CYNGOR CEFN GWLAD CYMRU
COUNTRYSIDE COUNCIL FOR WALES

CORE MANAGEMENT PLAN
INCLUDING CONSERVATION OBJECTIVES

FOR

CAEAU MYNYDD MAWR SPECIAL AREA OF CONSERVATION (SAC).

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Approved by: Tracey Lovering

More detailed maps of management units can be provided on request.
A Welsh version of all or part of this document can be made available on request.

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

NATURA 2000

Ramsar

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PREFACE

This document provides the main elements of CCW's management plan for the site named. It sets out what needs to be achieved on the site, the results of monitoring and advice on the action required. This document is made available through CCW's web site and may be revised in response to changing circumstances or new information. This is a technical document that supplements summary information on the web site.

One of the key functions of this document is to provide CCW's statement of the Conservation Objectives for the relevant Natura 2000 site. This is required to implement the Conservation (Natural Habitats, &c.) Regulations 1994, as amended (Section 4). As a matter of Welsh Assembly Government Policy, the provisions of those regulations are also to be applied to Ramsar sites in Wales.

1. VISION FOR THE SITE

This is a descriptive overview of what needs to be achieved for conservation on the site. It brings together and summarises the Conservation Objectives (part 4) into a single, integrated statement about the site.

Caeau Mynydd Mawr SAC lies at the centre of a wider area that sustains one of Wales' most important populations of the marsh fritillary butterfly. The butterfly functions in a metapopulation - a group of local populations connected by migrating individuals. The marsh fritillary requires large areas of continuous or closely connected habitat to survive in the long term, so this SAC is vital to supporting the marsh fritillary across the landscape stretching from Cwmgwili to Llyn Llech Owain Country Park. That is why the marshy grassland and other habitats in the SAC will be managed primarily for the benefit of this endangered butterfly.

Marshy grassland will cover the site, occupying at least 80% of the total site area. It will form a varied mosaic of habitats with areas of wet heath along with dry acidic and unimproved neutral grassland. There will also be a mix of community structures and heights, 8-25cm tall in autumn, at the end of the grazing season. This tussocky sward meets the needs of the marsh fritillary eggs and larvae for shelter and warmth.

There will be a strong population of devil's-bit scabious, which is the principal food plant of marsh fritillary caterpillar. Large-sized plants should be widespread and abundant throughout the site, creating a shimmering purple haze as it flowers in late-summer, and supplying nectar for a wide variety of insects at a time when most other flowering plants have gone to seed.

Most of the marshy grassland will be dominated by purple moor-grass with plenty of tormentil, and the delicate white flowers of whorled caraway should be frequent in the grassland in midsummer. A variety of grasses such as sweet vernal grass, red fescue and bents should be common. Other common species will include sharp-flowered rush, carnation sedge and greater bird's-foot trefoil. The remainder of the marshy grassland will be rush dominated and feature a range of herbs, including plenty of sneezewort, wild angelica and ragged robin.

Within the marshy grassland, a rarer fen meadow community with abundant meadow thistle must cover at least 10% of Caeau Ffos Fach and Broad Oak and Thornhill Meadows SSSIs; smaller patches should occur at Caeau Lotwen SSSI. The thistle is an important nectar source for the marsh fritillary adults in June.

The small areas of unimproved neutral grassland will also be species rich, including common bent, red fescue, common knapweed, common bird's-foot-trefoil and heath grass. The patches of acid grassland will contain plenty of tormentil, sheep's fescue, bent and heath bedstraw; this should cover at least 5% of Broad Oak and Thornhill Meadows SSSI, with smaller amounts on the other component SSSIs.

The wet heath will feature cross-leaved heath and heather throughout, with heath-spotted orchid. Most of the heath will be short and open enough for smaller plants such as bog pimpernel, bog asphodel, Sphagnum moss and short sedges to grow.

