoured by woodmen. (Rodwell 1991). Similarly the natural abundance of oak in W10 woods has often been reduced. (Rodwell 1991).

However, the majority of Welsh coppice woodlands do not conform to this archetypal English coppice. Even in W8 and W10 communities, especially towards North Wales, the predominance of hazel in coppiced woodlands was less. Here oak, (often *Quercus petraea*), and sometimes sycamore was the main crop species (Rodwell 1991)

The major source of underwood and timber in Wales, was derived from W11 *Quercus petraea - Betula pubescens - Oxalis acetosella* woods, and from the more calcifugous W17 *Quercus petraea - Betula pubescens - Dicranum majus* woodlands. (Linnard 2000; Rodwell 1991). Tracts of multi-stemmed, structurally-even oak are typical of much of upland Wales nowadays. Here hazel rarely formed a dense underwood and the principal crop was oak for charcoal (particularly for iron smelting), tan bark, pit props, and constructional timber, and sometimes birch for bobbins (Linnard 2000). However, as the coppice industry declined, coppicing conflicted with grazing in many of these woods and grazing is typical today.

Even many of the wet woodland communities were once systematically harvested for underwood. W7 *Alnus glutinosa, Fraxinus excelsior - Lysimachia nemorum* woodland was coppiced especially for alder, as at Aber, North Wales. Osier production was often super-imposed on W6 *Alnus glutinosa - Urtica dioica* communities, with the natural canopy largely replaced by intensively managed short rotation *Salix viminalis/ S. triandra* (often cultivars) (Rodwell 1991).

The effect of coppicing on any natural woodland community is a complex result of the nature of the existing vegetation, the history of local woodland management traditions, local products, and market forces. (See Peterken 1974, 1977, 1981; Rackham 1967, 1971, 1975, 1976, 1980, 1989). The history of management can cause long term changes in community (eg. the unnatural promotion of hazel in many woods, and replanting), but the most characteristic effects of coppicing are cyclical. More recently, neglect of coppices has become the norm. This too may have long term effects, though many changes would be reversible.

The traditional coppice rotation causes profound, unnatural perturbation of the local environment in which the plants and animals live. - a sudden increase and steady decline in the exposure of the ground to the unshaded, unsheltered microclimate, trampling and disturbance associated with cropping, cyclical changes in canopy and field layer vegetation. Rackham (1975 and 1980) estimates that, after coppicing, spring sunlight doubles, summer sunlight increases twenty-fold, and sun temperatures exceed shade temperatures by 6-9oC.

Initially, disturbance and trampling during harvesting the underwood and timber crop, will cause the destruction of much of the ground flora. Soil compaction and waterlogging in the winter and spring of the cut, and drought in the first summer may cause a further decline in shade adapted species, such as dogs mercury (Rodwell 1991). The decline of shade species, which had hitherto often dominated the ground flora, opens up the ground

for the prominence of other existing field layer associates and the spread or influx of adventives. The characteristic post-coppice flowering is well seen in W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* woodlands where the often almost total dominance of dogs mercury in the shaded coppice is superceded by various mixtures of bluebells, primrose, wood anemone, lesser spearwort, violets, herb robert, sanicle and ground ivy. Adventives such as soft rush may establish from seed and others such as marsh thistle, and greater willow herb may colonise from neighbouring habitats. Nettles and rosebay tend to colonise locally enriched ground such as bonfire sites. Overall, bramble, false brome, and tufted hair grass often thrive in the sunlight and may come to temporary dominance (Rodwell 1991). Within a few years, the underwood becomes a dense tangle of coppice sprouts and brambles, eventually leading to the re-establishment of the shade community. The flowery response to coppicing is similar in W10 *Quercus petraea - Pteridium aquilinum - Rubus fruticosus* woodlands with bluebells, red campion and foxgloves eventually giving way to the dominance of tangled , waist-high brambles and honeysuckle, or bracken (Rodwell 1991). Bramble and honeysuckle, which are more shade adapted, may persist for several years into the coppice cycle, and bracken may stifle coppice regrowth to produce open glades (Rodwell 1991).

The response of W11 *Quercus petraea - Betula pubescens - Oxalis acetosella* woods and W17 *Quercus petraea - Betula pubescens - Dicranum majus* woodlands, which are the commoner coppice stands in Wales, is less well studied or understood. In W11, as with W8 and W10, there may be an initial flush of vernal dominants such as bluebells where they occur on deeper soils, wood sorrel, greater stitchwort, and dog violets. However, in W11 and W17, the post-coppice ground community is generally predominantly grassy, with various ratios of soft grasses, wavy hair grass, sweet vernal grass, and *Agrostis* species. Bracken too may come to dominate in summer where the soils are deeper. Brambles and honeysuckle are typical in W11 but they are less vigorous than in W8 and W10 woods. Ericoid shrubs, ling and bilberry may dominate all coppice stages in some W17 sub-communities, but they respond less immediately and less dramatically than the grasses. As the coppice canopy closes, these coppice types form a rather open woodland. The forbs become less vigorous and mosses and ferns, such as hard fern, become more noticeable. (Rodwell 1991)

Virtually all Welsh coppices have now been neglected for several decades beyond their traditional coppice rotation. The unnaturally high density of stems created by coppicing has now developed into a closed and relatively high canopy. Eventually these woods would succeed to a high forest structure and many of the coppice stems are now dead as the coppice is naturally self thinning. Within about 20 - 50 years after canopy closure, neglected W8 and W10 coppices tend to succeed to the floristically rather dull W8 *Hedera helix* and W10 *Hedera helix* sub communities (Rodwell 1991). Here, because of their gloomy character, the ground flora is often sparse and dominated by a carpet of ivy. Bluebells (and dogs mercury in W8), which may predominate both coppice and high forest in spring, become rare or absent under such gloomy conditions. They give way to ivy or a sparse cover of brambles, rough meadow grass, ground ivy and mosses.

Neglected W11 and W17 coppices tend to be less dense and dark, under an oak *Quercus petraea* canopy, so the ground flora is less stifled. These upland woodland types often

ubut onto upland pasture or moorland and as they have ceased to be valued for coppice they have been left open to grazing stock. Grazing has exacerbated the openness of these woods, by preventing regeneration and reducing the cover of ericoid shrubs (often eliminating bilberry). Grazing favours the grass species and mosses. Birch is often a gap-coloniser. In neglected W11 and W17 coppices it has spread considerably and, especially at high altitudes, is often replaces oak as the dominant tree (Rodwell 1991).

Coppicing has often been the preferred method of woodland conservation for four main reasons. It maintains a historic management system, perpetuates native woodland types, generates diverse habitats, and produces a crop. For wildlife conservation, coppices maintain abundant open spaces with edge habitats which are buffered from agricultural effects; regeneration opportunities; young growth habitats; and support mature habitats such as standards, ancient stools, and boundary pollards.

However, as with all conservation management, there are disadvantages too and, as Peterken (1996) points out, it is important to realise that coppicing does not emulate natural forest processes. Coppiced woodland has a high degree of unnaturalness, creates a woodland devoid of real forest interior, and has limited standing or fallen deadwood. This is detrimental to hole nesting birds eg. nuthatch and shade species eg. white admiral, leaf miners and spiders (Sterling and Hambler 1988).

A number of woodland types are identified as priority habitats in the UK BAP (Anon., 1995). Of these the following are most likely to have been affected by coppicing: upland oak woodland; upland ash woodland; and wet woodland.

Associated Species

Many of the species which most typify woodlands, and many of the woodland rarities, have poor powers of dispersal beyond the moist woodland microclimate. For this reason conservation of these species depends on perpetuation of populations within a site, and so maintenance of a full range of ecological niches *within* a site. In high forest this is achieved by maintenance of a diverse age class structure. In coppice woodlands the same is achieved by rotation of habitats and communities within a relatively small area. Most areas of semi-natural woodland are less than 20ha in extent and it is impractical to maintain all age classes of a 150 year high forest rotation within such a small area. The solution is to coppice (Buckley 1992)

Long periods without management intervention in woodlands tend to result in uniformity and impoverishment of the ground flora, at a local level, due to competitive exclusion (Barkham 1992). Coppicing benefits a variety of spring vernal plants including ancient woodland indicator species such as wood anemone. However, low intensity grazing may be importance to maintenance of this herbaceous community. Without grazing brambles may become rampant (Barkham 1992).

Most woodland mammals benefit from coppicing despite the initial disturbance. The thicket stage in about the second to fourth years, gives abundant cover for deer and rabbits, and plenty of food for mice and voles. Of particular importance is the dormouse

(*Muscardinus avellanarius*), a UK BAP priority species (Anon., 1995) and a scarce species in Wales (CCW, 1997).

Coppicing favours those bird species which favour early stages of woodland succession. In particular, coppice seems to produce a habitat structure which is favourable for breeding migrants such as willow warbler and chiffchaff. The canopy closure stage, at about 4-5 years, holds the greatest density of warblers. Once the field layer has become shaded out, the bird community often becomes dominated by titmice, chaffinches, and robins. Long coppice rotations generally do not lead to a diverse bird fauna because, within coppice, there are few bird species which are absolutely restricted to the older stages. Derelict coppice is a poor habitat for birds.

Coppice management is not favourable for many of the woodland specialist birds. Dead and dying wood is one of the greatest resources for animals in a natural forest, and coppice woodland lacks the biomass of deadwood invertebrate food and hole nesting sites (Fuller 1995). In Wytham Wood, 18 of 60 breeding bird species depend wholly or partly on dead wood for nest sites (Kirby 1992)

Coppice woodland has three main qualities which benefit insects - sunlight, shelter from wind, and (depending on past history) a rich ground flora for larval and adult food plants. Some species complete their whole life cycle in the coppice. Others only use it for certain stages of their life history or certain needs such as nectar, basking, or food plants The widespread cessation of coppicing has led to many species declines and local extinctions. Invertebrates cannot survive temporary periods of adversity like seeds. They need continuity of habitats. Because many invertebrates are rather sedentary, they require coppice coupes to be reasonably close. Therefore many woodland invertebrates can only be conserved if coppicing is resumed and maintained or simulated by such as woodland rides. Fortunately large populations of many invertebrate species can be conserved by small patches of suitable habitat. Unfortunately, reinstating the coppicing regime may not reverse local extinctions if sedentary species have been lost.

Three quarters of British butterflies regularly breed in woodland and one third are confined to woodland over much of their British range despite the fact that few feed on trees. Only the green veined white and speckled wood tolerate up to 90% shade. Most require open, sunny areas such as the early coppice stages, which provide their herbaceous larval food and nectar plants. (Warren & Thomas 1992). Violets are particularly important for some of the fritillary species. Because of the decline in coppice management, the high brown fritillary, pearl bordered fritillary and heath fritillary, which were once widespread, are now highly endangered, and UK BAP priority species (Anon., 1995). Conversely however, the white admiral and speckled wood have benefited from the shady woodland interior and populations have increased (Warren & Key 1991)

Coppicing does not favour saproxylic invertebrates or fungi. Coppice stools may be centuries old and rotten in their heart but these do not compensate in either quality or quantity for the loss of other natural sources of dead wood. Dead wood on coppice standards tends to be sun-dried. However, as Kirby (1992) points out, most of the rarer dead wood invertebrates require habitat continuity. (Often this is why they are rare). Where a woodland has a long history of coppice management, it is unlikely to be of

importance to dead wood invertebrates anyway. Neglected coppice takes a long time to acquire a rich invertebrate fauna. Despite decades of coppice neglect there are few places which harbour a rich dead wood fauna. (Buckley, 1992)

Ancient wood indicators in coppice wood tend to be trees, shrubs, ground vegetation, molluscs, and butterflies but not epiphytic lichens, or dead wood beetles and fungi, reflecting the constituents of the habitat which have had continuity (Peterken, 1996).

Chronology and historical synthesis

Until the twentieth century, semi-natural woodlands were amongst the most important and valued resources for any local community, and coppicing was one of the most widespread of all woodland management practices.

Direct evidence for coppicing from the Neolithic (c.7,000-4,500BP) onwards is provided by archaeological finds of coppice products, such as the timber used in the construction of the Sweet Track, Somerset Levels (Linnard 2000). Incidental evidence for coppicing during the preceding Mesolithic (10,000-7,000BP) when Britain was populated by mobile groups of people, whose existence followed an annual cycle of hunting and gathering 'wild' resources, is given by patterns observed in pollen diagrams for the period. Some of the earliest evidence from Wales comes from palaeo-environmental samples taken during the excavation of a Bronze Age complex of burial and ceremonial monuments in the Brenig Valley, Hiraethog, Denbighshire. Pollen analysis indicated a rise of hazel pollen during the Bronze Age, which was interpreted as indicating coppice regimes (Lynch 1993, 11). Recent work at Castell Henllys, Pembrokeshire, an Iron Age hillfort which is subject to an ongoing programme of excavation and reconstruction has highlighted they substantial demand for coppice wood required for the maintenance of settlement sites of this period. The study has major implications for the importance of coppicing as a key element of the Iron Age landscape (Bennett 2001). Certainly, coppicing was part of the Romans' sophisticated forest administration. However, analysis of the Welsh Laws of Hywel Dda suggest that there was little systematic exploitation of forests in the tenth to twelfth centuries. Forests were largely free for tribal hunting and *vert*, and coppicing and woodland management was confined to 'Coed Cadw' (preserved woodlands) and to areas near settlements (Linnard 2000).

Coppicing really became important during the medieval period. Buckley (1992) states that by 1250, coppicing was universal in British woods and that until about 150 years ago, it was the most widespread silvicultural practice.

By the early twentieth century coppicing was declining greatly, especially WW1 and WW2. By the mid twentieth century there was almost no coppicing left in Britain, and the little that there was in southern England was dominated by sweet chestnut. The 1970s and 1980s saw a small scale resurgence in interest in coppicing, in part as a practical conservation tool in the practical management of woodlands.

The social and economic history of coppice management cannot be wholly diverged from that of forests and woodlands in general from the middle ages onwards. Multiple use of woodlands and complete utilisation of woodland products were the main features of the

feudal/peasant economy. Products were as diverse as timber, underwood, dead wood, bark, charcoal, wild honey and wax, fruits and nuts, mast, rabbits and game, hawks, foliage for fodder, herbage for grazing, wood ash and dye-stuffs. Use of trees included everything from the timber to the twigs. Incidental to timber itself were products such as furze (gorse), bracken, reeds and rushes, and metal ores within woodland. Furthermore, many different individuals and sectors of society may have had many, potentially conflicting, rights of ownership/use or common within one woodland. Timber for instance was often the property of the lordship, but the coppice which it overshadowed may have been the right of the commoners. The owner of deer, the graziers and the warreners, were similarly in conflict with the coppicers. This led to many disputes and medieval court cases and forests were strictly supervised by *foresters*, *verderers* and *woodwards*.

With the decline in hunting, woods became revenue generating parts of the lordship. Timber determined the capital value of a woodland. Underwood determined the annual revenue value of a wood (Linnard 2000).

Despite the progress of enclosure by Parliamentary Act and other mechanisms in the eighteenth and nineteenth centuries, many of the traditional uses of underwood continued to meet local community needs up to the mid-twentieth century. Some of the uses of coppice wood are given in Table 3. Until easy transport brought iron and affordable mass produced commodities to rural communities, locally harvested underwood was the raw material for most agricultural tools, baskets and storage vessels, domestic utensils, turnery such as plates and furniture, buildings, fences, and fuel (Tabor 1994; Seymour 1984; Abbot 1989; Jones 1978; Linnard 2000). Coppice with standards yielded timber in addition to this. Wood remained the primary source of fuel in Wales until the nineteenth century.

Real coppice industries developed in the seventeenth to twentieth centuries, to supply ship timber, tanbark , pitwood and charcoal. Whole communities were based on these forest industries.

Charcoal

The demand for charcoal for metal smelting (mostly iron and lead) has probably affected woodland over most of Wales in one period or another (Linnard 2000), but by the eighteenth century most of this industry was concentrated in South Wales. Iron smelting and mining totally dominated the market for underwood in the eighteenth and nineteenth centuries and the majority of South Wales woods were managed to provide pitwood and charcoal (Linnard 2000). There were complaints that 'iron-masters' decimated woodlands, and this may be true in some places, but the industrialists had a vested interest in maintaining their supply of coppice wood and most managed coppices sustainably or even increased their extent (Linnard 2000). Many industrialists bought their local woodlands, further concentrating wealth in fewer hands.

Oak and beech were the preferred species for charcoal but other broadleaves were also used. Charcoal was manufactured on site, in the wood, because it was easier to transport than wood, and the remains of many charcoal hearths are known in South Wales. The

wood colliers were usually men but often whole families lived in the wood. Felling and cording was concentrated in the winter and early spring. Little felling was done in the summer when the workers were probably employed in agriculture (Linnard 2000; Armstrong 1978).

The metal industries supported more woodmen and wood colliers than it did miners (Linnard 2000).

Many examples show the importance of the charcoal industry. In 1630 the Earl of Worcester enclosed 3,000 acres of Wentwood Forest (and prosecuted the dispossessed tenants who persisted in exercising their former common rights). In 1678 he felled, corded, and coaled wood alleged to be worth the very substantial sum of £60,000. In the fifteen years to 1603, Nanney, a local landowner, was accused of illegally felling 30,000 oaks, valued at £4,500 in the Forest of Snowdon to supply the Ganllwyd Ironworks. He was fined £800. It has been calculated that in 1704, the Pontypool and Llanelly (Llanelli) forges and furnaces consumed 320 acres of coppice wood *per annum*. Cut on a sixteen year rotation this required 5,120 acres of woodland to sustain it. In 1705 almost all the old woods (high forest) around Pontypool had been felled, but coppice was retained and carefully managed because of the good returns from cordwood for charcoal manufacture (all examples from Linnard 2000).

During the eighteenth century the use of coke (from coal) superseded charcoal in the iron smelting industry and the market for charcoal eventually collapsed. However, Wales was slower to adopt coke than England and even by 1809, charcoal fired forges still outnumbered coke fed ones in Merionethshire (Linnard 2000).

Pitwood

Simultaneous with the advent of coke and the consequent decline of the charcoal industry, was the great expansion of the South Wales coalfields, creating a demand for pit props.

The mining industry in South Wales demanded two grades of wood - hardwood poles to make pit props, and smaller corded material to make a crib framework to support the mine roof. This was produced by coppicing, so woodland management was directed towards simple coppice on a rotation of 20 - 30 years, rather than coppice with standards, and timber became uncommon.

Until the advent of conifer plantations during the nineteenth century, all pitwood used in south Wales was from Welsh hardwoods, mostly oak (Linnard 2000). The demand for pit props in South Wales was so great that North Wales too exported oak for the South Wales coal mines. Even though sawn timber was used in New England and Europe, Britain (and Wales especially) was slow to adopt sawn pitwood until the nineteenth century (Linnard 2000). As late as the 1920s mixed hardwood pitwood was extracted by mule teams from the woods above Tongwynlais (Linnard 2000). However by the 1880s local production was insignificant compared to softwood imports to Cardiff (Linnard 2000). At the turn of the century the pitwood industry was in decline. Local oak coppice, but also soft wood timber, were once again cut to sustain the colliery industry through the First World War and by 1919 large areas of the South Wales woodlands were devastated. By World War II

oak coppice was the dominant stand type in Wales. War production relied increasingly on oak coppice and small parcels of conifers, but because its peacetime market value had plummeted with the fall in the price of bark and decline of the charcoal and pitwood industry, only a proportion of the stands had been maintained in good condition (Linnard 2000).

Tanbark

Recorded history of oak-bark tanneries in Wales goes back to Norman times, and later to the Cistercian Monks. However the boom of the industry was between the late fifteenth century and end of the eighteenth.

Bark can only be detached with reasonable ease when the sap is rising in spring. In Wales the bark peeling season is April to June. The tanbark economy was a major provider of seasonal employment throughout Wales, for men women and families.

The best tannin (the active ingredient of the tanning process) is obtained from the bark of relatively small trees but these may be more costly to strip. Oak coppice on 25-30 rotation was considered optimal although all sizes of trees were de-barked. Although bark was always in demand, it was mainly a by-product, albeit a valuable one. The tanbark industry was dependent on other woodland industries producing underwood or timber. Because the mines generally wanted de-barked wood, the pitwood industry could be successfully combined with the tanbark industry. Felling could often be timed for sap flow but this led to compromise and conflict because some industries required winter felling because this yield better timber especially for construction and ship building (Linnard 2000).