Species indicative of agricultural modification, such as rye grass, should remain rare in the grassland. Scrub, trees and hedgerows provide important shelter for the marsh fritillary butterflies, but should cover no more than 10% of the site area, leaving plenty of open grazed grassland.

2. SITE DESCRIPTION

2.1 Area and Designations Covered by this Plan

Grid reference: SN575121

Unitary authority: Carmarthenshire

Area (hectares): 25.06 ha

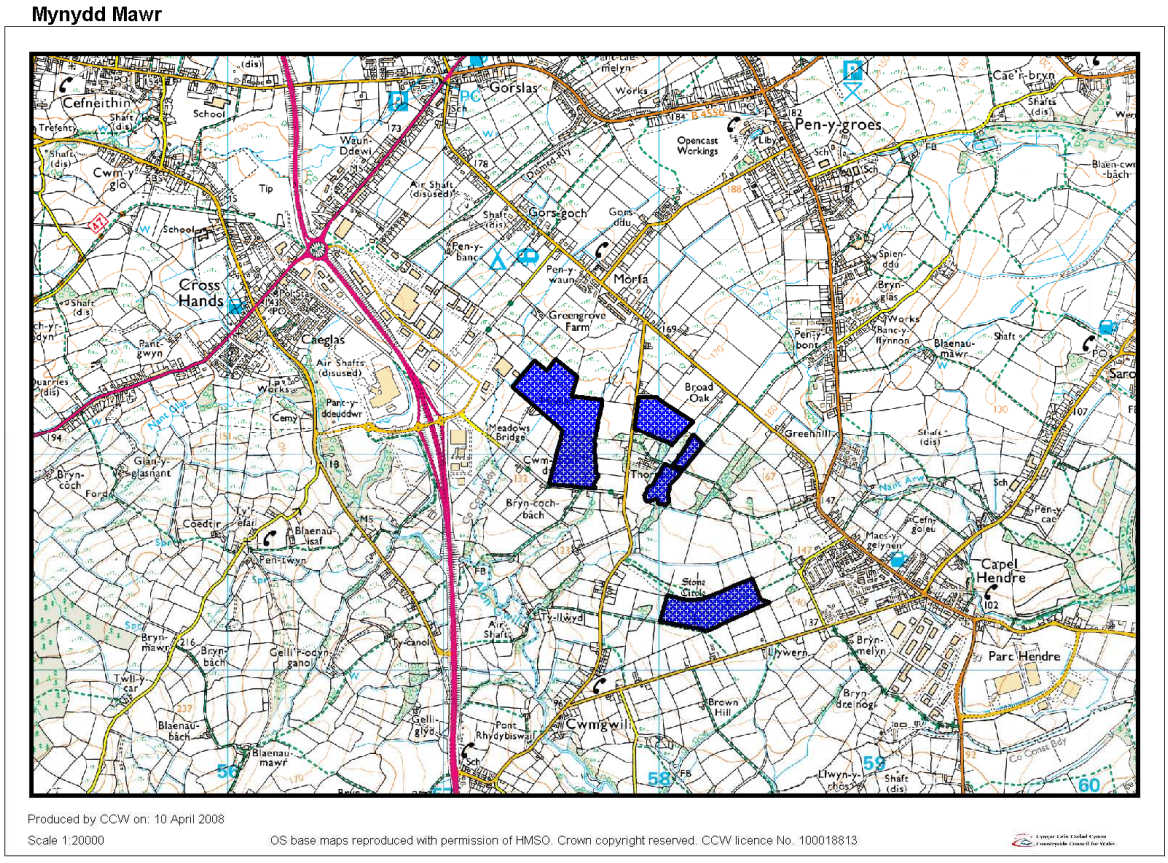
Designations covered:

Caeau Mynydd Mawr SAC is notified as three component SSSIs:

- Caeau Ffos Fach SSSI
- Broad Oak & Thornhill Meadows SSSI
- Caeau Lotwen SSSI
    i. 3 northern fields included in the Caeau Mynydd Mawr SAC
    ii. southern SSSI field has not been included in the SAC, and is therefore not included within this plan

Detailed maps of the designated sites are available through CCW's web site: http://www.ccw.gov.uk/interactive-maps/protected-areas-map.aspx

A summary map showing the coverage of this document is shown below:



2.2 Outline Description

This is the only SAC selected to represent the marsh fritillary butterfly **(***Euphydryas aurinia*)and *Molinia* meadows (on calcareous, peaty or clayey-silt-laden soils *Molinion caeruleae***)** in Carmarthenshire, and it is one of the major strongholds for the marsh fritillary in Wales and the UK. The *Molinia* meadows, characterised by the NVC type M24 *Molinia caerulea – Cirsium dissectum* fen-meadow, occur within a mosaic of more extensive stands of *Molinia* (M25), along with smaller areas of wet heath, acidic and dry neutral grassland.
The three component SSSIs are not contiguous, but stretch across an area of approximately 27ha, separated by a road and semi-improved grassland.

2.3 Outline of Past and Current Management

Historically, the site has been used as grazing pasture for cattle and ponies. All of the fields are currently being grazed, except for Greengrove Farm (Caeau Ffos Fach SSSI). Broad Oak (Broad Oak & Thornhill Meadows SSSI) is usually cut annually for hay, as were a number of the other fields in the past. The current management of the Thornhill Meadows fields in uncertain, although it appears to be annually grazed by cattle.
Butterfly Conservation Reserve (Caeau Ffos Fach SSSI) and Broad Oak (Broad Oak & Thornhill Meadows SSSI) are subject to section 15 management agreements. Western fields (Caeau Lotwen SSSI) is subject to a Mynydd Mawr Project Management Agreement (Section 15). Details of current management issues are discussed in Section 6 below.

2.4 Management Units

The plan area has been divided into management units to enable practical communication about features, objectives, and management. This will also allow us to differentiate between the different designations where necessary. In this plan the management units have been based primarily on tenure, with reference to features and land management requirements. A map showing the locations of the management units is available on the site's web page.

The following table confirms the relationships between the management units and the designations covered:

Unit number	SAC	SSSI	CCW owned	Other
Caeau Ffos Fach				
1 Butterfly Conservation Reserve (BC)	✔	✔	**x**	**x**
2 Median Farm (MF)	✔	✔	**x**	**x**
3 Greengrove Farm (GG)	✔	✔	**x**	**x**
Broad Oak & Thornhill Meadows				
4 Broad Oak (BO)	✔	✔	**x**	**x**
5 Thornhill (TH)	✔	✔	**x**	**x**
Caeau Lotwen				
6 Western fields (WF)	✔	✔	**x**	**x**
7 Eastern field (EF)	✔	✔	**x**	**x**
8 Southern field (SF) Not included in plan		✔	**x**	**x**

3. THE SPECIAL FEATURES

3.1 Confirmation of Special Features

Designated feature	***Relationships, nomenclature etc***	***Conservation Objective in part 4***
SAC features		
Annex II species that are a primary reason for selection of this site 1. **Marsh fritillary butterfly *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia (EU Species Code: 1065)***	Referred to as 'Marsh Fritillary' throughout this document.	1
Annex I habitats that are a present as a qualifying feature, but not a primary reason for selection of this site 2. ***Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (EU Habitat Code: 6410)**		2
SSSI features		
3. **Marshy grassland**		3
4. **Unimproved neutral grassland**		4

3.2 Special Features and Management Units

This section sets out the relationship between the special features and each management unit. This is intended to provide a clear statement about what each unit should be managed for, taking into account the varied needs of the different special features. All special features are allocated to one of seven classes in each management unit. These classes are:

Key Features
KH - a 'Key Habitat' in the management unit, i.e. the habitat that is the main driver of management and focus of monitoring effort, perhaps because of the dependence of a key species (see KS below). There will usually only be one Key Habitat in a unit but there can be more, especially with large units.
KS – a 'Key Species' in the management unit, often driving both the selection and management of a Key Habitat.
Geo – an earth science feature that is the main driver of management and focus of monitoring effort in a unit.