The scale of industry was considerable. In the late 1870's one Scotsman amassed a stack of bark at Hay-on-Wye which was reputed to be worth £6,000. Welsh oakwoods were able to supply the local tanneries throughout Wales but they also supported a substantial export trade to Bristol, Liverpool and Ireland. Small North Wales tanneries at one time specialised in producing roller leather for the Lancashire cotton mills (Jones 1978)

The main centre for the export trade was Chepstow, and here the trade grew from a few hundred tons *per annum* in the early eighteenth century to 4,000 tons *per annum* in the 1790s.

Competition from superior imported vegetable tanstuffs, cause the decline of the tanbark industry in the nineteenth century. The Chepstow bark export trade ended in the 1880s. There was some revival of oak-bark tanning in World War I and World War II, in west and central Wales, but the last oak bark tannery in Wales, at Rhayader, closed in the early 1950s

Ship Building

Ship building is not a coppice industry. However coppice with standards would have provided valuable ship timber and maiden trees in coppices would have been nurtured to provide specific naturally curved, angled or straight baulks for ships ribs, knees, planks, etc.

Former Geographical Distribution

By 1905 the total area of coppice in Great Britain had declined to 233,000 ha (Buckley 1996). Even so, about one third of all woodlands in Britain were coppiced and coppice woods were present in every county of Britain excepting some parts of Scotland (Rackham 1976). The amount of coppice in Wales was 0.33 % of the land surface of the nation, and this occurred mostly in the South, in Monmouthshire, Glamorganshire and Carmarthenshire. This compares to 1.65% in England and 0.12% in Scotland. Coppicing had been declining since the end of the nineteenth century and this decline was greatest in the North and West of Britain (Rackham 1976).

Just before World War I, almost 20% of all woodland in Wales was coppice. The percentage of coppice varied greatly between counties (Table 1). Monmouthshire accounted for over half of the coppice acreage in Wales, with 71% of its wood coppiced. All except the counties of Glamorganshire, Radnorshire, Carmarthenshire, and Monmouthshire had less than 10% coppice. The lowest coppicing rates (<3%) occurred in North Wales; Anglesey, Caernarfonshire, Denbighshire, and Flintshire (Linnard 2000). The extent of coppice was not correlated to the extent of woodland.

Table 1 Area of Coppice Woodland in Wales, by County in 1913 (source: Linnard 2000)

County	Coppice ha	Total Woodland & Plantation ha	Percentage
Anglesey	17	975	1.7%
Brecon	344	5795	5.9%
Caernarfon	184	6466	2.8%
Cardigan	747	7475	10%
Carmarthen	2215	9275	24%
Denbigh	194	7678	2.5%
Flint	56	3061	1.8%
Glamorgan	1868	10453	18%
Merioneth	476	6180	7.7%
Monmouth	8577	12076	71%
Pembroke	374	4180	8.9%
Montgomery	690	9658	7.1%
Radnor	1032	4355	24%
Total	17664	87614	19%

**note: figures in the above table must be treated with caution because different surveyors and authors have used different distinctions between coppice and neglected/ stored coppice and high forest.*

Between the World Wars, in 1924, Coppicing was still carried out on 214,000 ha, 18% of British woodland and 14,286ha., 14% of Welsh woodlands (Forestry Commission 1928; Tansley 1939). But, the area of worked coppice in Great Britain declined further to 142,000 ha in 1947 (Buckley 1992), and to 71,000 ha in 1965 (Locke 1969) and to 30,000 ha in 1965 (Buckley 1992)/ 27,000ha (Peterken citing Locke).

By 1982 there had been a modest revival to 39,000 ha. managed coppice in Britain (Locke 1987). Even so this was the least since early Medieval times (Buckley 1992) and

only about 17% of the estimated coppice area at the start of the twentieth century. About 93% of actively managed coppice was in England. In Wales there was only 1,929ha worked coppice in 1982, but a legacy of 17,900ha of derelict/stored coppice. Only about 11% of 1913 coppice area was still managed. The distribution of worked and neglected (stored) coppice in Britain in 1982 is shown in table 2

Table 2 Extent of coppice woodlands in Britain in 1982 (source: Locke 1987)

Area of Coppice (hectares)	**England**	**Wales**	**Scotland**	**Great Britain**
Simple coppice	25,711	1,849	4	27,564
Coppice with standards	11,473	80	15	11,568
Stored coppice*	48,100	17,900	5,900	71,900
Total	85,284	19,829	5,919	111,032

*now classed as high forest but of coppice origin

Still most of this coppice woodland was in South Wales. In 1982, there was only 20ha of simple coppice, and no coppice with standards in the then county of Gwynedd. It was predominately oak. This is less than 0.05% of the total woodland in Gwynedd and less than 0.2% of the broadleaved woodland (Forestry Commission 1985)

Reasons for Decline

Coppicing declined for economic reasons. Coniferous forestry was promoted by the new Forestry Commission after the World Wars and the market for coppice poles dwindled in favour of cheaper home grown or imported sawn softwoods. As wages increased and other opportunities for less arduous, better paid employment arose in the towns, the work force dwindled. Coppice decline has taken many forms:

Large areas of coppice were cleared for agriculture in the mid nineteenth century and since 1945 (Peterken 1996). In England and Wales, about 8% of all ancient woods, most of which were coppices, have been cleared since 1945 (Spencer & Kirby 1992)

Some Coppices were converted to high forest, either by replanting or by singling (the selection of single coppice poles on each stool). In Wales especially, many coppices were converted to coniferous plantations. Gutted of saleable timber and underwood by two World Wars, many coppices were prime sites for the new Forestry Commission's coniferous plantations in the first half of the twentieth century. Some 37% of English and Welsh ancient woods, most of which were coppiced in the 1920s, are now plantations (Spencer & Kirby 1992).

However, probably the greatest loss of coppice woodland has been through neglect. With no economic incentive for coppicing, almost half of the coppices which existed pre 1945 are now unmanaged (Peterken 1996). Some are used for game coverts. Neglect has allowed the underwood to grow tall, causing the density of stools to decrease, proportion of hazel and other low growing species to decrease, and the crowns of some canopy standards to die. However, the potential remains to reinstate coppicing on many of these sites.

In the Wales, most neglected woodlands now form elements of sheep and cattle pasture. This partly reflects their small acreage, but also other factors including lack of skills for their management and the lack of identified markets for products of coppicing. Coppice stools are destroyed and regrowth and regeneration from seedlings is eliminated.

Case Study Examples

Probably the best examples of historic coppice management are in England, namely Bradfield Woods, Suffolk (Gibbons 1991) and Hatfield Forest, Hertfordshire (Rackham 1989).

The Medieval management of Pengelli Woods, formerly the Forest of Penkelly as coppice with standards was described in detail in Linnard (2000) and its current management as a nature reserve by the Wildlife Trust West Wales is described by Comont (1986)

Much of the alder coppice has been restored at Coedydd Aber National Nature Reserve, Gwynedd, and the underwood is marketed as charcoal (unpublished CCW NNR management plan).

Ecological Aspects of the Practice

Almost all British broadleaved tree and shrub species are capable of vigorous regeneration after felling, by sprouting from the cut stump or 'stool' (eg. hazel, oaks, ash, wych elm, willows, sycamore, sweet chestnut) or by suckering from the root system (eg. elm, aspen). This creates a young and even age structure, on rotation so that within a relatively small area all age classes are present.

Nature of the Practice

The practical methods of coppicing - the felling of coppice stools to near ground level - are well described by Brooks (1980)

Coppicing traditionally took place in winter, October - March but there is no good silvicultural reason for this, except that, shoots sprouting from stools cut in late summer, July and August, will not be frost hardy (Mills, 2001). Wood cut in winter is preferred by traditional woodland craftsmen because it is less sappy and so needs less seasoning, dries with less splitting, and lasts longer. Conversely however, tanbark can only be stripped from the tree with reasonable ease in spring, when the sap is rising.

Nowadays, for conservation reasons it is recommended that coppicing is carried out in the winter when there will be least damage to flora and fauna, especially breeding birds.

It has generally been thought that coppicing entailed the cutting of all the stems at the end of each rotation with little management between harvests. However, at least sometimes, various assortments were harvested either opportunistically or systematically throughout the coppice cycle. Linnard (2000) cites the management of Pembrokeshire oak coppices in the eighteenth century. Here coppice shoots were thinned in an operation known as 'waste weeding' after three or four years growth so as to select only the best four to six shoots per stool. Five years later a heavy thinning known as 'cordwood thinning' was done

to produce wood for charcoal. Then about fifteen years later, at age 23 -35 years, the 'coppice of poles' was clear felled for pit props. Dominated by the market for charcoal and pitwood, the management of coppice oak was similar throughout South Wales (Linnard 2000).

Felling is normally divided into coupes (otherwise called fells, cants, hagg, or compartments). Coupes are usually at least 0.5ha. However, under the UK Woodland Assurance Scheme (UKWAS) certification standard, no more than 10% of a semi natural woodland over 10ha in size should be cut in any 5 year period.

Mediaeval coppice rotations seem to have been generally short. Several coppices in the Lordship of Denbigh in 1334 were worked on a twelve-year rotation (Linnard 2000). Coppice management was often extremely ordered. In forests belonging to Abaty Cwm Hir, in about 1545, there was an almost text-book coppice rotation of fifteen two acre blocks aged 1,2,3,4,5,6,7,8,9,10,12,14,16,18,and 20 years, plus twenty acres of coppice with standards, and ten acres of coppice with 'shrubbed' (presumably lopped) standards. (Linnard 2000).

Rotation length depended on species, site, intended product and demand.

It is likely that almost every species which grew in a coppice would be harvested. Some, although they were never dominant crop species, were highly valued, such as fruit trees and hawthorn for mallet heads, gear teeth and aromatic firewood; blackthorn for walking sticks; alder buckthorn for gunpowder charcoal; dogwood and spindle for skewers; holly for turnery; and box for fine carpentry tool handles (Tabor 1994).

Table 3 Traditional uses of Coppice Wood (sources: Tabor, 1994; Linnard 2000)

Species	**Age**	**Stools ha^{-1}**	**Product**
Hazel	6-12 years	~2000	Pea and bean sticks, flower stakes, walking sticks, thatching wood, wattle hurdles, house wattles, fascines, faggots, barrel hoops, ethering rods, pheasant traps, rick pegs, crates, rods, withies
	12-15 years		Gate hurdles, rake handles, poles, hedge stakes, morris staves, crate heads,
	>15 years		Firewood, charcoal
Oak	7-12 years	600 - 800	Sticks, heathers for basket rims
	12-20 years		Gate hurdles, hedge stakes, lathes, wedges, charcoal
	20-30 years		Spelk baskets, cleft stakes, tan bark, turnery, roof shingles, posts, pit props, firewood, charcoal
Ash	7-12 years	600 - 1200	Rake handles, scythe snaiths, gate hurdles, bean rods, truss hoops, wattles, besom handles and bonds, rick pegs
	12-15 years		Cleft handles, tent pegs, hop poles, crate heads, turnery, furniture, rake heads and teeth, fence rails, wedges,

			firewood, charcoal.
Sycamore & Maple	7-12 years		Bean rods, hedge stakes, fence stakes
	12-25 years		Turnery, furniture, carving, firewood, charcoal
Birch	5-10 years		Besom heads, swales, horse jumps, faggots, withes
	10-20 years		Besom handles, rake and broom handles and heads, bobbins, other turnery, firewood, charcoal
Alder	12-25 years		Faggots, scythe snaiths, broom handles and heads, scrubbing brushes, small turnery, river revetments, piles, charcoal, firewood
	20-40 years		Clogs, charcoal
Osiers	Annual -Biennial	~2000	Withies for basket making
Sallow	6-12 years		Withes, bean rods, rick pegs, thatching wood, gate hurdles, scythe snaiths, clothes pegs, hedge stakes, ethers, fascines, tool handles, rake handles and heads
	12-15 years		Firewood, charcoal
Aspen	6-12 years		Withes, besom handles
	12-25 years		Clog soles, firewood
Lime	10-15 years		Pea and bean sticks, besom handles, bast
	15-25 years		Hop poles, turnery, carving, charcoal, bast
Hornbeam	20-30 years		Gear teeth, pulleys, firewood, charcoal
Elm	7-12 years		Tree stakes, hedge stakes, gate hurdles, bean rods, withes
	12-15 years		Turnery, cleft stakes, firewood, charcoal
Sweet Chestnut	12 - 18 years	800 - 1000	Hop poles, pea sticks, spiles, posts, fence palings, gate hurdles, lathes, trugs, charcoal

Yield depends on rotation length and species. Indicative yields are as follows; oak 2-4 tonnes per hectare per year over a 30 year rotation, providing 200 - 500 stems per ha; hazel 25 tonnes and 1500 - 2000 stems per hectare after a ten year rotation, mixed species, 3-5 tonnes per ha per year or 45 -75 tonnes at year 15 and 90 - 115 tonnes at year 30 ;sweet chestnut up to 10 tonnes per hectare per year and 800 - 1000 stems per ha over a 15 year rotation (Mills 2001)

In later history, up to the beginning of the twentieth century, these traditional peasant needs were augmented by the needs of industry, especially tanbark and the coal mines and smelting works of South Wales, and many woods were managed specifically to meet the needs of these markets.

With the recent resurgence in interest in coppicing, there have been experimental attempts at economic coppicing of poplar and willows for biofuels. These are planted stands,

coppiced on a short, annual or biannual rotation to provide wood chips for industrial power, They are not relevant to this discussion of management of traditional coppice.

In theory coppice with standards could yield a constant supply of timber and underwood, and this steady state was achieved in some larger woods. However, whilst the coppice rotation was often maintained regularly, in order to maintain the quality of the product, standards were often regarded as a capital reserve to be liquidated in response to market opportunities or owner's need.

Coppice with Standards

The Medieval practice of coppice with standards is well described by the 'Statute of Woods' or 'Act for the Preservation of Woods' in 1543 (Linnard 2000). Twelve standards of oak were to be left per acre of coppice felled at 24 tears or under. If twelve standards oak were not present then standards of other hardwood species could be allowed to make up the deficit. The standards were to be kept until each was 10 inches square within 3 foot of the ground. It is not known how rigorously the Statute of Woods was obeyed.

The North West Coppice Association (Mills 2001) recommends that standards should be retained at a density of no more than 30 - 100 per ha (a 10 - 18m spacing) and should consist of a variety of age classes. Bratton & Andrews (1991) recommend no more than 15 large standards per hectare. The Forestry Commission (Hibberd 1991) recommends that Up 30 to 40% of the canopy may be occupied by standards. (Hibberd 91). Too many standards will result in poor coppice regrowth due to shading.

Standard trees are permitted to grow through several coppice rotations. Traditionally they are grown for 60 - 100 years but desecration of British woods in two World Wars, and the last attempts to realise capital as coppices were abandoned, left a legacy of rather few poor quality young and old trees in Welsh coppices.

New standards would be grown from seedlings or selected (singled) coppice sprouts, and are themselves grown on a rotation. Hibberd (1991) suggests standards of 3-6 differrent age classes with roughly equal area density of each. Felling should be coincident with the coppice rotation.

Sites where the practice still occurs

In addition to the sites described the following examples highlight the spread of the practice and its value to biodiversity:

Llethrid Valley is a geological SSSI in West Glamorgan, designated for its underground limestone cave system (see Appendix 3). However the woodland at the surface is coppiced to supply charcoal to local suppliers (Tony Jenkins, CCW District Officer South Area, pers. comm.)

Croes Robert Wood is a Gwent Wildlife Trust reserve and home to the highest dormouse population in the UK. The earliest evidence for a woodland at the site is the 1830 O.S. 1" map. Until 1981/2 the site was sporadically coppiced and then it was clear felled (GWT, undated). Coppicing has been re-introduced by the WT, primarily as habitat management

for the dormouse, it also supplies charcoal to local petrol stations. This source of income makes the coppicing self-funding Nicola Hawkswood, Conservation Officer, GWT, pers. comm.).

Coppicing is used as a management method on a number of other WT nature reserves throughout Wales e.g. Nantporth, Gwynedd; Burfa Bog, Radnorshire.

How the Practice may be Sustained

Demand for coppice underwood was largely supplanted by the rise of coniferous plantation after the formation of the Forestry Commission. More experimental research is needed to evaluate the potential for economic harvesting of low grade wood for fuel or pulp from coppicing.

Timber derived from alder coppice at Coedydd Aber National Nature Reserve, Gwynedd, is converted to charcoal on site in burning kettles. The product is marketed as barbecue fuel at local outlets such as garages and supermarkets.

However, the example of biofuel from short rotation willow coppice described above warns that such economic development may not preserve traditional coppice habitats. Traditional coppicing will still be needed for woodland conservation. Marketing development by organisations such as Coed Cymru and the Coppice Association, may help many individual traditional woodcraft industries.

The current Forest Authority Woodland Grant Scheme (WGS) encourages a wide range of woodland management, although tending to favour woodland planting. The Woodland Improvement Grant within this scheme has included "Woodland Biodiversity" and coppice management (FA, 1998). Tir Gofal also encourages farmers to apply for WGS.

On SSSI, or adjacent land, management agreements with CCW provide a further option for the re-introduction of coppicing, particularly with priority species in mind.

Potential re-introduction using modern techniques

Modern coppicing is usually done using chainsaws and tractors, but except for the use of modern tools, coppice management is similar to traditional coppicing in past centuries.

The efficiency of modern tools has often tempted tidy-mindedness, which is at best unnecessary, but is more often damaging to wildlife.

Especially where the underwood is over-mature and stools are old and decrepit, clear felling to near ground level may not be best to promote regrowth. Leaving a few of the over-mature stems standing, and leaving long stub ends, may help to maintain the health and vigour of stools (Green 2000). Where coppice regrowth is poor or spindly, or stools are far apart due to mortality, stools can be replaced and multiplied by layering (Brookes 1980) This preserved genetic integrity in ancient woods. Care should also be taken to avoid soil compaction from heavy vehicles because the consequent waterlogging may also kill stools and may promote rushes, *Juncus* and tufted hair grass, *Deschampsia caespitosa* rather than a distinctive coppice flora (Green 2000).

Rotation length, coupe sizes and density of stools and standards, coppice species may be varied, as it has over past centuries, to suit current objectives for nature conservation, historical conservation, woodland products, and available resources. The bird fauna within any area of woodland will be strongly influenced by these choices (Fuller 1995). Usually it is available resources which are limiting. Coppices which are to be coppiced for conservation are often derelict. Renovation can be costly, at least in labour. Coupe area will depend on labour available but it is considered better to aim for a sustainable coppice rotation of small coupes, 0.2 - 0.4 ha, rather than over-ambitious larger coupes (Brookes 1980).

Peterken warns that traditional management should only be reinstated where there are clear benefits (Peterken 1981). It is generally thought that coppicing should be resumed on sites where it is known that there has been a long continuity of coppicing or where a particular conservation interest has been identified. Coppicing does not benefit all species, and it is not analogous to natural woodland cycles. In other sites, it may be better to manage for more natural high forest, or some other habitat.

Unlike natural high forest, unmanaged coppices tend to have unnaturally long periods of closed canopy. This may result in a loss of biodiversity because the time span to gap formation is too long for seed bank survival. The seed bank in coppices would be expected to be adapted to a relatively short rotation. Rackham (1986) reckons that even after 100 years of neglect, derelict coppices will suffer no loss of ground flora diversity, but Brown & Warr (1992) found losses earlier than this. Hill and Stevens (1981) reckon that in temperate forests the seedbank will persist for about fifty years, beyond which it declines rapidly until at 100 years most of the original seed has disappeared. Fortunately, over such long time scales, even in neglected coppices, other disturbances may have boosted the seed bank in the intervening years.