Other Features
Sym - habitats, species and earth science features that are of importance in a unit but are not the main drivers of management or focus of monitoring. These features will benefit from management for the key feature(s) identified in the unit. These may be classed as 'Sym' features because:

a) they are present in the unit but may be of less conservation importance than the key feature; and/or
b) they are present in the unit but in small areas/numbers, with the bulk of the feature in other units of the site; and/or

c) their requirements are broader than and compatible with the management needs of the key feature(s), e.g. a mobile species that uses large parts of the site and surrounding areas.

Nm - an infrequently used category where features are at risk of decline within a unit as a result of meeting the management needs of the key feature(s), i.e. under Negative Management. These cases will usually be compensated for by management elsewhere in the plan, and can be used where minor occurrences of a feature would otherwise lead to apparent conflict with another key feature in a unit.

Mn - Management units that are essential for the management of features elsewhere on a site e.g. livestock over-wintering area included within designation boundaries, buffer zones around water bodies, etc.

x – Features not known to be present in the management unit.

The tables below set out the relationship between the special features and management units identified in this plan:

Caeau Ffos Fach	**Management unit**		
	1. BC	**2. MF**	**3. GG**
SAC	✔	✔	✔
SSSI	✔	✔	✔
NNR/CCW owned			
SAC features			
1. Marsh fritillary butterfly	**KS**	**KS**	**KS**
2. *Molinia* Meadows	**KH**	**KH**	**KH**
SSSI features			
1. Marsh fritillary butterfly	**KS**	**KS**	**KS**
3. Marshy grassland	Sym	Sym	Sym

Broad Oak and Thornhill Meadows	**Management unit**	
	4. BO	**5. TH**
SAC	✔	✔
SSSI	✔	✔
NNR/CCW owned		
SAC features		
1. Marsh fritillary butterfly	**KS**	**KS**
2. Eu Molinion meadows	**KH**	**KH**
SSSI features		
1. Marsh fritillary butterfly	**KS**	**KS**
3. Marshy grassland	Sym	Sym
4. Unimproved neutral grassland	Sym	Sym

Caeau Lotwen	**Management unit**	
	6. WF	**7. EF**
SAC	✔	✔
SSSI	✔	✔
NNR/CCW owned		
SAC features		
1. Marsh fritillary butterfly	**KS**	**KS**
2. Eu Molinion meadows	**KH**	**KH**
SSSI features		
3. Marshy grassland	Sym	Sym

The recommended grazing regime for the Marshy Grassland and the Marsh Fritillary is also sympathetic to requirements of the Neutral Grassland in Broad Oak and Thornhill Meadow SSSI (an SSSI feature, but not included in the SAC designation).

4. CONSERVATION OBJECTIVES

Background to Conservation Objectives:

a. Outline of the legal context and purpose of conservation objectives.

Conservation objectives are required by the 1992 'Habitats' Directive (92/43/EEC). The aim of the Habitats Directives is the maintenance, or where appropriate the restoration of the 'favourable conservation status' of habitats and species features for which SACs and SPAs are designated (see Box 1).

In the broadest terms, 'favourable conservation status' means a feature is in satisfactory condition and all the things needed to keep it that way are in place for the foreseeable future. CCW considers that the concept of favourable conservation status provides a practical and legally robust basis for conservation objectives for Natura 2000 and Ramsar sites.

Box 1
Favourable conservation status as defined in Articles 1(e) and 1(i) of the Habitats Directive

"The conservation status of a natural habitat is the sum of the influences acting on it and its typical species that may affect its long-term natural distribution, structure and functions as well as the long term survival of its typical species. The conservation status of a natural habitat will be taken as favourable when:

- Its natural range and areas it covers within that range are stable or increasing, and
- The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- The conservation status of its typical species is favourable.