Potential economic benefits as a basis for the sustainable management of biodiversity

Brookes (1980) lists coppice products with their values. Until a full rotation is re established the crop is usually low grade and suitable only for pulpwood or firewood, provided local marketing opportunities exist, but traditional products can be harvested once the coppice is due for recutting. There have been many efforts to sell the products of coppice and coppice restoration, but probably most are scarcely profitable unless voluntary labour is used. A few specialist markets niches have opened with the interest in sustainable lifestyles, such as the coppice charcoal sold from Coedydd Aber NNR, Gwynedd. Experience from here and the other sites described above show that coppicing is rarely commercially attractive but proceeds may be enough to offset the costs of conservation management. This is particularly the case when local markets (e.g. petrol stations are targeted). Improved marketing is needed. The formation of the Coppice Association is a sign of reasonable prospects.

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5.5 Peat Cutting

Definition

Peat has been cut and dried for fuel in some places for perhaps thousands of years. Turbary is the common right over an area of land to cut turves or peat.

Few people in Wales have or exercise common rights of turbary today. However, these rights apply on 12% of commons in Wales, mainly central Ceredigion, northern Radnor and eastern parts of Carmarthenshire (Aitchison 1997). Nevertheless the practice of peat cutting continued well into the twentieth century. Until the mid-twentieth century even the larger Welsh peat companies relied on hand labour and traditional methods. Latterly, mechanical methods were adopted, as the extraction industry become commercialised, and larger in scale.

Three methods of peat cutting have been used in Britain: sod or block cutting, surface milling and extrusion. Sod cutting alone is discussed here. Sod cutting, whether by hand or machine, is a progressive development of traditional turbary. Surface milling and extrusion use modern machines and are not based on any traditional methods.

'Turbary' may also refer to the place where peat is dug, but more usually these are referred to simply as peat workings or cuttings.

Associated habitats

Traditional peat cutting has probably affected all types or classes of peat forming vegetation in Britain but the effects of early traditional peat cutting in all mire communities in Wales were probably small scale, transient and localised. Conversely, large-scale commercial peat extraction has been limited to habitats and sites with extensive, deep peat deposits such as raised mires. Very few of Britain's raised bogs and basin mires survive intact and on many there has been wholesale stripping of peat (Rodwell 1991). In extreme cases, as at Fenn's and Whixall Mosses, virtually the whole mire surface has been removed such that the original M18 *Erica tetralix - Spagnum papillosum* community has been reduced to fragmented relics.

Initially, peat digging destroys all vegetation in the immediate vicinity. Cut over peat is sterile; without its own source of viable buried propagules. The extent to which mire species remain on a site or can recolonise depends directly on the degree of water-logging which remains and the proximity of remnant mire communities from which propagules can invade. This depends on the scale of peat extraction.

Old hand-cut workings hold a full range of plant communities from open bog pools and bare peat to dry heath and scrub on the high peat baulks. The open water is colonised by *Sphagnum cuspidatum*, followed *by S. recurvum, Sphagnum fimbricatum*, and cotton grasses. *Eriophorum angustifolium* is an important coloniser of bare peat, spreading by rapid vegetative growth to become dominant in natural or artificial bare bog peat within a range of mire communities. Bogbean and bladderworts may occur in open water. The raised mound between the peat baulks, formed from the discarded surface vegetation or

'fay', supports lawn communities with *Sphagnum papillosum, S. tenellum, S. pulchrum, S. magellicum, S. imbricatum*, white beaked sedge, cross leaved heath, sundew, cotton grasses, and bog asphodel, cranberry, bog rosemary, purple moor grass, heather, and birch (Berry *et al* 1996).

Rowell (1988) lists the following NVC communities occurring in peat cuttings:

M1 *Sphagnum auriculatum* bog pool community

M2 *Sphagnum cuspidatum / recurvum* bog pool community

M3 *Eriophorum angustifolium* bog pool community

M9 *Carex rostrata - Calliergon cuspidatum* mire

M13 *Schoenus nigricans - Juncus subnodulosus* mire

M14 *Schoenus nigricans - Narthecium ossifragum* mire

M15 *Scirpus cespitosus - Erica tetralix* wet heath

S1 *Carex elata* sedge swamp

S2 *Cladium mariscus* sedge swamp

S9 *Carex rostrata* swamp

S24 *Phragmites australis - Peucadanum palustre* fen

S27 *Carex rostrata potentilla palustris* fen

(Rodwell 1988)

The wet mire communities, M1, M2, M3, M13 may increase locally to exploit the wet peat cuttings (Rodwell 1991). For instance, M2 communities now form the majority of the wet mire at Whixall Moss, at the expense of the original natural vegetation, M18 *Erica tetralix - Sphagnum papilosum* (Berry *et al* 1996). However, such locally reconstituted stands often occur in a much altered mire context because of drainage. Drainage may have more widespread and damaging effects on the mire communities than the cuttings themselves. Overall the original mire surface and the peat baulks and walkways between cuttings tend to succeed to drier vegetation types. Wet Mire communities are lost. M2 is replaced by *Erica tetralix* wet heath with purple moor grass, clubrushes, and ericoid shrubs (Rowell 1988); M15 *Scirpus cespitosus - Erica tetralix* wet heath, which normally occurs on thin, relatively well drained ombrogenous peat, has extended onto areas of formerly deep wet peat; and M16 *Erica tetralix - Sphagnum compactum* wet heath has increased on some formerly wetter peats in response to draining (Rodwell 1991).

As well as the succession of mire vegetation following peat cutting and draining, there is an overall loss of mire communities. Many stands of all mire communities have been destroyed by drainage. Lack of waterlogging, and the consequent release of nutrients by decomposition of the peat, permits invasion by species which are more competitive and better adapted to the drier conditions. Species such as bracken, birch , heather, Scots pine and purple moor grass take over. The taller species shade out the mire species, evapotranspiration increases, and the problem is exacerbated. Abandoned, commercially cut areas, tend to be more uniform than old hand cut areas, and with drier communities.

Colonisation will be influenced by with whatever species are nearby and plant and animal communities become replaced by more ubiquitous species of damp woodlands.

However, all but the most limited peat diggings also entail drainage of the mire. Although some wet mire species may benefit from the increased availability of bare wet peat and pools in the abandoned cuttings, the surrounding habitat will be changed by the lowered water table. Many species will benefit but most of these will be less conservationally important species than those that they replace. The mire may become more diverse, at first anyway, but the commonplace will replace the rare.

Lowland raised bog is the most significantly affected priority habitat of the UK BAP (Anon, 1995). Other priority habitats which may have been affected are: blanket bog, fen and purple moorgrass and rush pastures.

Associated species

Small scale traditional peat workings, when abandoned and recolonised add community and species diversity to mires. Wet mire species and open water species benefit from wet peat and open water, as outlined above. Generally these species will have been present on the natural uncut mire, but digging causes shifts in species abundance. Some species such as bog pimpernel, fen orchid and lesser bladderwort are especially associated with the bare soggy peat and open water in peat workings (Rowell 1988). The mires are anyway important for invertebrate species too, but certain taxa such as the dragonflies, (eg white faced darter), caddis and the water spider *Argyroneta aquatica* may benefit from the artificially created bog pools (Berry *et al* 1996).

Chronology / Historical Synthesis

The Laws of Hywel Dda suggest that wood, rather than peat, was the main source of fuel in the tenth to twelfth centuries (Linnard 2000). This is borne out by the history of Fenn's and Whixall Mosses, Denbighshire (Berry *et al* 1996) where the raised mire was apparently little used during the Medieval period. Whilst records provide evidence of increasing utilisation of the natural resources in the surrounding woodland, reference to the Mosses themselves is not found until 1572 (Berry *et al* 1996). The history of the Mosses is presented here as a detailed case study as it has been research in considerable detail, and because it is indicative of the development of peat extraction elsewhere. However, peat cutting as a source of domestic fuel is known have been a historic feature of many communities throughout rural Wales. The logistics and customs of historic small scale exploitation of peat in Wales is covered in detail in Owen (1968, 1969, 1970 and 1991) and Jenkins (1992).

Turbary was well established in manyWelsh communities by late Mediaeval times. For example, a survey of the *Honoure of Denbigh* in 1334 records rights of turbary held by tenants in a number of villes. In Loydcote the whole village held the right of turbary. At Gwytherin there was turbary in the 'common waste'. In 1348 the Bishop of St Asaph prayed that the Black Prince would grant him a farm and 2 acres of turbary at Gronandesmore (Gronant); and by 1357, these same coastal peats were used for peat cutting and cattle grazing by the Black Prince. Peat was mainly used for domestic fuel but

turf houses were also built (all examples from Berry *et al* 1996). In Medieval Britain, rights of common were the basis of much of the peasant economy.

Medieval rights of common were granted by the landowners or nobility. From the later Medieval period, rights were often attached to certain dwellings rather than to people. In this way common rights became alienated (made permanent). Most grants of common rights were specifically for the sole use of the individual or household, but at Fenn's and Whixall Moss there is also an unusual record of a Medieval grant for cutting peat for commercial sale (Berry *et al* 1996).

From the late Medieval onwards, the history of Fenns and Whixall Moss is particularly well recorded. It may be taken as indicative of the social and economic history of many sites in England and Wales where common rights of turbary existed.

Common rights were closely monitored. Transgressors were presented to a manorial court but it seems that action was only taken where unlicensed peat digging reached intolerable levels. Fines levied by the Lord of the Manor were more a means of deriving revenue rather than a punishment or means of deterring illegal digging as such. Fines were also levied for the unlicensed use of peat, such as to burn weed growth on ploughland, or for selling peat outside the bounds of the Manor. From 1652 the increasing occurrence of fines for selling peat beyond the bounds of Whixall Manor suggests an increasing and flourishing trade. Again the level of fines indicates that this practice was tolerated and the fines were principally to yield appropriate remuneration for the Lordship (Berry *et al* 1996).

However, by 1702 the Lord of Whixall Manor was regulating the trade in peat more closely by levying punitive fines on those who had not compounded with the bailiff before they cut. These increasing efforts at regulation of peat cutting in the early eighteenth century span the period of the first eclosures by Act of Parliament, and reflect the Lord of the Manor's efforts to secure better control over the lands and better returns from them.

The first enclosure though Act of Parliament at Whixall Moss was in 1704. Under the terms of this, ancient rights of common remained unaffected (Inclosure by agreement). Even so some 23 commoners objected and an acrimonious dispute ensued. The well developed system of turbary continued, coexistent with the changing landscape until all common rights were extinguished by Act in 1823. Fenn's and Bettisfield Moss was similarly enclosed in 1775. Here, one landowner was awarded 50% of the land, and the commoners were compensated for their traditional rights of turbary by the creation of one hundred and eleven narrow turbary allotments. Of these, the landowner had half, with the remainder distributed to the poor, the alms houses and school and to 31 individuals.

Enclosure effectively freed principal landowners from the constraints of common rights and enabled the subsequent commercial development of peat on land over which they now had absolute control.

From 1889, the central part of Whixall Moss was rented out acre by acre to local peat cutters. This continued until 1956 when the whole area was acquired by a commercial peat extracting firm. The commercial firms extracted and dried peat for a variety of

purposes: for sale as livestock bedding and as a packing material; for fuel and the manufacture of charcoal; for some metal manufacturing processes; and for distilling. It was not until the mid-twentieth century that these uses were exceeded by the use of peat in horticulture. Despite the increasing use of machinery to transport and process the peat, all cutting at Fenn's and Whixall Mosses was done by hand labour, until 1968.

Throughout late nineteenth century, individuals continued to cut peat alongside the large scale commercial companies both for their own homes and for sale. Some individuals had rights to turf banks on the Moss, assigned under the 1823 Enclosure Act. Local peat cutters worked at Fenn's and Whixall Mosses into the 1960s (Berry *et al* 1996).

Former Geographical Distribution

There is no single summary of the historic extent of peat digging in Wales. Small-scale peat workings were used by many communities throughout Wales wherever peat occurred, but there was probably less dependence on peat than in Scotland and Ireland. Woodland depletion through the middle ages and certainly during the Early Modern and Post Medieval periods, particularly in North Wales meant that the rural poor was acutely short of fuel. This meant that greater pressure was placed on peat and turf (see for example the discussion of this subject for the Llyn Peninsula during the eighteenth and nineteenth century in Roberts 19). Peat digging was not restricted to the deep peat of lowland raised mires. The thinner blanket bog peat of the uplands was also exploited by rural communities, as were coastal peats.

The present extent of lowland raised bogs in Britain is a mere 6% of the original natural cover. In Wales the estimated original 4,000ha of raised bog has diminished to 20% (800ha) of its former area. There have also been substantial losses of blanket bog (UK Biodiversity Group 1999). However the greatest causes of peatland decline have been agricultural improvement, afforestation and heavy grazing. Traditional peat digging has been one factor in the decline of peatlands in Britain but has probably only caused significant habitat loss in the case of the commercial exploitation of lowland raised mires.

Case study examples

Fenn's and Whixall and Bettisfield Mosses, on the English Border of Flintshire, have been managed as a National Nature Reserve by Countryside Council for Wales and English Nature since 1990. The history of this site has been thoroughly researched (Berry et al 1996). It is a severe example of the effects of commercial peat cutting both by hand and machine. The effects of digging on the flora and fauna, the restoration techniques and recolonising flora and fauna have been well monitored and recorded.

Raised mires at Cors Caron and Cors Fochno are also being restored by CCW.

Relic small scale hand peat cuttings may be found in many localities, such as Cors Bodgynnydd, Betws y Coed, Conwy or Cors Goch, Anglesey. Both sites are North Wales Wildlife Trust nature reserves.

Ecological aspects of the Practice

Peat is a pure organic soil, formed by the accumulation of dead plant material in waterlogged conditions. Because of the waterlogging, conditions are anoxic, there are no earthworms and few soil bacteria, and so decomposition is greatly retarded. The accumulating peat forms an irreplaceable palaeoenvironmental record, acts as a globally important carbon sink, and provides specialised mire habitats. Two types of mires can be distinguished.

Firstly, minerotrophic mires or fens are fed by ground water. The peat tends to be neutral or basic. The influx of nutrients allows more decomposition and so fen peat rarely accumulates to great depths. The surface vegetation may root through the peat into the mineral substrate below.

Secondly, by contrast, ombrogenous mires, or bogs receive their water and nutrients only from precipitation. They are nutrient poor and acidic. Because they are dependent on the balance between precipitation and evapotranspiration, bogs occur only in oceanic areas, like Britain, with over about 800mm rainfall p.a.. Britain is regarded as globally important for bogs. The deepest peat (up to about ten metres) forms in basin, or raised mires, which form in lowland landscapes as great domes of peat lying over basins in the topography. In wetter areas, with over about 1200mm rainfall pa. peat formation escapes the confines of topography. Here blanket bog mire covers the uplands. Though the peat is not so deep.

Traditional peat cutting shows its greatest development on raised mires, because of their depth and quality of peat, and it is only here that there has been large scale commercial peat extraction. However, even many of the shallower peats such as those found throughout upland Wales were formerly important for domestic fuel in some communities.

Nature of the Practice

Peat cutting is based on a long history of local traditions, varying in detail between communities, each with their own tools and terminologies. Detailed examples of the logistics, traditions and customs of peat cutting are given in Owen (1968, 1969, 1970 and 1991) and Jenkins (1992).. In terms of the Denbighshire case study, two cultures of hand cutting can be identified at Fenn's and Whixall Moss.

Whixall Bibles were peat blocks named because of their shape, 9 x 7 x 4 inches. Whixall Bibles were cut and lifted with a short spade. They were put on a peat barrow to be wheeled to the drying area where they were part dried before stacking in 'windrows', two Bibles high. They were cut from small oblong pits about 3-5 x 5-7m . Little or no drainage was attempted and the depth of cut was determined by the water table. Once a pit filled with water it was abandoned and a new pit was opened. Large scale hand cutting of Whixall Bibles was done by English Peat Moss Litter Company 1886 to 1920's when it was superseded by Dutch Pattern cutting (Berry *et al* 1996).

The Dutch pattern comprised a series of flats and drains and enabled much deeper extraction. Each flat was 88 yards wide and up to 550yds long. Each flat was divided

lengthwise by a drain. Peat blocks were cut from the flats to create a stepped surface of bare peat and so maintain drainage into the central drain. Peat continued to be cut in the Dutch pattern until the cessation of commercial cutting at Fenn's and Whixall Mosses in 1990. The mechanical sod cutting introduced at Fenn's and Whixall Mosses in 1968 essentially cut blocks to the same Dutch pattern. Some hand peat cutters still use this traditional method with traditional tools on Fenn's and Whixall Mosses under license from English Nature and Countryside Council for Wales.

All methods of peat digging first require the removal of the top layer of living vegetation, or 'fay,' and the drainage of the mire to permit access and allow the peat to dry.

There are major differences in these respects between hand and mechanical sod-cutting, which greatly affect the survival of the mire species. The hand cutter throws the discarded surface vegetation down into the wet base of the cuttings where elements of it can survive, whereas with mechanised cutting it is scraped off and left high and dry to rot on the surface. Secondly, because it is so laborious, hand diggers drain only the minimum which is necessary in the vicinity of their workings. Unused drains are allowed to gradually block up. By contrast, large scale commercial peat digging uses excavators to maintain an effective drainage system. Whole landscapes may be networked with drains.

With commercial surface milling and extrusion the surface vegetation is removed and destroyed over very large areas, the drainage system is effective, and there are no high peat baulks to act as dams and create pools. Extrusion additionally creates sub-surface drainage.

Sites where the practice still occurs

Peat cutting using the traditional techniques described above is all but extinct in Wales. Jenkins (1992) shows examples of peat cutting by hand in Cwmhesgn, Llanfachraeth, and Bwlch y Groes, Cynllwyd as late as 1968. These techniques, or something approximating to them may occassionally be used in the creation of small ponds or pools or nature reserves, such as at Cors Goch, Anglesey (Chris Wynne, Conservation Officer NWWT, pers. comm.).

There are a number of examples of small scale operations where peat was or continues to be extracted using modern techniques. For example near Brynteg, Anglesey, where marl and peat were extracted from a small calcareous valley fen until fairly recently to supply the local market (Chris Wynne, Conservation Officer NWWT, pers. comm.).

Potential for re-introduction using modern techniques

Peat digging is a destructive and unpredictable management tool. Its use should be restricted to the attempted regeneration of rare communities known to be dependent on extraction, and only to sites which have been dug extensively before (Rowell 1988). On any wetland site, disturbance of the hydrology is potentially severely detrimental. On sites of nature conservation importance this should be avoided.

Experimental peat cuts (eg Wicken Fen) clearly show that carefully designed peat cuts may produce interesting plant communities. Small cuttings within bog vegetation are relatively quickly colonised. However, large areas are only slowly recolonised by mire

species and may be invaded with agricultural weeds (Rowell 1988). Results of conservation peat cutting are greatly affected by subtle variations in hydrology. At Cleddon Bog in Gwent, where monospecific purple moor grass stands had taken over following drainage and afforestation, peat digging and stripping of vegetation has been used experimentally to reinstate the mire. The hoped recolonisation by Sphagna, sundews, and bog asphodel was rapid except in one deeper, wetter cut. This was slow to colonise and infilled with *Sphagnum cuspidatum* (Rowell 1988; Etherington 1983)

Experience shows that hand cutting of peat by teams of enthusiastic volunteers results in a pit full of peaty slurry. The resulting enrichment does not result in the hoped revegetation. Although the resulting pools can be of value for other species including dragonflies.

Restoration of Cut-over Peat

There is rarely scope for new peat digging. Of greater relevance to nature conservation is the restoration of formerly dug sites, especially where digging has been extensive with effective drainage. Techniques of restoration are well documented, see for example, the handbook by Brooks and Stoneman (1997) and for Fenn's and Whixall Mosses, Berry *et al* (1996).

There are two principle management objectives- restoration of the hydrology and reinstatement of the vegetation.

Restoration of the subtle hydrology is a difficult feat of engineering. Waterlevels should be restored to close as possible to ground level. This may involve re-sculpturing the topography and damming the drainage system.

Reinstatement of the mire vegetation cannot be successful without restoration of waterlevels. A degenerate mire surface may contain propagules of lost species which will recolonise without intervention, but many species will not have a persistent bank of propagules, and deep cut peat is sterile, so unless a nearby source is available they will not recolonise unaided. Even if a source is nearby, many of these species are rather immobile and will take a very long time to colonise if at all. An alternative or additional approach is reintroduction of vegetation in the form of turves (Berry et al 1996; Brooks & Stoneman 1997). *Sphagnum* has been successfully transplanted but the long term prognosis for its survival in Britain are unclear (Rodwell 1988).

Mowing, burning, and grazing may be used concurrently with restoring water levels to manage and reduce the cover of non-target vegetation which has colonised the drying mire.

Regeneration of anything like a true mire vegetation is a long term process, and as it currently stands, is both expensive and experimental.

Potential for re-introduction using modern techniques

The widespread removal of peat is not desirable. Generally, the issue is one of repairing the damage done. However, consideration can be given to the creation of pools or scraps on otherwise homogenous wetland or degraded wetlands and a small scale and on a

rotational basis. Re-initiating the process of hydroseral succession could add to the biodiversity of a site and provide valuable information on successional pathways.

Current knowledge of the requirements of various groups could be taken into account in creating such features, combined with knowledge gleaned from traditional small scale peat cutting as outlined above. Modern machinery would allow the digging/cutting to be carried out quickly and reduce damage to the wetland surface.

Potential economic benefits as a basis for the sustainable management of biodiversity

For the reasons outlined above it is not envisaged that this practice be reintroduced. The potential economic benefits associated with repairing damaged sites or small scale operations on degraded sites are likely to be negligible.

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5.6 Ffridd

Definition

Ffridd and its historical relationship to seasonal pasture
The term, a long-standing Welsh word, is in fact a borrowing from middle English *frith,* from Old English *fyrhthe* ('land overgrown with brushwood, scrubland on the edge of forest; Gelling 1984). The Anglo-Saxon usage, in a land-use context, is indicated in an 11th-century document where *weald, freyth* and *heyninga* are distinguished as forest, heathland and enclosed arable, respectively (Gelling and Cole, 2000, 225).

The earliest documented Welsh use of *ffridd* is of the 14th-century where the meaning would appear to be comparable to English usage. By the middle of the 14th-century *ffridd* is an established Welsh place-name element and a term applied to the condition of land in administrative accounts (Ellis, 1838 *passim*). It is also found in a literary context as a descriptive term applied to a particular characteristic of landscape.

Thirteenth-century manuscripts referring to royal rights and prerogatives allow that it is right that of the two townlands (trefi) held by the king in each *commote*, one should be his *maerdref* or royal estate and the other should be his summer pasture-land and waste (*hafotir* and *diffaith*) (Jenkins, 1986). Elsewhere in the same manuscripts there are references to 'winter houses' (*gaeafdy; hendref*). The Latin texts have '*mansio hyemalis, id est, hendref*' (Jenkins, 1986, 236:40.12). The context of these references is clear in considering the presence of animals on the *hendref* between May Day and the time of reaping as trespass. Animals, during this period, should be grazing the summer pasture. The provisions are theoretical and schematic. Nevertheless, documents of the 13th- and 14th-centuries, referring to the administration of the Welsh Princes of Gwynedd, identify extensive pastures in upland locations within townlands in the king's holding (Ellis, 1838 *passim*). Particularly clear examples may be identified at Dolbadarn in Nant Peris with pastures on the slopes of Snowdon and at Dolwyddelan (Ellis, 1838 10,18). Dolbadarn and Dolwyddelan are the counterparts of the *maerdrefi* of Caernarfon and Trefriw in their respective commotes of Is Gwyrfai and Nantconwy. The clear relationship with summer pasturing is evident in the names of the holdings within these upland townlands. Four *hafodydd* are described in Dolbadarn. Ten *hafodydd* are recorded in Dolwyddelan. At least four of the ten *hafodydd* have names which imply original woodland associations. It is similarly notable that the element *ffridd* is regularly applied in association with documented *hafodydd.*

Ffridd, however, at this date did not have a specifically upland connotation. On Anglesey, in royal surveys of the mid-14th century *ffridd* is used to describe land lying waste or uncultivated, generally through lack of tenants or heirs to that land (Carr, 1971-2, Ellis, 1838). The context is the aftermath of the Black Death. Uncultivated upland, however, made suitable summer pasture and at the thirteen locations described as *ffridd* in 14th- and 15th-century royal surveys of Caernarfon and Meirionydd, seven are also

described as *havotiroedd* while an eighth is described as woodland pasture. In Meirionydd the term *havotreffrith* is used to describe a townland characterised by summer pasturelands on *ffridd* – that is, on uncultivated scrub. It is a designation which closely matches the lawbook provision of *hafotir* and *diffaith* – summer pastureland and waste. The extent of these summer pasturelands may be gauged by the twenty-three documented *hafodydd* in the 13th- and 14th-century surveys (Ellis, 1838 *passim*). The hafodydd are consistently described as vaccaries, identifying them as cow pastures.

In north Wales topography and climate determined that these summer-seasonal pastures coincided with upland scrub, above the level of cultivation, so that *ffridd* came to be synonymous with upland grazing. Eighteenth-century definitions of *ffridd, inter alia*, include 'a tract of ground enclosed from the mountains, a sheep walk, a track enclosed on the side of hills to turn cattle into at all times', and: 'ar lafar yn gyff. yn enw. yn y Gogledd, am tir sydd agosaf at glawdd y mynydd' – 'in common speech, especially in the North, for land that is closest to the mountain dyke'. (Owen-Pughe, 1795).

Modern perceptions of 'ffridd'

There is a long tradition of upland grazing in Britain in general and in Wales in particular. Much of this grazing is on the open mountains and commons, where livestock, perhaps of several graziers can apparently graze unrestricted. Ffridd is enclosed rough upland pasture. Generally the ffridd is the upper edge of a farm. In the U-shaped glacial valleys of much of Wales, ffridd is typically the land between the more intensively farmed valley floor, and the mountain wall; approximately 180 - 360m. above sea level (Rimes 1998).

Associated habitats

Ffridd encompasses a wide range of upland habitats. Rimes (1998) identified the following phase I habitat classes on traditional ffridd in Arfon and Dwyfor:

Acid grassland
Marshy grassland
Acid dry heath
Dry heath / grass mosaic
Wet heath/ grass mosaic
Bracken
Acid Flushes
Wet modified bog
Valley Mire, and
Broad-leaved woodland

Ffridd has been imposed upon many upland habitats. Much ffridd was formerly upland oakwood (Condry 1981), and remnants of this remain. The essential feature of ffridd is that it is grazed.

Most ffridd is relatively fertile with *Agrostis - Festuca* grasslands. Often this forms a mosaic with soft rushes, bracken or scattered scrub, especially hawthorn. *Festuca - Nardus -Deschampsia flexuosa - Molinia* grassland with heathers, and bilberry predominate on peatier soils, and this community is diversified, with common sedge, cotton grasses, deer grass, and bog asphodel, where wet flushes occur. On the least fertile soils, ffridd may be dominated by ericoid heaths with the heathers, bilberry and western and European gorse (eg Pensychnant, Conwy) (Ball *et al* 1982, Rimes 1998).

Extensive grazing maintains these grassland habitats. However, the semi-natural upland vegetation is sensitive to changes in grazing pressure and changes in stocking rates or season can cause shifts in floristics. The slow response and recovery time of some communities means that the characteristic upland mosaics will remain in a state of flux for many years in response to changes in management. Partly, this flux helps to maintain diversity. The component which is most vulnerable to change is the ericoid shrubs. They are quickly suppressed by increased grazing pressure, in favour of a more grassy sward, but slow to re-establish when grazing is reduced (Ball *et al* 1982).

The reduction in numbers of cattle and mountain ponies and replacement of wethers by breeding ewes over the past century, is thought to have caused a down grading of the ffridd in some places, where bracken and unpalatable Nardus or Molinia grassland expanded at the expense of Agrostis/ Festuca swards. (Roberts 1959)

Increasingly, throughout the twentieth century, there has been agricultural improvement of the ffridd by fertilizing and reseeding. Even in, 1936, Davies recommended that much of the *Festuca / Agrostis* grasslands could be improved to *Agrostis -Trifoium* swards, and Rimes (1998) concluded that considerable grassland improvement has indeed occurred, especially on less steeply sloping ground.

Bignal and McCracken (1993) consider that conservationists have undervalued the importance of long established upland pastoral systems for wildlife. In farmed landscapes in Dwyfor and Arfon the highest proportion of semi natural vegetation is found adjacent to the uplands in the ffridd (Rimes 1998). As more and more lowland farmland becomes less and less suitable for wildlife, the ffridd and other marginal land becomes an increasingly important reservoir of biodiversity.

Associated Species

The value of ffridd to wildlife depends on the ratio of semi-natural to improved habitat, as well as the diversity of the mosaic of semi natural vegetation. The juxtaposition of sheltered lowland habitats such as woodland, hedges and buildings, and relatively natural, undisturbed upland habitats may make ffridd particularly attractive to a wide range of species.

The rough upland pastures are important breeding and feeding areas for birds such as wheatear, stonechat, meadow pipit, and skylark. The rough vegetation is good for small mammals such as field voles and for invertebrates. Acid grassland with bracken and scattered hawthorn and rowan is particularly important for whinchat, redstart, tree pipit, and is also good hunting territory for birds of prey (Tyler 1988).

Bignall and McCracken (1993) however point out some of the complexity of ffridd ecology, and the current lack of in depth understanding. It is well known for instance that the chough uses upland grazing such as ffridd for feeding. However, the pattern and rotation of grazing, and stocking rates, which best benefit choughs is complex. Many seasons of specific livestock management must come together to provide the ideal conditions for the life cycle of their leather-jacket prey and then to suit the feeding behaviour of the choughs. Small changes in the pattern or intensity of grazing have profound effects on chough productivity (Bignall & McCracken 1993)

Ffridd woodland is grazed, and this inhibits regeneration unless there are periods of low stocking rates. However the open structure of such grazed woodland is beneficial to some such as the pied flycatcher, and redstart.

Chronology and historical synthesis

Refer to definition of Ffridd *at start of this section for discussion of early history and associations.*

Transhumance and summer grazing

The historic practice of farmers accompanying their livestock, mostly cattle, onto the upland pastures of the Welsh mountains in the summer months, and to return to lowland grazing at the approach of winter is an ancient custom whose origins may lie in later prehistory, but which had become well established by the Middle Ages. This annual movement (transhumance), was the basis of most pastoral farming in Wales, and is still ensconced in the placename elements 'Hafod' and 'Hendre' meaning the summer dwelling area and winter homestead respectively.

Transhumance declined with the impact of the Enclosure Acts, mostly between about 1780 and 1830. Despite acrimonious local opposition, powerful and wealthy landowners enclosed much common rough hill grazing to form enclosed ffridd. The hafodtai either became used as permanent homesteads or were abandoned to ruin (Dodd 1990). Usually each ffridd was contiguous with its home farm, but because of the established traditions of transhumance at the time of enclosure, some ffridd land is isolated from the lowland farm to which it belongs or once belonged. For instance, Ffridd Buckley, on the mainland at Penmaenmawr, historically belonged to one of the principal land-owning families of Anglesey.

Enclosure of the ffridd was initially accompanied by a decline in the milking herds, in favour of store cattle and a long term shift in pastoral farming from cattle to sheep rearing, encouraged by growth of the local woollen industry (Scott1949, Hughes et al 1973). The ffridd wall allowed cattle to be confined within the lower hill pastures, whereas wethers were commonly turned out on the mountain common.

Sheep numbers on the more productive ffridd pastures have increased dramatically since the beginning of the twentieth century. Good *et al* (1990) estimated that sheep densities in Snowdonia increased from 2.8 per hectare in 1901-10, to 7.5 per hectare in the period 1971 - 1980.

Former Geographical Distribution

The distribution of ffridd has probably not changed significantly since the pattern of upland enclosures was established in the early nineteenth century. There have been some local losses, especially to coniferous forestry.

However, although the pattern of land use is similar, there have been losses of semi-natural habitats within ffridd, due to agricultural improvement. There are no detailed statistics on the improvement of ffridd, but fortunately improvements have been much less wholesale than improvements to lowland or valley bottom pastures.

Case Study Examples & Sites Where the Practice Still Occurs

Ffridd occurs throughout Wales wherever livestock are reared in mountainous or hilly regions. The ffridd in parts of Arfon and Eastern Dwyfor includes a rich mosaic of habitats resulting from a complex landuse history. A particularly varied and extensive example is at Cwm Pennant. (Rimes 1998). Work on non-statutory sites in Gwynedd will further elucidate the biodiversity value of this habitat. In Montgomeryshire the WT is surveying over 80 ffridd sites focussing on the value of these sites for butterflies (Clive Montgomeryshire WT Conservation Officer, pers. comm.)

Nature of the Practice

Ffridd is extensively grazed. Formerly grazing would have been principally for store cattle, but nowadays ffridd is almost exclusively grazed by sheep. Depending on the custom of the local farmer, grazing livestock may be removed in winter.

How the practice may be sustained

The long history of pastoral management in the uplands has created habitats and their dependent wildlife which are now only sustainable through the continuation of traditional farming.

Tir Gofal could be used to support traditional extensive grazing on ffridd through both the mandatory and voluntary habitats; local non-statutory sites (Wildlife Sites) should be targeted by liaison with Wildlife Trusts or Local Authorities

Bignal and McCracken (1993) point out that there is a great need for conservationists in general to better understand the ecology of upland systems and to better understand the principles of agricultural management. This is essential to give informed and practical management advice to the farmers who manage the land.

Potential re-introduction using modern techniques

Traditional seasonal exploitation on summer upland pastures was dominated by herds of cattle. Cattle grazing is more conducive to biodiversity than extensive stocking by sheep.

Further research into specific grazing and stock practices is required before detailed recommendations can be made. Suitable information is available in reference material highlighted during searches made for this project and would provide a basis for more detailed analysis.

Potential economic benefits as a basis of sustainable management of biodiversity

The ffriddoedd are an active component present day pastoral farming in Wales. It should be maintained as an important part of a low intensity, low-input, low-output systems. Some farmers are increasingly finding that low-input, low-output farming is preferable to the expense and effort of intensive farming.

Payments from Tir Gofal or Management Agreements would help re-build or maintain farm incomes so that extensive pastoral systems can continue on ffriddoedd. The sustainability or otherwise of extensive agriculture is still unclear (Webster, 1997), and requires further investigation.

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5.7 Water Power

Definition

The use of rivers and streams to power industrial processes, agricultural mills, public supply and transport systems. Water-courses were created where a more powerful flow of water was needed, with which holding ponds, dams and other water management features are associated.

Associated habitats

A broad distinction could be made between flowing water (rivers, streams, mill-races) and standing water (mill-ponds). Maintenance of flow channels and the speed of flows in the immediate vicinity of a mill would restrict the range of species found compared with areas further up stream and down stream. Other factors important in determining the biotic component of a river system would play an important, for example hydrochemisty, water temperature, flow rates, substrates and pollution levels.

Rodwell (1995) describes the range of aquatic communities which can be encountered in the UK. For example in the lime-poor and less fertile waters frequently found in upland Wales, alternate-flowered water milfoil (*Myriophyllum alterniflorum)* and its associated National Vegetation Classification community (A14) is widespread although not common. This community would be expected in areas where waters are more base rich and mesotrophic, for example in the calcareous areas of Wales (Vale of Clwyd, north-eastern Anglesey, parts of Brecon etc), communities associated with spiked water milfoil (*Myriophyllum spicatum*) and fennel pondweed (*Potamgeton pectinatus*) are common (National Vegetation Classification community (A11).

These communities could also be present in the associated millponds along with other communities more typical of deeper water. The water lilies (*Nymphaea alba* and *Nuphar lutea*) are typical species of such communities. *Nymphaea alba* and its associated National Vegetation Classification community (A7) and is most characteristic of oligotrophic and base-poor conditions (Rodwell, 1995); *Nuphar lutea* and its associated National Vegetation Classification community (A8) is characteristic of the mesotrphic to eutrophic waters of the calcareous areas of Wales (Rodwell, 1995).

The hydrological gradient associated with the edge of these water features can give rise to a range of communities progressing towards more terrestrial habitats. Again local environmental factors will be critical in determining the nature of these gradients. Typically one would expect zones of semi-aquatic species such as common reed (*Phragmites australis*)or reedsweet-grass (*Glyceria maxima*) giving way to marshy grassland and then to grassland communities (Rodwell, 1992).

The abandonment of water mills can allow natural successional processes to lead to the loss of open water and the development of an wider range of habitats, particularly areas of reedbed and/or wet woodland (National Vegetation Classification community W1, W2; Rodwell, 1991). Although at any one site the extent of these habitats may not be great.

With such possibilities for the range of communities that can develop in association with water management infrastructure it is not surprising that they include a number of UK BAP habitats (Anon, 1995). For example, mesotrophic and eutrophic standing waters are all included as priority habitats, along with fens, reedbeds and wet woodlands. Although as previously stated, at any one site the extent of these habitats may not be great.

Associated species

A wealth of species could be associated with the habitats described above. This would also include bat species such as Daubenton's bat (*Myotis daubentoni*) that may feed over the areas of open water. Other bats species e.g. lesser horseshoe bat (*Rhinolophus hippoosideros)* and pipestrelle bat (*Pipistrellus pipistrellus)* could be found in the mill buildings themselves particularly if the buildings are abandoned. Local Bat Groups would hold confidential records of such sites (Jean Matthews, CCW Species Officer, pers. comm.).

Other examples of UK BAP priority species potentially associated with water management features such as mills are great crested newt (*Triturus cristatus*), water vole (*Arvicola terrestris),* otter (*Lutra lutra)* and reed bunting (*Emberiza schoeniclus).*

Other priority invertebrate species and lower plants may also be associated with water management features however the lack of readily available data on the distribution of these species in Wales prevents further comment.

Chronology

Within Wales, water has been harnessed for industrial and agricultural purposes, to provide drinking water, and to provide transport systems.

Industrial mills are first recorded in Wales in a Roman context, at Dolaucothi gold mine, where an extensive water-catchment system was used to power a water-wheel operating a stamp-mill, as well as underground pumping systems making use of self-acting water-raising wheels. It is possible that such systems were used elsewhere, but the water-driven industrial mill only re-appears in Wales in the seventeenth century, to drive mine pump systems. Water-power rather than steam underpinned the early industrial revolution in Wales, powering blast-furnaces, drainage mechanisms and processing plant. Increasing sophistication in water-wheel technology in the early nineteenth century made the water-driven industrial mill a paying proposition until well into the twentieth century in many cases. Even comparatively small industrial undertakings might have catchment systems extending over many miles. The development of turbine systems in the nineteenth and twentieth centuries gave a new lease of life to industrial water-power systems, and to public electricity supply systems, a number of which continue to operate.

Within the agricultural economy, water-power has been used to grind corn and other foodstuffs; to power agricultural machinery; and to power textile-processing.

Agricultural water-mills, though attested to the sixth century AD in parts of Ireland, seem only to have been introduced into Wales in the second Christian millennium, by the Anglo-Normans and by religious movements such as the Cistercians. To produce

essential ingredients for many rural foods, every locality in Wales ultimately had a corn mill; these were water-powered when conditions offered. They were also part of a mixed-farm regime where it was obligatory for each farmer to grow his/her own quota of oats, rye, barley and corn to feed both his/her family and animals, even though often the land was completely unsuited to tillage. The practice of milling corn in rural water-mills persisted in Wales well into the twentieth century. In 1923, Cardiganshire had 77 such corn mills, Breconshire 44 and Pembrokeshire 54, all of which were water driven. Since then there has been a marked decline for numerous reasons, though some corn mills, such as Melin Pontbren in Cardiganshire, survived until the early 1960s. There is an active example remaining at Melin Hywel, Anglesey (pers. comm. Buddug Jones, Countryside Council for Wales).

Many farms made use of water-power to operate butter-churns or chaff-cutters. While until the nineteenth century, the water would be used to turn a wheel, from the beginning of the twentieth century small turbines were commercially available, which could be used coupled to machinery directly or used to power a generator.

Fulling mills and their associated industries were also established in all parts of Wales from the Middle Ages to provide workable wool for the woollen industry both locally and further afield. From the early nineteenth century onwards, other processes such as carding and spinning were increasingly housed under the one roof in industrial textile mills, generally water-driven, supplying world markets. At the end of World War I the price of wool fell and the Welsh woollen industry steadily declined. The 250 woollen functioning mills recorded in 1926 had shrunk to 81 in 1947, and 24 in 1974.