The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:

- population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

Achieving these objectives requires appropriate management and the control of factors that may cause deterioration of habitats or significant disturbance to species.

As well as the overall function of communication, Conservation objectives have a number of specific roles:

- Conservation planning and management.

  The conservation objectives guide management of sites, to maintain or restore the habitats and species in favourable condition.

- Assessing plans and projects.

  Article 6(3) of the 'Habitats' Directive requires appropriate assessment of proposed plans and projects against a site's conservation objectives. Subject to certain exceptions, plans or projects may not proceed unless it is established that they will not adversely affect the integrity of sites. This role for testing plans and projects also applies to the review of existing decisions and consents.

- Monitoring and reporting.

  The conservation objectives provide the basis for assessing the condition of a feature and the status of factors that affect it. CCW uses 'performance indicators' within the conservation objectives, as the basis for monitoring and reporting. Performance indicators are selected to provide useful information about the condition of a feature and the factors that affect it.

The conservation objectives in this document reflect CCW's current information and understanding of the site and its features and their importance in an international context. The conservation objectives are subject to review by CCW in light of new knowledge.

b. Format of the conservation objectives

There is one conservation objective for each feature listed in part 3. Each conservation objective is a composite statement representing a site-specific description of what is considered to be the favourable conservation status of the feature. These statements apply to a whole feature as it occurs within the whole plan area, although section 3.2 sets out their relevance to individual management units.

Each conservation objective consists of the following two elements:

1. Vision for the feature
2. Performance indicators

As a result of the general practice developed and agreed within the UK Conservation Agencies, conservation objectives include performance indicators, the selection of which should be informed by JNCC guidance on Common Standards Monitoring[1].

There is a critical need for clarity over the role of performance indicators within the conservation objectives. **A conservation objective, because it includes the vision for the feature, has meaning and substance independently of the performance indicators, and is more than the sum of the performance indicators.** The performance indicators are simply what make the conservation objectives measurable, and are thus part of, not a substitute for, the conservation objectives. Any feature attribute identified in the performance indicators should be represented in the vision for the feature, but not all elements of the vision for the feature will necessarily have corresponding performance indicators.

As well as describing the aspirations for the condition of the feature, the Vision section of each conservation objective contains a statement that the factors necessary to maintain those desired conditions are under control. Subject to technical, practical and resource constraints, factors which have an important influence on the condition of the feature are identified in the performance indicators.

[1] Web link: http://www.jncc.gov.uk/page-2199

4.1 Conservation Objective for Feature 1:
Marsh fritillary butterfly Euphydryas (Eurodryas, Hypodryas) aurinia

Vision for feature 1

The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- The population will be viable in the long term, acknowledging the extreme population fluctuations of the species.
- Habitats on the site will be in optimal condition to support the metapopulation.
- The SAC populations will be the core of the metapopulation. The metapopulation will consist of the SAC populations plus populations breeding on land within c. 2 kilometres of the SAC boundary.
- At least 13 ha across the three component SSSIs will be marshy grassland suitable for supporting marsh fritillary, with *Succisa pratensis* present and only a low cover of scrub.
- At least 6 ha of this will be good condition marsh fritillary breeding habitat, where, for at least 80% of sample points, the tussocky vegetation is within the range of 12-25 cms tall and *Succisa pratensis* is present within a 50 cm radius sample point. Scrub (>0.5 m tall) covers no more than 10% of area.
- At least another 7 ha of this will be suitable condition marsh fritillary breeding habitat where *Succisa pratensis* is occasional/frequent/abundant and vegetation height is usually 12-25 cms. Scrub (> 0.5 m tall) will cover no more than 10% of the total area.
- The marshy grassland will be well sheltered by hedgerows and mature trees.
- All factors affecting the achievement of the foregoing conditions are under control.