The construction of piped water systems for domestic consumption, and their associated dams, catchment systems and purification plant reflect the spectacular urban growth of the nineteenth century and increasing awareness of the causes of diseases such as cholera. By the later nineteenth century and in the twentieth century, ambitious public supply systems were providing Liverpool, Birkenhead and Birmingham, as well as urban conurbations within Wales, with water from the Welsh uplands.

Though the earliest canals in Wales date to the immediate post-Conquest period, the present Welsh canal system only began to develop from the late eighteenth century, bypassing rivers which were too shallow or too steep for boats, and as a rule, unlike English canals, they were not interconnected.

Former geographical distribution

Industrial mills powered by water tend to be located in mountainous areas where a good head of water is available. There was also a marked expansion of woollen mills in the middle Teifi valley and along the Severn valley during the nineteenth century.

Agricultural mills are to be found all over Wales, though in lowland areas where streams are sluggish and wind-power is a practical option, they were fewer in number.

Public water-supply systems are located in the most easily accessible mountainous regions from the location they were supplying. There is therefore a concentration in the eastern half of Wales.

Few canals were built outside north-east Wales and the border, and the industrialised areas of the south.

Case study examples

A detailed study has been carried of the development of industrial water-power at Dolgarrog, in the Conwy valley (Gwyn, 1989). This outlines the successive use of water to power a Cistercian fulling mill, nineteenth century corn mills, paper factories and slate quarries and to provide industrial conurbations with drinking water, and, from the early twentieth century onwards, to provide electricity for aluminium reduction and public supply.

A study of a fulling mill in Anglesey published in the journal of the Welsh Mills Group *Melin* illustrates the change from pre-Industrial to Industrial use of water power within the rural economy (Davidson A, 1983).

A detailed study of the Montgomeryshire canal has made clear the uses to which the canal was put. As well as providing a transport system, the canal supplied water to local industries along its route (Hughes, 1989).

Ecological aspects of the practice

The ecological value of the practice is thought to lie predominantly with derelict or redundant features which provide niche habitats in areas where small volume water bodies may not naturally be present. Too little evidence is currently available on this subject and further research, including field observations is required before any informed statements can be made under this and the subsequent headings.

How the practice may be sustained

Biodiversity value is thought to lie in derelict features (creation of ponds) rather than in the practice itself, although this remains to be fully investigated. See comments above.

Attention would need to be paid to the conservation of protected species, particularly bats, during any renovation work on mill buildings or walls (Jean Matthews, CCW Species Officer, pers. comm.).

Potential re-introduced using modern techniques

See comments above.

Potential economic benefits as a basis for sustainable management of biodiversity

Could be re-introduced where appropriate on a small scale as a low impact means of creating electricity rather than the milling of corn and fulling of wool.

Other examples of water-management systems with ecological implications.

In addition to the use of water to power a prime-mover, water-management includes the construction of dams, sluices and spillways, such as at Malltraeth in Anglesey and the Traeth Mawr in Gwynedd, with their own distinct ecological implications. Other examples of the industrial use of water-power include the extensive system of precipitation at the Mynydd Parys copper mines, where copper-rich water was precipitated with scrap iron in large open ponds, and the use of hushing in mines, whereby controlled floods were unleashed on mountain sides to reveal mineral lodes.

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5.8 Reed Cutting

Definition

Cutting of reeds (*Phragmites australis* or *corsen* in Welsh) for use as material for thatching. Although other materials, such as wheat straw or sometimes heather, rush and gorse were used, the most durable material used was the common reed.

Associated habitats

Reed-bed is dominated by a single species - common reed (*Phragmites australis*); the associated National Vegetation Classification community is S4a *Phragmites australis* swamp and reed bed *Phragmites australis sub-community*. Reed-bed is a priority habitat in the UK BAP (Anon., 1995). There are remarkable few examples of this habitat over 2 hectares in England and Wales; with only 15 sites over 40 hectares (Bibby and Lunn, 1982). Regular management is necessary to maintain a reed-bed. It effectively maintains the hydrological succession at a chosen point by the removal of litter and maintenance of water levels.

The manipulation of water levels and cutting regime can also promote the growth of other species of value in the thatching industry. For example saw sedge or great fen sedge (*Cladium mariscus* or llemfrwynen in Welsh), is often found in associated with reedbed in base rich areas. It can be used to form the ridge of a thatched roof. The associated National Vegetation Classification community associated with this species (S2 *Cladium mariscus* swamp and sedge beds) is to be found on the suite of sites known collectively as the Anglesey fens, a candidate Special Area of Conservation under the European Habitats Directive.

In association with reedbed, and primarily reflecting variations in water levels, one would expect to find a range of wetland communities. Rodwell (1995) describes this variety of communities, which can include open water bodies and fen communities. Both of these are UK BAP priority habitats. With a decline in management the hydroseral succession can re-commence. This is can be seen at an early stage by the transition to other S4 NVC communities and later by the occurrence of other fen and mire communities. Ultimately there will be the development of woodland, this may include areas classified as wet woodland (NVC W1, W2,) which is also a UK BAP priority habitat. The Anglesey fens are an internationally important series of sites primarily noted for their rich botanical and entomological interest.

Associated species

Reed beds as described above are botanical relatively poor. They are however, amongst the most important habitats for birds in the UK (Bibby and Lunn, 1982; Brookhouse, 1998). They support distinctive bird assemblages. In the UK as a whole 6 National Red Data Book species are associated with reedbeds. In Wales the relevant species are: bittern (*Botanus stellaris*), marsh harrier (*Circus aeruginosus*) and Cetti's warbler (*Cettia cetti*).

The bittern, a UK BAP priority species (Anon., 1995), is known not to have bred in Wales since the mid 1980's and the majority of former sites are now thought to be unsuitable (Lovegrove *et al* , 1994). The RSPB are attempting to create large areas of suitable habitat for the bittern and other reedbed species on Anglesey.

Other UK priority species, which may be associated with reedbed sites, are: great crested newt (*Triturus cristatus*); water vole (*Arvicola terrestris)*; reed bunting (*Emberiza schoeniclus); o*tter (*Lutra lutra);* dwarf stonewort (*Nitella tenuissima);* lesser bearded stonewort (*Chara curta);* and the medicinal leech (*Hirudo medicinalis).* Six of these species occur at Cors Goch, Anglesey (Chris Wynne, Conservation Officer, North Wales WT).

Priority invertebrate species and lower plants may also be associated with water management features however the lack of readily available data on the distribution of these species in Wales prevents further comment.

In addition, high levels of abundance of water shrew *Neomys fodiens* have been recorded in shallowly flooded sites (Jowitt & Perrow, in press). Harvest mice *Micromys minutus* are abundant in reed growing in water where *Phragmites* seed heads are most abundant.

Socio-economic context

Reeds harvested to supply thatchers with a long-lasting raw material. A roof made with reeds is believed to last for at least one hundred years (Jenkins 1976). Some reed beds were specifically grown for this purpose, particularly in the Jersey Marine area of west Glamorgan.

Chronology

Reed cutting for thatch continued for centuries until the improvements in transport and the expanding of the slate industry reduced the need for thatched roofs. The practice of reed cutting still persists especially in west Glamorgan, with the Vale of Glamorgan being an area where thatched roofs are frequently seen.

Former geographical distribution

The practice of reed cutting was widespread with Anglesey being a particularly important area together with the Jersey Marine area of west Glamorgan, Oxwich on the Gower Peninsula and the Gwent Levels. Many former reed beds have since dried up and reverted to fen or carr woodland. In 1979-80 there were only 109 reed beds in England and Wales exceeding 2h.a. of which only 33 were over 20h.a. (Bibby & Lunn, 1982).

Case study examples

Thatched roofs may still be seen in the border counties and the Vale of Glamorgan (Jenkins, 1992).

At Cors Goch, Anlgesey, at least part of the reedbed was cut on an annual basis for reeds. These were then used to provide thatched covers for hay stacks. The reed was cut by hand

on a "collective" basis by surrounding farmers. The aftermath was grazed (Mr W. Williams, pers. comm. 1995).

Ecological aspects of the practice

Winter cutting of reeds and maintenance of hydrological regimes to increase the dominance of Phragmites to yield a good crop for the thatching industry. Cutting arrests the build up of litter (Gryseels, 1989a; Haslam,1972a,b; Wheeler & Giller, 1982). Further details on the characteristics of reed exploited by reed cutting are to be found in Rodwell (1995) and in the classic reference on the species, by Haslam (S.M. Haslam 1972, *Biological flora of the British Isles: Phragmites communis*, Journal of Ecology, 60: 585-610).

Nature of practice

The most durable roof is that built with common reed *Phragmites australis*, an aquatic plant that grows in many parts of the country, for example in Anglesey, the Gwent Levels and the Jersey Marine district of west Glamorgan (near Swansea), where it was harvested annually. (Jenkins writing this in 1976 uses the present tense, suggesting that the reed was still harvested then). Reed, most expensive of all thatching materials, was grown specifically for that purpose. It was cut with a scythe or sickle.

The long term existence of reedbeds is largely due to management by humans. The reeds were harvested on a regular basis and the litter disposed of and burned. The dead reed stems were cut during winter. The flow of water into the reedbed was strictly managed. Sutherland and Hill (1995) give comprehensive details on managing reedbeds using modern techniques.

Although the best thatched roofs were made from reeds, many other locally available materials were used for roofing. In South Cardiganshire roofs were thatched with wheat straw or sometimes heather, rush or gorse. However in the eighteenth century, slates were imported by sea (Jenkins 1992).

Straw from wheat threshed in the normal way was used by many generations of thatchers. This became less popular when combine harvesters and bailers came into use. In Glamorgan, it was customary to cut the wheat close to the ear, leaving the stems undamaged by threshing. Even in recent years it had been customary to reserve for thatching wheat growing around the edges of the harvest field. It was generally cut either with a sickle or scythe and cradle to open the field for the reaper. Threshed long straw was applied so that the stalks lay along the plane of the roof, which then shredded the water falling on it (Jenkins 1992).

The cutting of reeds must also have been combined with grazing management and/or burning on some sites (Mr W. Williams, pers. comm. 1995). It may be this combination of practices that has given the Anglesey fens their unique character.

Sites where the practice still occurs

Small scale reed cutting for nature conservation reasons or fire prevention/control occurs at a number of sites managed by the Wildlife Trusts or RSPB e.g. Cors Goch, Anglesey; Malltraeth Marsh, Anglesey.

How the practice may be sustained

The use of cutting as a management tool on reedbed sites should be given careful consideration on a site by site basis. The current interest of the site would need to be thoroughly assessed.

Most of the extensive reedbeds in Wales have been designated as Sites of Special Scientific Interest (CCW, 1995). The most appropriate means of ensuring the sustainable management of these sites would be through management agreements with the Countryside Council for Wales. Other smaller areas could be managed through Tir Gofal. Reedbeds are one of the mandatory habitats attracting payments of £35 hectare (NAW, 2000).

In the mid 1990s the Anglesey Wetland Strategy achieved considerable success in managing existing reedbeds and creating new ones. The latter included the RSPB project at Malltraeth Marsh, which has since attracted further funding from the Heritage Lottery Fund.

The Heritage Lottery Fund is also funding the Wetlands for Wales project which aims to purchase, create and manage a number of wetland sites across Wales.

Tir Gofal also includes a voluntary category for the creation of reedbeds through capital payments. The creation of new reedbeds could also be achieved through their potential as waste filters (Morris, 1998) or for water treatment (Worrall, 1998).

Potential for re-introdtion using modern techniques

An abundance of written material has been published regarding the management of reed beds using modern techniques (e.g. Hawke and José, 1996; Burgess *et al*, 1995). Winter cutting should take place after the reed leaves have fallen and the stems dried out. The ground should be left to dry out to allow machinery onto the site without causing compression of the ground which damages dormant reeds shoots and rhizomes. The cut bed should be exposed to two moderate frosts before reflooding – this will increase the density of reed the following season (Haslam, 1972a, b). Flooding protects the reed shoots from many hard frosts and prevents competing vegetation from becoming established. The reeds could then be sold on a small scale as material for thatching in those areas of Wales where the craft still occurs e.g. Vale of Glamorgan.

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5.9 Marram Grass Cutting

Definition

Cutting of marram grass *Ammophila arenaria* for the production of mats and ropes.

Associated habitats

Marram grass (***Ammophila arenaria)*** grows in coastal habitats dominated by sand. It is particularly associated with areas where the sand is mobile as a result of wind or other types of erosion and is a vital constituent in the structure and function of the dune system as a whole. A range of National Vegetation Classification communities include marram grass (Rodwell, 1991): Shifting sand dunes along the shore line, SD6 *Ammophila arenaria*, dunes with creeping willow *Salix arenaria* SD14, SD15, SD16; fixed dunes with herbaceous vegetation (grey dunes) NVC SD8. Newborough Warren, the key site associated with this practice, is a candidate Special Area of Conservation under the European Habitats Directive. Since the 1950s, there has been a dramatic decline in shifting dunes with marram at Newborough. This trend towards over-stabilised dunes is seen throughout Wales. At Newborough the decline is thought to be related to the reduction in grazing, rather than the cessation of this practice (see below) (CCW and FE, 1999).

Associated species

Plants such as sea holly *Eryngium maritimum* and Lyme-grass *Leymus arencrius* are typically found in the shifting dune habitat (Anon., 1995).

Priority invertebrate species and lower plants may also be associated with sand dunes, however the lack of readily available data on the distribution of these species in Wales prevents further comment.

Socio-economic context

The harvesting and use of marram as a local raw material for the making of mats and ropes was a response by villagers to extreme poverty. The lack of agricultural land for growing crops and animal husbandry forced the villagers of Newborough, Anglesey to create a local industry to support themselves. The main products were thatching mats which were used by farmers to throw over haystacks prior to thatching proper. At the beginning of the twentieth century, mats for horticultural use were produced such as strawberry mats, also table mats, floor mats, foot stools and baskets. Closely related to this industry was the making of besoms or brooms by villagers from Rhosneigr, Valley and Aberffaw. This was a part-time occupation since more land was available in these areas for farming. The history of Newborough industry and its communities are well documented by Griffiths (1997), Hughes and Jenkins (1992).

Chronology

There are no records of when and how the industry began at Newborough, but it is assumed that the methods passed on to the nineteenth and early twentieth centuries were ancient ones, dating back to the middle ages (Griffiths 1997, 1). The first reference to the marram grass in the area is a royal edict dating to the sixteenth century restricting the cutting of the grass to prevent further erosion of the sand dunes (the village was becoming engulfed in sand). An account of 1629 notes that the production of marram mats and ropes was the sole occupation of Newborough people at that time (Griffiths 1997, 3). Historical documents relating to the timber trade in the Conwy Valley show that rope from Newborough was used to tie felled timber into rafts for floating down the river Conwy (pers. comm. Gareth Haulfryn Williams, Cyngor Gwynedd). Marram grass weaving is known to have continued at Newborough until the beginning of the twentieth century when the invention of corrugated sheeting for barn roofs was introduced and contributed to the demise of the marram industry. A gradual decline was seen with eventual cessation of the craft in the 1950s (Griffiths 1997, Jenkins 1992).

Former geographical distribution

Anglesey attained considerable fame as the only county in Wales where marram grass growing on sand dunes provided the raw material for an important industry (Griffiths 1997, Jenkins 1992). Other areas of Wales where the habitat occurs are Morfa Dyffryn and Morfa Harlech in Gwynedd and the Burry Inlet on the South Wales coast. 6,406 ha of dune habitat exists in Wales at present. The dune area around Newborough was substantially reduced in the last century due to the planting of the conifer forest.

Case study examples

Anglesey was the only county in Wales where marram grass (also known as seed-reed; matweed and stare grass) growing on sand dunes provided the raw material for an important industry. Marram, known locally as *morhesg,* grows profusely on the west coast of Anglesey particularly in Newbourough and Llanddwyn.

For many centuries, the inhabitants of Newborough made a scanty living by plaiting the material into mats for farmer's haystacks, barn roofs and cucumber frames as well as into nets and cordage for fishermen.

Undoubtedly, mat making in Newborough came into existence as an antidote to poverty.

Ecological aspects of practice

The cutting of marram grass on a rotational basis so that the stool continued to bear its crop for many years. Marram can tolerate 20% salt. It flourishes best under conditions of great sand mobility. It can withstand burial up to 2 feet and grow through new sand cover by vertical rhizomes. On the older fixed dunes, the marram is stunted and withered. The main dunes carry other xerophytic type plants which flourish in this type of habitat e.g. Sea spurge, Sea Holly and Sea bindweed (Robinson, 1980). When cut, marram responds by re-growing and sending out further rhizomes. This increases its function as a sand-building agent and assists in preventing 'blow out' in the dunes. The practice of cutting

the marram below the surface would also encouraged its typical tillering response to covering with sand.

The key to the success of *Ammophila arenaria* is in its ability to keep pace with burial by blown sand. Its rhizomes and roots help bind the substrate against erosion and the densely crowded tillers enhance accretion by reducing the speed and carrying capacity of the wind. (Willis et al, 1959b), but when buried the internodes and shoots elongate, effectively converting them into vertical rhizomes which are able to maintain upward growth through one metre or so of sand a year (Greig-Smith et al, 1947). By producing more daughter tillers and horizontal rhizomes, the plant can thus re-establish dominance on upbuilding the surface it has helped create.

The plant's impressive sand-binding ability has resulted in it being planted around the coast to stabilise eroding stretches of dune. This is especially important where dunes form an integral part of soft sea defences (Kidson & Carr, 1960)

Nature of practice

The marram was cut in the summer months when green, usually late August or September, although the season could continue until the beginning of November, depending on the weather. The best raw material was two years old and cut with a scythe, but more commonly with a broad-bladed reaping hook. The first year was deemed too weak to plait with and the third year it was too withered and white. Each woman had her own particular area of the dunes, so that too much grass was not cut from the same area. Four to six stalks only, were cut form each stool or root, being cut as near to the stool as possible, usually two inches below the level of the sand. Parts of Newborough Warren were sub-let during this period to the mat makers (Owen, 1923).

Sites where practice still occurs

No known sites.

How the practice may be sustained

The practice is not seen as being ecologically or economically sustainable.

Potential for reintroduction using modern techniques

There are no perceived benefits to reintroduction of the practice.

Potential economic benefits as a basis for the sustainable management of biodiversity

The practice is not seen as being ecologically or economically sustainable.

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5.10 Bracken Cutting

Definition

The cutting of bracken (*Pteridium aquilinium*) for several uses including as animal bedding and soap making.

Associated habitats

Bracken is a component in 36 National Vegetation Classification communities and is a dominant member in two: *Pteridium aquilinum - Rubus fruticosus* (W25) (Rodwell, 1991) and *Pteridium aquilinum - Galium saxatile* (U20) (Rodwell, 1992). The W25 underscrub (is the most floristically diverse since it) is able to support woodland species such as bluebell and also provides habitat and cover for a range of animals. Bracken can play a key role in the successions to woodland habitats. Any floristic interest that these communities may possess is outweighed by concern over the vast nature of the "bracken problem (Rodwell, 1992).

From a biodiversity aspect, bracken is often associated with the decline in quality of a habitat, and therefore has a very negative image. The main communities affected by bracken encroachment are lowland acid grassland and lowland heathland, both UK BAP priority habitats (Anon., 1995). More specifically the following National Vegetation Communities are affected (Rodwell, 1991 and 1992):

U1 *Festuca ovina - Agrostis capillaris - Rumex acetosella* grassland

U2 *Deschampsia flexuosa* grassland

U3 *Agrostis curtisii* grassland

U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland

W11 *Quercus-Betula-Oxalis*

H8

It is likely that the decline in area and quality of lowland dry acid grassland and to a lesser extent lowland heathland, is due in part to the decline in the cutting of bracken. Other impacts can be summarised as follows (after Jones, 1997):

a) Reptiles such as adder *Vipera berus* and common lizard *Lacerta vivpara* may suffer from lack of areas to bask.

b) Ground flora reduced and rare varieties of plants lost.

c) Herbivorous mammals such as voles are uncommon in bracken stands.

d) In the uplands, many bird species are lost.

e) Dense bracken stands can hinder woodland regeneration.

Associated species

The W25 underscrub provides habitat and cover for birds such as whinchat (*Saxicola rubetra*), ring ouzel (*Turdus torquatus*), merlin (*Falco columbarius*), little owl (*Athene*

noctua), short eared owl (*Asio flammeus*), long eared owl (*A. otus*). In Wales the nightjar (*Caprimulgus europeaus*), a UK BAP priority species (Anon., 1995). Prior to its decline in the 1920-30s, this unusual bird was also known as the fern owl because of its association with large stands of bracken in Wales (Lovegrove *et al*, 1994).

Bracken dominated habitats may also be important for mammals such as wood mouse (*Apodemus sylvaticus*) reptiles such as slow worm (*Anguis fragilis*).

Pearl-boarded fritillary (*Boloria euphrosyne)* is a priority BAP species associated with bracken slopes and rough grassland. Other threatened fritillary butterflies such as the high brown (*Argynnis adippe)*, the small pearl-bordered (*Boloria selene)*, the dark green (*Argynnis agalaja)*, use bracken stands rich in violets (*Viola* spp.) (Warren & Oates 1995).

These three species of butterfly are now among Britain's most rapidly declining. *A. adippe* was once widespread in England and Wales, using woodland and hillside habitats, but has declined in over 492 ten km sq. to just 29 presently. Most of this decline has taken place in the last 40 years. (Warren, 1992). It is now one of Britain's most endangered butterflies. Current loss for the other two species is estimated as 39% for *B. euphrosyne* and 41% for *B. selene*. (Warren, 1993).

With the loss of their traditional woodland habitats, these butterflies have become increasingly restricted to rough, scrubby grassland and to certain bracken communities (Oates, in press; Warren 1991, Warren 1992). Their conservation is an urgent priority and will hinge on two main factors:

1. Instatement of management practices akin to traditional woodland management under which they thrived in the past
2. The conservation of the alternative habitats.

Over three quarters of *A. adippe* breed in fairly dense bracken stands, therefore the conservation of bracken habitats is a priority.

There is increasing evidence that many colonies of B. euphrosyne and B selene occur with bracken communities and are highly dependent on them in some regions. eg. North Wales (Hinde, 1993). Bracken communities commonly used by butterflies are NVC W25 *Pteridium aquilinium- Rubus fruticosus* underscrub and U20 *Pteridium aquilinium-Galium saxatile.*

Bracken is a food plant for moths such as the broom and brown silver line. Although bracken communities may be important in providing habitat for invertebrates, the potential loss is not great compared to that of other communities that may replace them. (Rodwell, 1992).

The key plant species associated with the most important NVC communities as described above are:

U20 – *Pteridium aquilinium-Galium saxatile* community. Apart from *Potentilla erecta* and *Galium saxatile*, the herbaceous constituents of this vegetation type are not very numerous. There are occasional *Oxalis acetosella, Teucrium scorodonia* and *Rumex acetosella.* In less heathy stands, there can be scattered plants of *Viola riviniana,*

Campanula rotundifolia, Veronica chamaedrys and *Veronica officinalis.* (Rodwell 1992). The U20 community is an important habitat for declining and rare BAP species of butterfly (see above notes) which are dependent on the *Viola* spp.

W25 - *Pteridium aquilinium-Rubus fruticosus* community. Often with dense cover, the abundance of associates is sometimes low and very much confined to more open areas between bracken and bramble. *Silene diocia, Rumex acetosa* and *Viola riviniana* (Rodwell, 1991). *Hyacinthoides non-scripta* is a sub-community of W25 (Rodwell, 1991) where bracken has often replaced the woody cover.

Socio-economic context

It is thought that the widespread use in the past of bracken for animal bedding is indicative of the plant's abundance rather than of any particular property of it. Other uses include: winter fodder (dried and mixed with straw or hay) for horses and mules; as a thatch material; use in the woollen industry for dyeing and bleaching; in the production of soap; as a source of potash for use in the glass making industry. It is known that in the Conwy valley bracken was regularly harvested and burnt as late as the 1860s, the ashes being collected and transported by boat to soap making establishments in Lancashire (Denman et al 1967). There are accounts of bracken being used as fuel in Britain, (especially in Scotland) although no records of this practice have been recorded for Wales.

An old welsh verse refers to how bracken indicates good agricultural soil:

'aur o dan rhedyn (gold beneath bracken)

arian o dan eithin (silver beneath gorse)

newyn o dan grug' (starvation beneath heather)

Chronology

Pronounced local increases in the amount of bracken spores in the pollen record have been related to sporadic and shifting woodland clearances during the Mesolithic and Neolithic (Rodwell, 1992 citing several references). It is however difficult to determine when bracken cutting may have been initiated to provide a useable product as opposed to maintaining areas for agriculture. The practice of cutting bracken goes back many centuries. The spread of the plant in the twentieth century is an indication the shift from the rearing of cattle to sheep in the nineteenth century. Cattle were the dominant element of pastoralism in the uplands until the seventeenth and eighteenth centuries. Their trampling kept the bracken in check. Sheep have a much lesser impact, allowing the young fronds to grow and the bracken spreads. Bracken is poisonous to sheep, cattle, voles and rabbits in its green form.

Former geographical distribution

The practice of cutting bracken was widespread throughout Wales especially in areas of acidic dry slopes where the plant thrived.

There has been a considerable loss of agricultural land, and of land of general biodiversity value, to bracken. In Wales bracken cover is estimated at approximately 6% the land surface (Taylor, 1985). Of this 29,000 ha is in the lowlands and 33,500 ha is in the uplands (CCW and FE, 1999). It is particularly abundant in the hill slopes around the upland fringe i.e. the fridd. Formerly it was estimated to be increasing by an average of 1% per annum. Nicholson & Paterson (1976) concluded that although the bracken community may be important in providing habitat for invertebrates, the potential loss is not great when compared to the biodiversity benefits of the other communities that may replace it. Current estimates indicated that bracken may actually be in decline (CCW and FC, 1999).

The following factors have influenced the spread of bracken in the Twentieth century (Rodwell, 1992; Godfrey, 1988; Brown, 2000):

1. Deforestation – bracken has taken hold where forest used to grow.
2. Climatic change - it is known that bracken is sensitive to low temperatures and grows best in warmer conditions.
3. The shift from cattle to sheep rearing. When cattle were reared on slopes, the new fronds were trodden underfoot.
4. Neglect of remote grazing areas
5. Burning. In particularly, poor control of heathland fires, since fire encouraged the spread of bracken.
6. The cessation of cutting for bedding etc.

Ecological aspects for the practice

The considerable volume of literature on bracken and its autecology is summarised in Rodwell (1992) and also in Page (1982). The key features which allows it to survive repeat cutting, or even burning, is the extensive rhizomes network and energy reserves which allow a rapid response by newly growing fronds. It is also only rarely taken as the preferred food by stock and trampling damage is often more important than grazing in holding the species in check (Rodwell, 1992).

Nature of practice

The cutting of bracken when brown for animal bedding which rotted down into a potassium-rich manure. Regular harvesting of the crop and then burning for the ashes for use in the soap making industry and for cloth-cleansing at fulling mills.

Sites where the practice still occurs

Control of bracken through cutting, crushing, spraying and so on is widespread. However, teh authors do not know of any active examples of cutting for use as bedding or as a fodder supplement. If occurring at all, harvesting may be taking place on a very small scale, possibly for use as compost.

How the practice may be sustained

The need to control bracken is beyond doubt, because of its detrimental impact on both biodiversity and agriculture. The control of bracken could be subsidised by agricultural schemes and Tir Gofal, with other funds available for the control of bracken on or adjacent to Sites of Special Scientific Interest through Management Agreements.

Potential for re-introduction using modern techniques

Management options for bracken control are described in detail in Crofts & Taylor (1999). Brown & Robinson (1997) outline four broad approaches:

1. No interference
2. Conservation management where the aim is to maintain a relatively low density of bracken by selective control.
3. Control where the aim is to severely limit the vigour of a bracken stand.
4. Eradication.

A combination of some or all of these may be necessary. Before control, an assessment is needed of the existing wildlife value of the impact of control.

The following has drawn extensively from experience gained from bracken control and management at Brettenham Heath NNR in Norfolk (English Nature 1995a):

Cutting
3 times a year, then once a year. Repeated cuttings reduces energy reserves in underground rhizome system and inhibits the production of new fronds. Cutting should be done early June to mid July, then late July and August. Final cut in September before the first frost.

Swiping
Regular swiping requires specialist equipment. This has been done on Brettenham Heath. Thursley NNR in Surrey uses a forage harvester to remove growth and litter. This is effective on undulating terrain.

Chisel ploughing
Deep line cultivation technique (to 18 inches deep) which creates maximum stress by damage to bracken. The rhizomes are killed by frost and drought. It is best done in hot weather and where there is a monoculture and no risk of damage to archaeology. It is a very destructive method which damages the soil profile.

Crushing

Flattens, bruises and crushes stems and bleeds sap. Reduces vigour. A variety of machines are available including a ring roller, bracken crusher and bracken breaker. This is done in mid July and repeated in subsequent years. More information in Lewis et al (1997).

Pulling

An eco-puller has been used, but its effectiveness has not been evaluated. It is advisable to pull the bracken at an early stage of growth.

Herbicide control

Asulam is preferred. Aerial spraying is expensive, but the most cost effective for large stands of bracken. There is some concern with drifting. Knap sack spraying is effective on most heathland NNR's where accuracy is required and is also best on adverse ground conditions. But this is labour intensive. One spray is recommended to eradicate the bracken and follow up treatments as necessary in later years.

Grazing

Cattle grazing allied with trampling was the most effective sustainable management tool at Brettenham. Grazing helps suppress bracken by creating a dense, species-rich heathland sward allowing species such as *Festuca ovina* and *Deschampsia flexuosa* to outcompete bracken.

Potential economic benefits as a basis for the sustainable management of biodiversity

Payments from Tir Gofal or other schemes would help re-build or maintain farm incomes. However the wider economic consequences of sustainability in agriculture are unclear, although there may be an increased demand for labour it is likely to be of a seasonal or causal nature (Webster, 1997).

Bracken compost can be used as a substitute for peat (Pitman 1995, in Smith & Taylor 1995; Seymour, 1978). The general use of bracken in horticulture is well documented (Rymer, 1976). Is has been used as a surface mulch to retain moisture and suppress weed growth and for potting specialist acid-loving plants when mixed with blood and bone, spent hops, peat and grit. (See article for method of composting). The characteristics of composted bracken shows that a horticultural product can be prepared with low pH, low conductivity, good water retention, light weight and an acceptable colour, to match peat as a mulching and potting medium. Composted bracken could replace a significant portion of the 3 million cubic metres of peat used in the British horticultural trade.

There could be a significant production of composted bracken from the British resource, estimated recently at 6770 km2. (Taylor, 1986 in Smith & Taylor). This might be selectively cut, collected and composted at regional depots, particularly from upland Britain where control is mostly by spraying chemicals. Farmers might be more interested in cutting bracken if they could see a sustainable economic return for management effort. (Varvarigos & Lawton, 1991).

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6 Discussion

The following sections discuss briefly some of the wider issues that would influence the extent to which knowledge of traditional land-use practices may be used to inform contemporary and future land management for biodiversity benefits. It also acknowledges the role of support mechanisms such as Tir Gofal in delivering the biodiversity benefits of historic land use practices and wider benefits for the environment and rural economy.

6.1 Sustainability & Biodiversity

The challenge to "meet the needs of the present generation without compromising the ability of future generations to meet theirs" (Brundtland, 1987) lies at the heart of the UK Governments commitments given at the Earth Summit in Rio in 1992 (see DoE, 1994). The sustainability challenge is being addressed in Wales (CCW, 1995; CCW & FE, 1999) and consultation is progressing on a Sustainable Development Scheme to influence the second edition of the Assembly Strategic Plan (NAW, 2000b).

The Summit also concluded that biodiversity is one of the key tests of sustainability. For example wild bird populations are included as one of the "quality of life indicators" by the UK Government. DETR (now DEFRA) recently reported that this was one of the headline indicators which had shown an improvement since 1999 (DETR, 2001). The UK government's objective is to reverse the long-term decline of farmland birds.

The development of the UK Biodiversity Action Plan and the parallel programme in Wales is well documented (Anon, 1995; CCW, 1995; Byron, 2000; Avery *et al*, 2001). Not only has the number of Habitat Action Plans now increased to 45 and the number of Species Action Plans to 391 (UKBG, 1998), but these have also been translated to the local level in 5 Local Biodiversity Action Plans in Wales (source: JNCC web site LBAP database as at February 2001). For some habitats and species Wales has a key role, notably lowland heathland, purple moor grass and rush pastures, marsh fritillary butterfly (*Eurodryas aurinia*) and the black bog ant (*Formica candida*) (CCW, 1995).

Avery *et al* (2001) identified agriculture as one of the top ten challenges over the next five years for biodiversity and in particular the issue of achieving comprehensive reform of the CAP to shift agricultural payments from intensive production to support sustainable rural development including positive wildlife management.

Avery *et al* (2001) also stress that achievement of BAP targets helps deliver other facets of government policy including the economy of rural areas; people's health; and quality of life. BAP targets also tie into Local Agenda 21 initiatives such as local distinctiveness and sense of place (Countryside Commission, English Heritage and English Nature undated).

Fundamental to this is the need to introduce less intensive farming regimes to sustain and enhance the natural beauty of the Welsh countryside as part of a "living environment" (CCW and FE, 1999). However, sustainability is still not an operational concept in many agricultural situations; the impact of the reduction in the use of external inputs on gross agricultural profit margins is an important area for further investigation. Some authors, such as Webster (1997) believe that current approaches to extensification may not be

capable of delivering sustainability in terms of either the economy of individual farm enterprises, or of broader patterns across the rural economy (particularly employment).

6.2 Biodiversity, farming and other land use practices

An overview of the effect of traditional farming and other traditional land uses

There are many similarities between the basic form of techniques utilised in traditional farming practices and those used in modern farming. Any conflicts with biodiversity generally arise from: the intensifcation of these techniques; the scale at which they are applied; and from increasing specialisation of farm enterprise (with the attendant shift away from mixed economies and patchwork landscapes, with high biodiversity potential, to monocultures). For example, the 20th century decline in old hay meadows and neutral grasslands, combined with the structural uniformity of the remaining grasslands, and the loss of mixed agriculture has been mirrored by the decline in many farmland birds notably skylark, lapwing and corncrake. Arable weeds are now also some of the rarest plants in Wales (Appendix 2). The fact that former hay meadows are now managed as nature reserves and notified as SSSI is testament to the biodiversity value of the practice and is an indictment of its decline. That small-scale arable farming is being investigated by conservationists, rather than through traditional channels of mainstream agricultural research is indicative of the seriousness of the decline of many species. Whilst on the one hand agriculturalists do not see this as a priority area for research, conservationists have become so concerned that they are now worried that large numbers of species may become locally extinct from our farmed landscapes. Agriculture and wildlife can co-exist on a conventionally managed farm (see Boatman and Stoate, 1999) using the techniques detailed by Andrews and Rebane (1994), including for example use of conservation headlands and grassy field margins.

One of the major problems faced by attempts to extensify is that the kinds of historical mixed agricultural system which can be shown to have operated sustainably in the past were able to do so because they occupied land of reasonable agricultural potential. Shifts in patterns of land holdings and the impact of market capitalism has meant that many of these areas are now predominantly occupied by substantial, intensive, high-input, high-profit agricultural operations. As Albery (1994) has stated one of the great challenges for the promotion of extensive systems may lie in the fact that they may of necessity have to be developed on land that would have been considered marginal in the past, and on which some traditional practices may therefore be neither suitable or successful.

Several traditional land use management practices, whilst not witnessing the same level of intensification as mainstream agriculture, do raise questions over both their sustainability and environmental impact attendant upon the nature of modern technologies and methods. For example, Traeth Lavan, Gwynedd, has a long history of cockle fisheries by hand. The use of mechanised collecting methods raised serious concerns about the impact on the bird assemblages of this SSSI and Special Protection Area (see Allen, 1995).

Several traditional techniques are being re-vitalised because of their biodiversity benefits.

For example, the dormouse (*Muscardinus avellanarius*), a UK BAP priority species benefits from coppicing despite the initial disturbance. At a few sites a renewable product - charcoal - has been developed for local markets e.g. Coedydd Aber and Croes Robert Wood. However, coppice management is not favourable for many woodland specialist birds. Dead and dying wood is one of the greatest resources for animals in a natural forest, and coppice woodland lacks the biomass of deadwood invertebrate food and hole nesting sites. That the ecologically negative impacts of coppicing are exacerbated by larger scale cropping operations is obvious.

Reed beds are amongst the most important habitats for birds in the UK; in Wales bittern (*Botanus stellaris),* marsh harrier *(Circus aeruginosus)* and Cetti's warbler *(Cettia cetti)* are three of the most important bird species associated with this habitat. Although reed cutting as a commercial operation has all but vanished in Wales the value of the habitat is such that conservationists are seeking to create large reedbeds at several sites in Wales and to maintain them through cutting and water level manipulation e.g. Malltraeth Marsh, RSPB reserve, Anglesey. Detailed research into possible markets for reeds was not carried out as part of this project. However, anecdotal information from archaeological colleagues in south and east Wales suggests that there is currently too little known about the properties of reed thatch, besides which, reeds are not currently produced in sufficiently large quantities to meet potential local thatching requirements. It would clearly be worth investigating this area in more detail as there may be potential for the creation of a suitable market. As a roofing material reed thatch is renewable, promotion of thatching would help create local employment, and thatched roofs make a key contribution to the local distinctiveness of the historic environment in some areas of Wales.

The value of some practices may still not be fully understood. The points made by Bignal and McCracken (1993) in relation to our lack of understand of the importance of long established upland pastoral systems for wildlife has already been discussed here in relation to the complexity of ffridd ecology and the current lack of in-depth understanding (see pages 56 and 57). Extensive grazing regimes also play a key role in maintaining, enhancing or creating biodiversity across a broad range of habitats including saltmarsh, rhos pasture, fen meadows and wood pasture. The last two are included within UK BAP priority habitats (Anon., 1995).

However, the positive biodiversity benefits of some practices are debatable. Are the wildlife communities that develop in response to small-scale peat digging or perhaps the creation of water management infrastructure more or less valuable than what was there before ? How important was marram cutting in encouraging stabilisation of the sand dunes at Newborough, at a time when grazing levels were much higher than currently? The issue for many sand dune systems in Wales now, however is one of "over-stabilisation".

One land use practice often viewed negatively is that of wildfowling and hunting in general. The positive role of countryside sports in the UK BAP are addressed in Sugget (1999) and BASC (undated).

The decline in some practices can be linked to negative biodiversity effects. When linked with changes in grazing patterns and the shifting nature of agriculture, the decline in bracken cutting is at least a factor in the spread of this species at a local level. This increase can be linked to a decline in area and quality of two UK BAP priority habitats: lowland dry acid grassland and to a lesser extent lowland heathland, along with a decline in the extent of pasture land and particularly within "ffridd". The decline in the use of gorse as both fodder and a fuel may also have had a similar effect.

Avery et al (2001) report that habitat destruction, agricultural intensification *and* lack of appropriate management are the three most important factors affecting UK BAP habitats and species. Since 1990, there has been a continued decline in the diversity of our least agriculturally improved grasslands and other changes in vegetation indicating increasing levels of eutrophication and conditions which favour tall competitive plants (Countryside Survey, 2000). However, the general conclusion from the broad national indicators which form part of the Survey, is that the negative trends in some key components of countryside quality e.g. hedgerow length, creation of broadleaved woodland and plant diversity in arable fields, have slowed or halted during the 1990s (Countryside Survey, 2000).

Farming - the current economic climate: opportunities for integrating environmentally friendly practices

The farming industry in Wales, and elsewhere in the UK, is beset by significant economic and structural problems. These problems have been discussed in a wide range of recent documents and consultations e.g. the National Assembly for Wales (NAW) consultations on the Rural Development Plan for Wales 2000-2006 (NAW, 1999) and the Welsh Local Government Association (WLGA, 1998) report to the Welsh Assembly on agriculture. It is worth briefly considering the current situation for agriculture in Wales.