Favourable Conservation Status of the metapopulation requires the appropriate management of a network of Potential, Suitable and Good Condition marsh fritillary habitat to include, at a minimum, 50 ha of suitable habitat within which 10 ha of Good Condition habitat is supported. Caeau Mynydd Mawr SAC cannot support the required criteria alone since the total area of the component SSSIs is too small (25.1 ha). It is stressed that the condition and status of the metapopulation remain dependant on the appropriate management of a network of well-managed sites rather than on one site, however large and well managed (A. Fowles, pers. comm. 2006). Component populations of a metapopulation must be within c. 2 kilometres of other populations for the metapopulation to function. The habitat of an individual SSSI or SAC may be assessed as in favourable condition if management objectives are met. However, unless the site/sites are large enough to support favourable conservation status of the metapopulation, the marsh fritillary remains in unfavourable condition. It should also be noted that constituent SSSIs and SACs may be unfavourable with particular regard to habitat when the meta-population is itself at Favourable Condition Status (Fowles, 2005, Lovering 2006).

Performance indicators for Feature 1

The performance indicators are part of the conservation objective, not a substitute for it. Assessment of plans and projects must be based on the entire conservation objective, not just the performance indicators.

Performance indicators for feature condition		
Attribute	***Attribute rationale and other comments***	***Specified limits***
A1. Density of larval webs	Research on population dynamics has demonstrated that marsh fritillary populations cycle between periods of high and low numbers. During peaks in the population cycle (c. one in every six years) it is estimated that a density of 200 larval webs per hectare of good condition habitat is an appropriate target for strong populations (Fowles, 2003). This figure is based on the Rhos Llawr Cwrt NNR long-term surveillance based on adult counts and larval web counts. Larval web density in a 'good' year for marsh fritillary has been identified as a measurable performance indicator of the population. During peaks in the population cycle a density of 200 webs per hectare of suitable habitat is an appropriate target to set as defining favourable condition for strong populations. The density of larval webs is estimated via transects running across the area of suitable habitat, counting all webs up to one metre either side of the transect. The transects should also be representative of the proportion of good to suitable habitat (see Feature 1 & 3 – Attribute 2). Wide fluctuations in abundance occur, with dramatic crashes in population size occurring every ten years or so. Recovery from these crashes may take 4 or 5 yrs.	*Upper limit*: Not required. *Lower limit*: In any year in 6 the number of larval webs is estimated to be: > 200 per hectare of Good Condition habitat
A2. Distribution of larval webs	The marsh fritillary occurs in metapopulations, where dispersal from a core population during good years permits colonisation of nearby habitat patches. Periodic extinctions and colonisations of patches will occur, and can be tolerated as long as sufficient habitat overall is in good condition for breeding.	*Upper limit:* not required *Lower limit:* Larval webs should be present every year on all three of the component SSSIs