Farm income is volatile, reflecting changing profit margins and agriculture's susceptibility to changes in the exchange rate and in natural factors (such as climate). As incomes from farming have decreased, both in real terms as a share of Gross Domestic Product, the number of holdings has decreased and the average size of agricultural holdings has increased. This is compounded by the fact that 40% of Welsh farmers are aged 60 or over. A further set of negative factors has exacerbated these changes (NAW, 1999):

the high value of sterling against other currencies;

the former export ban on British beef;

increased beef imports which have depressed domestic prices;

decreasing cattle and lamb prices;

decreasing milk prices and increased collection charges.

(At the time of writing the full scale and impact of the 2001 Foot and Mouth Disease outbreak remains to be seen).

Despite this around 74,000 people in Wales may be dependent on agriculture for their employment (NAW, 1999) and even in the most urbanised community agriculture is an

important contributor to the environment in the urban fringe . Its benefits for social objectives go far beyond this as do its contributions to biodiversity and other environmental objectives.

Priority areas for action to meet the challenges facing rural Wales include:

- spreading economic prosperity;
- investing in rural infrastructure and;
- strengthening communities and enhancing the rural environment.

The promotion of environmentally sustainability requires greater integration between agricultural practices and the socio-economy of the local community. Webster (1997) and others have indicated that extensification and sustainable agriculture may become reliant on seasonal and causal labour. In this scenario, a broader programme of sustainable thinking is required to ensure that opportunities and jobs are made available to offset quiet times on the farms.

Tir Gofal (NAW, 2000) and the Organic Farming Scheme are key tools in increasing the environmental and ecological sustainability of Welsh farming. Additional support may come via Objective One projects or other more local Assembly initiatives such as Cronfa Arbrofol Eryri (CAE) in the Snowdonia National Park, and the Adfwyio regeneration fund.

The Rural Development Regulation review, within the Common Agricultural Policy, is introducing changes from production subsidies to increased support for rural communities, sustainable farming and the countryside under its agri-environmental programme (2078/92). Tir Gofal, the all Wales agri-environmental scheme should receive increased funding as a result of the Rural Development Regulation review. As Avery *et al* have stated (2001), the review needs to emphasise the key importance of biodiversity.

These increased funding levels will no doubt provide benefits to biodiversity, but to ensure its long-term sustainability farm produce needs to attract a premium and/or find the right market. This is a similar dilemma to that faced by organic producers. The question of the longer-term economic sustainability of reversion or habitat creation, beyond the scheme's ten-year period of payment, also needs to be adequately addressed.

The biodiversity benefits of organic farming are well known (Stockdale *et al,* 2000; Elsen, 2000; Wilson *et al* 1997 for example) and the opportunities for UK producers to expand still further into organic farming to meet the ready market have also been highlighted (Agriculture Select Committee, 2001). It is vital that the organic industry becomes more effective by becoming more market-orientated and appeals not only to health and to ethical consumption choices, but to other proven benefits such as biodiversity enhancement. Stockdale *et al* (2000), in a major review of the literature, conclude that organic farming is a "valid alternative approach to intensification" and can also "inform and improve (the) sustainability of other forms of agriculture". The need for Welsh agriculture as a whole to become more economically viable by linking more directly to markets has also been recognised (NAW, 1999). This must be at the same time as improved environmental and ecological sustainability. This would not only help meet biodiversity targets for Wales (see Chamberlain *et al*, 2000 for example) and strengthen

the country's attractiveness for tourism but also form the basis for marketing Welsh food as a premium product (NAW, 1999).

In addition to these national initiatives, the development of agriculture also requires strong local action as identified by the Welsh Local Government Association (WLGA, 1998). The Agriculture Select Committee (2001) also recommended encouraging the further development of local marketing schemes, such as farmers' markets and vegetable and wholefood box delivery schemes. In Wales, farmers markets currently operate around Bangor, Colwyn Bay and in Pembrokeshire. These initiatives will hopefully come to fruition with the reality of Objective One funding from Europe. Further impetus for production to become more market orientated is a result of consumer and other pressures for farming to be more welfare and environmentally friendly. Economic pressures will necessitate farms diversifying their sources of income, on and off the holding.

The Welsh Local Government Association (WLGA, 1998) has stated that, to be sustainable, farming needs to include a balance of both large scale units that are internationally competitive and small-scale units offering more local social, environmental and cultural benefits. However, the debate about the contribution of integrated crop protection (ICP) systems of farming to mainstream agriculture continues. A key feature of ICP systems is that they address the inequitable balance between food production and biodiversity in mainstream agriculture (Atkinson and McKinlay, 1997).

Drawing on traditional management techniques

Some ecologists believe that past human land-use has had a generally detrimental effect on biodiversity. Hambler and Spreight (1995) have stated that "much of Britain's wildlife has survived despite traditional management". However as pointed out by Avery *et al* (2001) lack of *appropriate* management is one the three most important factors affecting UK BAP habitats and species, and as this study has shown some traditional management techniques are widely used to provide biodiversity benefits. Any economic benefits derived from the application of tradition land-use practices tend to be an incidental bonus rather than the central rationale. Further, the biodiversity benefits derived from these practices have so far tended to operate on a small scale, for example on protected sites managed by conservation orientated organisations. For example: coppicing at Croes Robert Woods by the Gwent WT to benefit dormouse; or hay meadow management on a number of SSSI.

As part of the monitoring process for Tir Cymen, Entec (1998) identified the need for appropriate prescriptions for the specific character of each individual area (habitat parcels) including the management of both individual historic and archaeological features within them and of the historic *character* of the particular areas. Only 55% of habit parcels were found to be managed in a wholly beneficial manner. The study highlighted the value of a taking a more integrated approach to the development of prescriptions that draw on knowledge of past land-use alongside present day ecology, to establish management prescriptions.

Many of the historic land-use practices described above have declined for the very reason that in comparison with modern techniques they were uneconomic. Tir Gofal, Organic

Aid or any other support mechanism might be an economic incentive but unless there is a market value attached to produce grown in an environmentally friendly way then in the long term the practice will be economically unsustainable.

Many traditional land-use practices were only possible under the very different social and economic realities of rural life in the past. The authors of this study are certainly not advocating a return to these conditions (lives which were often hard in both physical and economic senses). In conserving for both historic landscapes and biodiversity through agricultural strategies we should not aim to prevent change in the rural environment. It is important that we avoid replacing a landscape of production (agriculture) with one based purely on service (namely tourism and leisure) (Cooper, 2000), with attendant problems of maintaining viable economies for the inhabitants of the countryside. However, the importance of the past in the presence operates on a number of levels. The physical remains (from the sites of prehistoric farms, to areas of ancient woodland) underpin the character of much of today's landscape. Understanding the sorts of societies and practices which these remains represent helps us to explain the way that present day environments and biodiversity has come to be the way it is today. By appreciating how different landscapes have come into being, particularly through knowledge of past land-use practices and past landscape management, we can contribute to debates about the way in which these landscapes should be managed for the future. It is notable that long time spans of human history have been occupied by periods of little change, implying that people in the past have achieved, at different times, a high degree of sustainability in the way in which they have exploited the landscapes around them.

The key to reconciling human life and economic activity with maintaining biodiversity (Cooper, 2000) is the incorporation of appropriate land-use practices into the full range of agricultural support mechanisms including those in the more mainstream sectors. This recognises that "enlightened inputs into a common deliberation process [are] needed, not scientific management based on operational concepts" (Arler, 2000).

7 Recommendations for further study

This project is rare in its joint historical and ecological approach to investigating land-use practices and their possible relationship to contemporary landscape management. The project has generated examples of past land management practices benefiting biodiversity. However, it is the identification of the specific useful aspects of these practices which are of particular benefit, and the way in which these may be worked into modern techniques. It is important to understand individual site histories as well as the general picture. Further work should be focussed on collecting detailed records from individual sites to gain an insight into stock density, timing of hay making, fertiliser use etc.

Work on the ten historic land-use practices has revealed some of the potential benefits of this approach:

- The relationship between people and landscape over time, as mediated through agricultural systems, shows that for much of human history past societies have been 'sustainable' (i.e. self-sufficient and stable over long periods of time). Past agricultural societies, at least, prior to the agricultural revolution, were necessarily 'extensive' in their farming systems. Given the acknowledged importance of a mixed, extensive, economy, and of sustainable agriculture, for biodiversity, it could be expected that knowledge of past societies and their practices may help inform management in the present.
- Nature and culture cannot be held apart in the understanding of present day landscapes and biodiversity, as their histories are bound-up with one another.
- A substantial body of information is available on the themes investigated during the project.
- These sets of information differ in focus across the disciplines of archaeology/history and ecology, and proved important compliments to one another.
- Similarly, the sharing of professional knowledge and expertise was shown to have been mutually helpful.

The methodology developed during the course of this scoping study should be taken forward in a number of ways.

1. The scope of the project prevented full consideration of a number of the main themes around which work could be focussed. These are particularly:
   - Associated species (UK BAP priority species)
   - Associated habitats (UK BAP priority habitats)
   - Welsh language terms for techniques, traditions, habitats and species
   - Biodiversity index (a practical way of assessing the biodiversity values of traditional practices has been established by Chris Wynne of NWES.
   - Active/current examples of sites

2. The biodiversity index should provide a way of identifying practices of key biodiversity value. Further more detailed work, based on that carried out for this report, should be conducted for practices with a high index value.

3. During the research for this project, a wealth of material on historic aspects of different practices has been compiled. Full consideration and synthesis of this material is beyond the remit of the current study, but would provide a solid platform for detail study of specific issues such as stock breeds, plant varieties, seasonal sowing and grazing timings and so on. This is particularly true of material relating to small-scale arable, upland grazing (ffridd section) and reedbeds. For example detailed accounts in the following source types hold key information:
   - Historical agricultural reviews and treatises on agriculture and improvement in Wales (eg the Board of Agriculture accounts);
   - Archival records of selected County / Regional Public Record Offices and of the National Library of Wales, Aberystwyth;
   - Agricultural Societies' reports;
   - Relevant volumes of the Annals of Agriculture;

4. Further work would be usefully carried out on a selection of those of the ten practices which have been demonstrated to have greatest biodiversity benefits, including small-scale arable, upland grazing (ffridd section), reedbeds and 'catchwork'(valley side) water meadows. The need for further research into small-scale, low-technology, water power systems, including field observations has been highlighted.

5. We have identified a number of organisations and individuals who could be productively approached for further information. These include:
   - David Stephens: re water meadows and open field systems in Wales.
   - Archives of National Museum and Galleries of Wales (NMGW) St Ffagan's. Extensive collections highly relevant to most of the practices highlighted by this report. Discussion with ecologists at NMGW.
   - Peter Jones CCW – re peatlands
   - Trefor Owen – formerly NMGW St Ffagan's
   - Professor Moore-Colyer, University of Aberystwyth
   - Twm Elias (editor *Fferm a Thyddyn*), Snowdonia National Park Centre, Plas Tan y Bwlch re Welsh agricultural terms

6. Full investigation of pictorial material has been beyond the scope of the project. Searches of the collections of the Reading Rural History Centre and St Ffagan's has highlighted the potential of this source of material (for example as sole records of particular technologies, techniques and implements accompanying land-use practices; as a document of dress and customs; as a dating technique; as a historical document in their own right, and as a source of presentation and interpretative material. This area is considered to be of great potential and should be drawn upon in any future phase of the project.

7. Fieldwork. Foot and Mouth Disease restrictions prevented any fieldwork being carried out through the current project. However, site visits are needed to carry forward some of the observations of the study. For example, visits to waterpower features (mills, ponds etc) would confirm their possible biodiversity value and potential. This is particularly important in terms of making specific recommendations for Tir Gofal.

8. The potential relationship between organic farms, traditional practices (extensive agricultural systems) and biodiversity benefits.

9. Oral sources of information where possible, within the projects time-scale. Assessment of the potential of oral history sources was beyond the remit of the current project but should be made as part of further work. It is thought that this area would be particularly useful in terms of small-scale arable farming.

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APPENDICES

Appendix 1 –

Abbreviated Gazetteer of Historic Landuse Practices

Broad land-use type	Land-use management type	Land-use management practice	Rural industry / product
WOODLAND			
	wood extraction	cropping	controlled burning, e.g. charcoal burning, 'white-coal' production for lead industry etc and oil and acid distillation
		coppicing	Timber for use in a wide range of rural and industrial contexts, including pitwood (initially hardwoods, mainly oak, later import and domestic pine and larch), fuel either directly or after processing, such as charcoal burning, production of oils and acid
		gathering and cropping	timber for uses as above.
		pollarding	timber and foliage
		osier growing	basket and lobster pot making etc
		bark stripping	tanning
	wood pasture	stock grazing / shelter	stock (food and by -products)
	pannage	fattening pigs in woodland	stock (food and by -products) / scrubbing up and turning soil
	exploitation of non-timber resources	gathering and cropping	foodstuffs including berries, mushrooms and nuts
	creation and promotion of game habitats	copses planted and maintained as game cover	game for hunting
ORCHARDS			
	Cultivation of fruit trees	arboriculture, harvesting	fruit, pressing - cider and perry making
	Cultivation of nut producing trees	arboriculture, harvesting	nuts e.g. hazel nuts
PASTURE			
	Ffridd (enclosed upland grazing)	seasonal grazing and dairying	fodder/meat (beef/lamb/mutton), dairying, by-products (hides, wool, etc)
	Open upland and mountain grazing	grazing	fodder/meat (beef/lamb/mutton), dairying, by-products (hides, wool, etc)
	Rough grazing (including saltmarsh and rhos)	grazing	fodder/meat (beef/lamb/mutton), dairying, by-products (hides, wool, etc). store cattle and lambs – lowland farming – breeding stock for lowlands
	Stinting (temporary grazing enclosures)	manuring	fertilising land
MEADOW			
	Hay meadows	Seasonal grazing and manuring (possible seasonal stinting of animals), seasonal stock exclusion. Mowing, drying, stacking.	Hay as fodder. Rick making and rick thatching.
	Water meadows	Controlled flooding, seasonal grazing and manuring (possible seasonal stinting of animals), seasonal stock exclusion. Mowing, drying, stacking.	Hay as fodder. Rick making and rick thatching.
HEATHLAND AND OPEN MOUNTAIN			
	Bracken (annual harvesting)	cutting	Used as bedding, and in production of potash for soap manufacture
	Heather harvesting (broom)	cutting	Thatching, rope making and other rural crafts
	Gorse harvesting	Cutting, transporting and milling	fodder
	Paring	turf cutting	fuel
	Rough grazing (rhos)	grazing, burning (in some areas: encourages growth of young shoots preferred by stock)	fodder/meat (beef/lamb/mutton), dairying, by-products (hides, wool, etc)
	Game habitats	burning of heather moorland to encourage browse for grouse etc	game
ARABLE			
	Crop husbandry	sowing (broadcasting, drilling etc) and planting	crops: variety of produce including roots and grain (legumes, wheat etc) for human and animal (oats, beats, rape-seed etc) consumption as well as to provide materials for crafts and industries (hemp, flax, woad, linseed, wheat straw as thatch etc)
		fertilising / manuring	fertile land
		harvesting (scything, mowing, digging etc)	grain, roots etc

		crop processing (drying, threshing, milling, storage)	food / materials
		crop rotations	maintenance of soil fertility and productivity
		plough cultivation (mould-board plough, ard, iron plough shares, mechanisation etc)	Breaking earth : aeration, mixing, etc
		spade cultivation	Soil preparation
		deliberate terracing (as opposed to lyncheting)	Prevention of erosion, creation of flat surface for cultivation, creation of greater surface area for cultivation.
		Field clearance: creation of cairns, consumption walls etc.	Increasing area available for cultivation (or grazing), and facilitating ploughing etc.
PARKLAND			
	Ornamental plantings and layouts alongside other land-use types (such as woodland and grazing)	arboriculture, landscape gardening etc	Designed landscapes. Miscellaneous products. Timber
	Wood pasture as above	_	
	Woodland activities as above	_	
	Grazing as above	_	
	Creation and promotion of game habitats	copses planted and maintained as game cover	
WETLAND			
	Peat cutting / turbary	cutting, stacking and drying	fuel (and occasionally as building / roofing material)
	Historic large scale (commercial) peat extraction	cutting, stacking and drying	fuel / horticultural material
	Rough grazing (including saltmarsh, *waun*, etc)	grazing, burning (in some areas: encourages growth of young shoots preferred by stock)	fodder/meat (beef/lamb/mutton), dairying, by-products (hides, wool, etc)
	Drainage	Cutting and maintenance of ditches, dykes, reens (Gwent Levels, Malltraeth) etc	Maintenance of arable or pasture land
		Laying of field drains	Maintenance of arable or pasture land
	Land reclamation	Cutting and maintenance of ditches, dykes, reens (Gwent Levels, Malltraeth) etc	Creation of new pasture or arable land
	Rush harvesting	cutting, stacking and drying	Thatching
		cutting, stacking and drying	Bolster making (?)
	Reed harvesting		Thatching
			Mat making
	Game habitats	creation and maintenance of wildfowl habitats: ponds, reed / rush stands. Also, decoys, hides etc	Hunting / fowling. Game
FRESHWATER and WATER POWER			
	Fish ponds	digging, puddling, maintenance of ponds and water supply	Fish (e.g. carp)
	Game habitats	Creation and maintenance of fish and wildfowl habitats: ponds, lakes, rivers, reed / rush stands. Also, decoys, hides etc	Hunting / fishing / fowling. Game.
WATER POWER			
	Control and storage of water supply as source of power	Industrial water power (ponds, leats, races, wheel pits etc as potential habitats)	Power in quarries and mines (inclines, cutting mills, pit-head haulage gear etc). Also smithies.
		Agricultural water power (ponds, leats, races, wheel pits etc as potential habitats)	Power for corn mills, *pandai* (fulling mills), gorse mills (often domestic mills on farms), paper mills etc.
MARINE: OPEN SEA AND INTER-TIDAL ZONE			
	seaweed harvesting		Kelp industry (potash for glass making), food: 'laver' bread, use as a fertiliser.
	fishing	fishing: fish weirs / traps (inter-tidal) and netting (open sea)	fish (herring, cod, mackerel etc)
	shellfish harvesting	propagation, gathering	shellfish: cockles, mussels, lobster, crab etc
	tidal water as source of power	tidal mills	power
DUNE SYSTEMS			
	Marram grass	cutting	Mat and rope making
BOUNDARIES			
	Enclosing / bounding land to enclose or exclude stock, plants, people	hedgerows, walls, cloddiau, slate fences, earth banks, ditches etc	construction and maintenance of boundaries
	Growth of gorse on cloddiau and earth banks	maintenance and occasional cropping	gorse as barrier to stock (plus occasional cropping and milling as fodder)

	Exploitation of wild food resources	Gathering and promoting wild foodstuffs	soft fruit / berry collection
	Major geo-political boundaries (ancient parish boundaries, Commote boundaries, County boundaries, Cistercian grange boundaries, estate boundaries of the Welsh Princes).	Construction and maintenance	Physical and symbolic boundaries
QUARRYING / MINING			
	Active and disused quarries	Small scale quarrying / field stone gathering	building / walling materials
		Large scale stone quarries	building / walling materials
		Metalliferous mines	ore
MISCELLANEOUS			
	Bee keeping	Apiary	Honey
	Warrens (occurred on a number of different land-use types including: rough grassland, heathland and dune systems).	creation and maintenance of artificial warrens	meat (rabbit)
	"Wild food"	Collection and / or harvesting	A wide range of food products from "laver" to mushrooms or gulls eggs