Performance indicators for factors affecting the feature		
Factor	***Factor rationale and other comments***	***Operational Limits***
F1. Extent of habitat	The main larval food plant for the marsh fritillary is *Succisa pratensis*, especially large-leaved plants which are thought to be preferred by egg-laying females. **Good Condition** habitat describes grassland where, for at least 80% of sampling points, *Succisa pratensis* is present within a 50cm radius at >5% cover and vegetation height is 12-25cms. Scrub (>0.5 metres tall) covers no more than 10% of the area.	*Lower limit:* 12.9 ha of Available marsh fritillary habitat, including: 7 ha **Suitable Condition** and 6 ha **Good Condition** habitat.
F2. Condition of habitat	Based on the Standard CSM attribute for marshy grassland, but modified for the marsh fritillary habitat requirements. An additional lower limit has been set for the presence of *Succisa pratensis* as this is the host plant for the marsh fritillary butterfly. Limits for sward height in the late summer/ autumn have also been modified to ensure marshy grassland with a suitable vegetation structure is available for the marsh fritillary population. The marsh fritillary is a highly localised and sedentary butterfly that inhabits unimproved *Molinia* grassland in the lowlands. It has an annual life-cycle and feeds as a larva on *Succisa pratensis*, especially on large-leaved plants that are growing amongst vegetation that is between 10 and 20 cms tall in late summer/autumn. The larvae over-winter communally amongst litter in such situations and the shelter provided by leaf litter and tussocks is important.	*Upper limit*: Not required *Lower limit*: For at least 80% of sampling points and within a 50 cm radius of any point: • Tussock forming grass species are present. • *Succisa pratensis* is present at >5%. • Vegetation height is 12-25 cm at the end of the grazing season And Scrub (>0.5 m tall) is <5% within sampling area and <10% within field enclosure.
F3. Livestock grazing **F3.** Livestock grazing (cont.d)	The *eu-Molinion* marshy grassland has traditionally been maintained through grazing. Without an appropriate grazing regime, the grassland would become rank and eventually turn to scrub and woodland. Light grazing by cattle and ponies between April and November each year is essential in maintaining the marsh fritillary and the marshy grassland communities (see Feature 2)	*Lower limit*: The *Eu Molinion* grasslands will be subject to light summer grazing by cattle and/or ponies in at least 4 in every 5 years. Light summer grazing is defined as - cattle and/or ponies at a rate of 0.3 – 0.4 SU/ha/year for the period April to October (to be adjusted as necessary to achieve the desired vegetation height between 12-25 cm). *Upper limit*: The *Eu Molinion* grasslands will be subject to light summer grazing by cattle and/or ponies annually

Performance indicators for factors affecting the feature		
Factor	***Factor rationale and other comments***	***Operational Limits***
F4. Scrub		*Upper limit*: Scrub (>0.5m tall) to be controlled in any field when it exceeds 10% of area within that field enclosure
F5. Shelter belts	Hedgerows, woodland and mature trees in and around the site provide the sheltered conditions which the marsh fritillary require. These should be retained and managed.	On each component SSSI *Upper limit:* As limited by other habitat types *Lower limit:* at any given time least 80% of the existing mature hedgerows (over 4 metres tall) should be retained. The remaining 20% should be subject to a sustainable hedgerow management rotation, where appropriate. Any existing blocks of woodland should be retained.
F6. Hydrological regime	Refer to Feature 2 (*Eu Molinion* marshy grassland)	Refer to Features 2 & 3.
F7. Burning	Burning is a habitat management tool that may occasionally be used with great care and in limited areas only for the restoration of marsh fritillary habitat.	*Upper limit:* Burning should only be employed in the restoration of *Eu Molinion*/marshy grassland, in areas where marsh fritillaries are known not to breed. Areas where marsh fritillary are known to breed must be avoided. No more than 1/3 of a site should be burned in any one year

Other factors considered include –

Owner/occupier objectives – Some owners/occupiers of the land may have an interest in securing some financial/agricultural/ 'horsiculture' benefit from the land. This return could be optimised by the agricultural improvement of the land, e.g. by installing new drainage, fertiliser application, or re-seeding. However, these operations would cause significant long-term damage to the marsh fritillary habitat, namely the marshy grassland. This factor will be controlled through management agreements and the SSSI legislation. An operational limit is not required.

Weather conditions - Weather conditions have an effect on the breeding success of the marsh fritillary. In particular, poor weather conditions during the adult flight period will reduce opportunities for mating, egg-laying and dispersal from core areas. Weather conditions during early spring influence the rate of larval development of the marsh fritillary and the effects of the parasitic wasp (see below). This factor is outside the influence of the site manager and an operational limit is not required.

Parasitoids - The larvae of marsh fritillaries are often parasitised by species of braconid wasp of the *Cotesia* genus. The parasitoid numbers can periodically build up to infect a large number of larval webs, causing a crash in the subsequent adult populations of marsh fritillary. This factor is outside the influence of the site manager; and an operational limit is not required.