Appendix 2 –

Scarce arable weeds in Wales

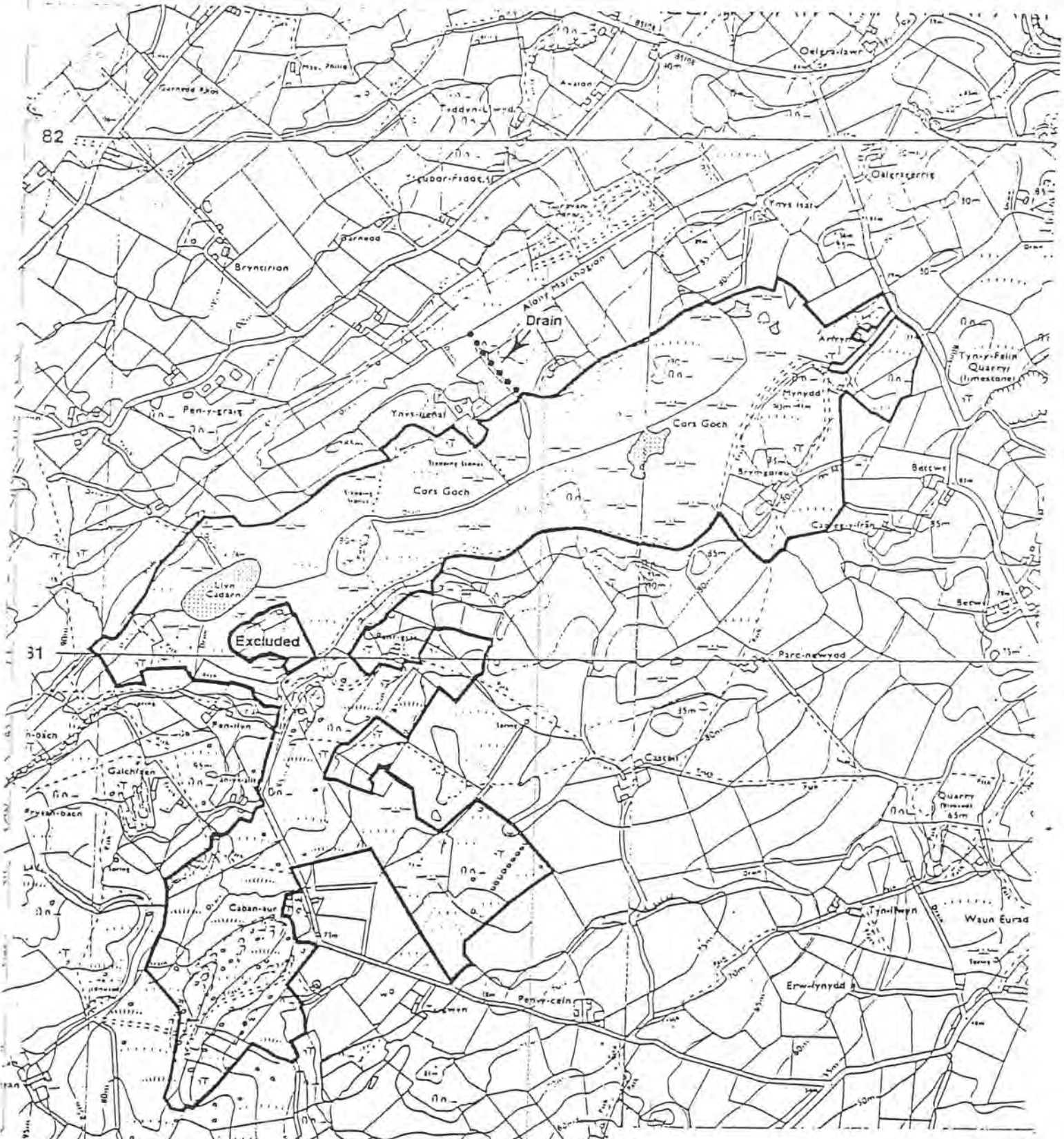
Scientific Name	Common Name (English)	Welsh Name	STATUS (no. of 10 km sq)	
			Ellis (1983)	Stewart et al (1994)
Adonis annua	Pheasant's Eye	Llygad y Goediar Gwanwynol	8	NS
Buglossoides arvensis	Corn gromwell	Maenhad yr Âr	33	NS
Centaurea cyanus	Cornflower	Penlas yr Yd	59	9[a]
Euphorbia platyphyllos	Broadleaved spurge	Fflamgoed Lydanddail	4	X
Fumaria bastardii	Tall ramping fumitory	Mwg y Ddear Grymus	89	155
F. *densiflora*	Dense-flowered fumitory		2	X
Galeopsis angustifolium	Red hemp nettle	Penboeth Gulddail	36	2
Papaver argemone	Prickly Poppy	Pabi Hirben Gwrychog	36	c8
Petroselinum segetum	Corn Parsley	Eilun Berllys	20	NS
Ranunculus arvensis	Corn Buttercup	Crafanc yr Yd		1?
Scandix pecten-veneris	Sheperd's needle	Nodwydd y Bugail	47	X
Silene gallica	Small-flowered catchfly	Gludlys Brutanaidd	59	19
S. *noctiflora*	Night-flowering catchfly	Gludlys Nos-flodeuol	19	5
Torlis *arvensis*	Spreading hedge-parsley	Troed-y-Cyw Clymog	5	c4
Valerianella dentata	Narrow-fruited cornsalad	Gwylaeth yr Oen Deintiog	61	X

X = no known records in this period
NS = not a scarce species in the UK i.e 16-100 10 km sq.

For Stewart *et al* (1994) all records are for the period 1980-1992, except *Torlis arvensis* which is pre-1970.
Distributions of these plants are shown in Ellis (1983) Perring and Walters (1982) and Stewart et al (1994)

Appendix 3 -

SSSI Citations



NATURE CONSERVANCY COUNCIL			
File 3001211	Date	Drawn by EMG	
Site CORS GOCH			
Drawing one NATURE CONSERVATION REVIEW SITE			
Reference SH58	Scale 1:10,000		
KEY NCR Grade Site shown thus ———			

ANGLESEY

CORS GOCH SSSI

Date of Notification: 1957, 1983, 1990
National Grid Reference: SH497813

O.S. 1:50000 Sheet Number 114
1:25000 Sheet Number SH48, SH58

Area: 54.4 hectares (134.4 acres)

Description

Cors Goch is a nationally important valley mire developed in a hollow in Carboniferous Limestone. The geology is complex and interstratified with the limestone are beds of a coarse pebbly sandstone. In close proximity are found acidic heaths with heather Calluna vulgaris and pale dog-violet Viola lactea, limestone grassland with green-winged orchid Orchis morio and base rich fen. The fen is almost divided by a rock promontory into an east and a west basin. The east basin is very wet with an excellent association of 'brown mosses', black bog-rush Schoenus nigricans with sedges Carex spp and with communities dominated by great fen-sedge Cladium mariscus, common reed Phragmites australis and blunt-flowered rush Juncus subnodulosus. Higher areas in the fen have acidic vegetation with bog mosses Sphagnum papillosum and S. plumulosum. Around the margin bog-myrtle Myrica gale forms a zone with black bog-rush Schoenus nigricans. The western basin is somewhat drier, but contains similar fen communities, and a lake Llyn Cadarn, which has an interesting hydrosere with bulrush Typha latifolia common club-rush Schoenoplectus lacustris and water-lilies Nymphaea alba and Nuphar lutea. The fen has a rich insect fauna, the Lepidoptera and Odonata being well represented.

Disgrifiad

Cors dyffryn pwysig yw'r Cors Goch sydd wedi datblygu mewn ceunant o galchfaen Garbonifferaidd. Mae'r ddaeareg yn gymhleth, ac ymhlith y galchfaen ceir gwelyau o dywodfaen raenog gwrs. Yn agos iawn at ei gilydd ceir tir grug asidig lle ceir grug Calluna vulgaris a'r fioled Viola lactea, tir porfa calchfaen lle ceir tegeirian yr waun Orchis morio a ffen cyfoethog. Mae'r ffen wedi ei rhannu bron gan benrhyn creigiog yn fasn i'r dwyrain a'r gorllewin. Mae'r basn dwyreiniol yn wlyb iawn gyda chasgliadau gwych o "Fwsogl brown", y gorsfrwynen ddu Schoenus nigircans a hesg Carex spp a chasgliadau o'r llemfrwynen Cladium mariscus, cyrs cyffredin Phragmites australis a brwyn Juncus subnodulosus. Yn y mannau uwch ar y ffen ceir planhigion asidig gan gynnwys mwsogl y gors Sphagnum papillosum a S. plumulosum. O gwmpas ymyl y gors ceir helygen Mair Myrica gale a y gorsfrwynen ddu Schoenus nigricans. Mae'r basn gorllewinol beth yn sychach, ond mae yma eto gymunedau'r gors tebyg i'r ddwyreiniol. Mae'r llyn, sef Llyn Cadarn a llysieuaeth Schoenoplectus lacustris a dau fath o lili'r dwr Nymphaea alba a Nuphar lutea. Mae'r gors yn gyfaethog mewn gwahanol fathau o bryfetach yn enwedig y Lepidoptera a'r Odonata.

Remarks

1. It is listed as a Grade 1 site in 'A Nature Conservation Review' ed by D A Ratcliffe C.U.P, 1977.
2. The site boundary has been modified.
3. A major part of the fen, with limestone grassland and acidic heathland is managed as a nature reserve by the North Wales Wildlife Trust.

Sylwadau

1. Fe'i rhestrwyd fel safle Gradd 1 yn 'A Nature Conservation Review' cyh gan D A Ratcliffe, C.U.P, 1977.
2. Mae ffin y safle wedi ei newid.
3. Mae rhan fwyaf o'r ffen, ynghyd a'r tir porfa calchfaen a'r tir grug asidig, yn cael ei reoli fel gwarchodle natur gan Cymdeithas Byd Natur Gogledd Cymru.

WEST GLAMORGAN

LLETHRID VALLEY

Swansea District

Local Planning Authority	Swansea City Council
Date of Notification:	1961, 1986
National Grid Reference:	SS 535900
O.S. 1:50,000 Sheet No:	159
1:25,000 Sheet No:	SS 59

Site area: 95 hectares (234.5 acres)

Description:

The site covers the complete dry valley of Llethrid together with the sinkhole, resurgence and intervening caves of the underground drainage system. It is an excellent example of the Gower karst with well preserved surface morphology and associated underground features extending across the entire width of the narrow karsted limestone outcrop.

Remarks

Within Gower AONB.

DATE OF NOTIFICATION
27 OCT 1986

WEST GLAMORGAN HAFOD WENNOL GRASSLANDS SSSI

Borough of Lliw Valley

Local Planning Authority: Lliw Valley Borough Council

Date of Notification: 6 December 1993

National Grid Reference: SN 678093

OS: 1:50,000 Sheet No: 159
1:25,000 Sheet No: SN 60

Site Area: 18 hectares (44.6 acres)

Description

Hafod Wennol Grasslands consist of an extensive series of hay meadows, pastures and rough grazings situated approximately 6 km south-east of Ammanford. The site lies at an altitude of 210 - 260 metres on Mynydd-y-Betws and is drained by the Nant Melyn, a headwater tributary of the Lower Clydach River. Most of the land slopes gently to the south and supports brown podzols and gleyed soils derived from boulder clay overlying sandstone of the Upper Pennant Measures.

These meadows and pastures have long been managed using traditional farming methods and form the third largest example of lowland neutral grassland in West Glamorgan and Llanelli Borough. Unimproved grassland of this type and quality supporting such a wide range of uncommon plant species is increasingly scarce in Wales.

A wide range of grassland and mire communities occur within the site including dry hay meadow, rush pastures and flushes, purple moor grass mire, with smaller areas of fen-meadow and swamp. These habitat mosaics are enhanced by the presence of hedgerows and scattered scrub with peripheral areas of broadleaved woodland.

Approximately half the site (9.8 ha) consists of dry neutral and lightly flushed grassland characterised by crested dog's-tail (Cynosurus cristatus) and common knapweed (Centaurea nigra), with common bent (Agrostis capillaris) and sweet vernal-grass (Anthoxanthum odoratum), plus a wide range of herbaceous associates including meadow vetchling (Lathyrus pratensis), oxeye daisy (Leucanthemum vulgare), rough hawkbit (Leontodon hispidus), yellow-rattle (Rhinanthus minor) and common spotted-orchid (Dactylorhiza fuchsii).

Notable plant species recorded in this community include broad-leaved marsh-orchid (Dactylorhiza majalis), greater butterfly-orchid (Platanthera chlorantha), adder's-tongue (Ophioglossum vulgatum), pale sedge (Carex pallescens), great burnet (Sanguisorba officinalis), petty whin (Genista anglica) and whorled caraway (Carum verticillatum).

The remainder of the site is dominated largely by mire communities of purple moor grass (Molinia caerulea), frequently with cross-leaved heath (Erica tetralix) characteristic of damper poorly drained areas. Several small stands of fen meadow occur in these rough grazings, creating interesting vegetation transitions dependent upon drainage patterns. Additional notable species recorded here include meadow thistle (Cirsium dissectum).

The marsh fritillary butterfly (Eurodryas aurinia) has also been recorded from this site.

Remarks:
New site on county boundary.

POWYS
Radnor District

MARCHEINI UPLANDS, GILFACH FARM AND GAMALLT SSSI

Date of Notification: February 1988

National Grid Reference: SN 957733

O.S. 1:50,000 Sheet No: 147
1:25,000 Sheet No: SN 97

Site Area: 810.0 hectares (2001.6 acres)

Description:

This site is of outstanding ornithological interest because of the range of breeding bird species occurring on the upland plateau sheepwalks and craggy hill slopes, and in woodlands varying from scattered scrub to well developed sessile oak wood. The area is of additional importance because of its representation of blanket mire, heather moorland, western gorse heathlands, lichen-rich rock outcrops and the occurrence of rare species.

The site supports such a remarkable assemblage of breeding bird species because of the variety, extent and juxtaposition of scrub, woodland and upland habitat. Species breeding in woody habitat include birds of prey such as buzzard and sparrowhawk, tawny owl, three species of woodpecker, pied flycatcher, spotted flycatcher, redstart, wood warbler, garden warbler and blackcap. The surrounding upland and wetland habitats provide breeding habitat for birds such as curlew, ring ouzel, dipper and grey wagtail. Red grouse breed on the high moorland and rare raptors, including peregrine falcon and red kite, hunt over the land.

Wyloer Hill and Gamallt support extensive areas of western gorse Ulex gallii on their south and west facing slopes. Heather Calluna vulgaris is extensive and dominant on Gamallt, but though represented on Wyloer this latter hill is predominantly a mosaic of acid grassland and bracken Pteridium aquilinum. The western (fridd) slopes of Gareg-lwyd are a similar grassland type, but with scattered hawthorn Crataegus monogyna bushes forming a generally sparse shrub component, particularly in association with the crags. This upland edge fridd is a very characteristic habitat mosaic of great value for species such as redstart, whinchat and wheatear. The Wyloer cliffs and rock outcrops comprise Tarannon and Llandovery Shales mud-stones and grits, which support one of the richest assemblages of lichens for this rock type recorded in mid-Wales. A number of locally and nationally uncommon species occur, forming good examples of sunloving lichen communites, but with a more montane element also represented. Although modified by current agricultural usage, moorland on Drysgol is an important component of the ornithological habitat. It grades into an outstanding example of watershed mire at Waun Goch, in which the nationally uncommon species, bog rosemary Andromeda polifolia, occurs. There are valley mires at the headwaters of the Marcheini Fawr and blanket bog and dwarf-shrub heath on Pyllau Clais.

Running through the southern part of the site is the River Marteg, a major tributary of the Wye. It falls steeply in a series of pools, riffles and occasional waterfalls. The banks are tree-lined, and species-rich alder carr is well developed. The deep rock gorge provides ledges free from grazing by stock, and the high humidity favours atlantic or sub-atlantic moss and liverwort species. With over one hundred moss and liverwort species and a good range of flowering plants, ferns and lichens, the river and gorge is a particularly valuable wildlife habitat. The river is noted for its otters. The steep valleys of the Marcheini Fawr and Marcheini Fach are also important, with good dwarf-shrub vegetation, rock outcrops and their variety of upland bird species.

Allt-goch Wood is included as a good example of grazed sessile oakwood with a typical spectrum of bird species associated with woodland and the adjacent uplands. The abundance of natural holes has resulted in good populations of pied flycatchers and redstarts. The mixture of woodland types on Gilfach Farm and the small fields among the bands of woodland containing varied hedgerows, isolated trees and patches of scrub, all greatly contribute to the ornithological interest. The inclusion of the adjacent conifer plantation adds to the variety of species present.

Remarks:

Gilfach Farm (153 ha, 378 acres) is owned by the Radnorshire Wildlife Trust.

GWYNEDD/ARFON

COEDYDD ABER
SSSI

Date of notification: 1957, 1985

National Grid Reference: SH665710

.S. 1:50000 Sheet Number: 115
1:25000 Sheet Number: SH66 and SH67

Site area: 185 hectares (457 acres)

Description

This site contains a range of native broadleaved woodlands, open hawthorn (Crataegus monogyna) scrub, submontane heaths, acidic grasslands, a precipitous upland river (the Afon Rhaeadr Fawr) and the associated Aber Falls with its rich Atlantic bryophyte flora.
Coedydd Aber is a large representative example of a Ranunculus repens - Quercus/Alnus (creeping buttercup - oak/alder) type woodland and is partly ancient. In character it varies from dry sessile oakwood (Quercus petraea) through mixed broadleaved woodland including ash (Fraxinus excelsior) and wych elm (Ulmus glabra) to wet alderwood (Alnus glutinosa) on the flatter valley floor. Wind-pruned oakwood and ungrazed cliff woodland are also represented. Uncommon plant species recorded include wood fescue (Festuca altissima) and the bryophytes Fissidens rufulus, Hygrohypnum dilatatum and Philonotis rigida. The epiphytic lichen flora is one of the most interesting in North Wales and the fungal flora is also diverse. There is a varied bird fauna including breeding populations of wood warbler, pied flycatcher and redstart. The pine marten also reputedly occurs. The Afon Rhaeadr Fawr is one of Britain's most precipitous rivers outside Scotland and is considered to be of national importance as a representative of this habitat type.

Disgrifiad

Y mae Coedydd Aber yn safle pwysig gan gynnwys amrediad o goed llydan-ddail, prysg agored o ddrain gwynion (Crataegus monogyna), rhosydd is-fynyddig, tir glas asidig, ac afon o'r ucheldir a ddisgyn dros ddiffwys sef Afon Rhaeadr Fawr ynghyd â Rhaeadr Aber â'i fflora bryophyte Iwerydd cyfoethog.
Mae Coedydd Aber yn enghraifft fawr gynrychiadol o'r math o goedwig a elwir yn Ranunculus repens-Quercus/Alnus (Crafanc y frân rhedegog-derw/gwern) ac mae'n rhannol hynafol. Ceir amrywiaeth o goed o'r coed derw ddigoes (Quercus petraea) ar dir sych yna'r coed llydanddail cymysg gan gynnwys yr onnen (Fraxinus excelsior) a'r lwyfen lydanddail hyd at y coed gwern (Alnus glutinosa) ar dir gwlyb mwy gwastad ar lawr y dyffryn. Gwelir ôl tocio gan y gwynt ar ran o'r coed derw, a cheir rhai coed yn tyfu ar glogwyn nas gall anifeiliaid pori eu cyrraedd. Cofnodwyd rhywogaethau o lysiau anghyffredin megis peisgwellt y gwisgoedd (Festuca altissima), a'r bryophytau canlynol Fissidens rufulus, Hygrohypnum dilatatum a Philonotis rigida. Y mae fflora'r cen epiffityg gyda'r mwyaf diddorol yng Ngogledd Cymru ac mae hefyd amrywiaeth dda o fflora ffyngoedd. Ceir amrywiaeth dda o adar gan gynnwys poplogaeth nythu o delor y coed, y gwybedog brith a'r dingoch. Y mae son fod y bele i'w gael yma. Ystyrir Afon Rhaeadr Fawr o bwys cenedlaethol gan y cynrychiola fath arbennig o gynefin. Oddigerth afonydd yr Alban, hi yw un o afonydd mwyaf diffwysol Prydain.

Remarks

(1) It is listed as a key site in a 'Nature Conservation Review'.
(2) The major part of the SSSI (169 ha) is managed by the NCC as a National Nature Reserve (NNR).
(3) It lies in the Snowdonia National Park.

Sylwadau

(1) Rhestrir yn 'Arolwg Gwarchod Natur' fel safle allweddol.
(2) Rheolir y rhan helaethaf o'r SDGA (169 ha) gan y CGN fel Gwarchodfa Natur Cenedlaethol (GNC).
(3) Lleolir ym Mharc Cenedlaethol Eryri.