Metapopulations - The Mynydd Mawr Marsh Fritillary Project, funded by the Countryside Council for Wales and managed by Butterfly Conservation, was set up in April 2004 to identify areas of suitable habitat that could be managed for the marsh fritillary meta-population within the wider landscape surrounding Caeau Mynydd Mawr SAC. A survey to evaluate the habitat condition of an additional 83 fields using the landscape boundary definition in Fowles (2005) was undertaken in 2004-2005. The survey included all marsh fritillary habitat in the Mynydd Mawr area lying within a 1 km radius from post-1990 records. The survey followed a provisional assessment by Pryce Consultant Ecologists of marsh fritillary habitat in 2001 (Smith *et al.* 2002). Performance indicators have been set for the marsh fritillary butterfly metapopulation supported by Caeau Mynydd Mawr SAC and surrounding habitat (Lovering, 2006). The total area of Good Condition habitat available to the metapopulation is 8.7 ha (including 2.2 ha SAC habitat); this falls short of the target of 10 ha. The total area of Suitable Condition habitat, including 10.7 ha of SAC habitat, is 54.6 ha and is within the limits of the target of 50 ha (including 10 ha Good Condition habitat). Following guidance (Fowles, 2003) there is currently insufficient Good Condition habitat available to the metapopulation therefore the conservation status of the marsh fritillary metapopulation is assessed as Unfavourable.

4.2 Conservation Objective for Feature 2: *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (EU Habitat Code: 6410)

- The *Molinia* meadow feature (M24) will occupy between 25% and 80% of the total site area.
- The remainder of the site will be other semi-natural habitat.
- The following plants will be common in the *Molinia* meadows: purple moor-grass *Molinia caerulea*; meadow thistle *Cirsium dissectum*; devil's bit scabious *Succisa pratensis*; carnation sedge *Carex panicea* and tormentil *Potentilla erecta*.
- Cross-leaved heath *Erica tetralix* and common heather *Calluna vulgaris* will also be common in some areas.
- Rushes should not be allowed to spread and species indicative of agricultural modification, such as perennial rye grass *Lolium perenne* and white clover *Trifolium repens*, will be largely absent from the *Molinia* meadow.
- Scrub species such as willow *Salix* and birch *Betula* will also be largely absent from the *Molinia* meadow.
- All factors affecting the achievement of these conditions are under control.

Performance indicators for Feature 2

The performance indicators are part of the conservation objective, not a substitute for it. Assessment of plans and projects must be based on the entire conservation objective, not just the performance indicators.

Performance indicators for feature condition		
Attribute	***Attribute rationale and other comments***	***Specified limits***
A1. Extent of *Molinia* meadow	The attribute also relates to the habitat requirements of the marsh fritillary (Feature 1) The extent of *Molinia Meadows* (NVC community M24) as mapped in 1991 & 1994 by Phase II survey: Caeau Ffos-fach SSSI: 1.7 ha of field A (1994) Broad Oak and Thornhill Meadows SSSI & annexe: 0.25 ha of Field A (1991/1994) Caeau Lotwen SSSI & Annexe: 0.13 ha of Field O (Phase II compartment I in 1991/1994). The CSM guidance provided attributes and limits with which site-specific limits were developed.	*Upper limit*: None set *Lower limit*: *Molinia* meadow should cover at least 80% of the site area Caeau Ffos-fach SSSI: *Upper limit:* None set *Lower limit:* 1.3 ha. Broad Oak and Thornhill Meadows SSSI & annexe *Upper limit:* None set *Lower limit:* 1.0 ha. Caeau Lotwen SSSI & Annexe: *Lower limit:* 0.1 ha.
A2. Quality of *Molinia* meadow grassland	**The attribute also relates to the habitat requirements of the marsh fritillary (Feature 1)** Good quality *Molinia* meadow grassland is defined as stands of grassland vegetation where within any 1 m radius*:*	*Upper limit*: None set *Lower limit*: At least 70 % of the area of *Molinia* meadows mapped on each SSSI should be attributable to good quality *Molinia* meadow.

Performance indicators for feature condition		
Attribute	***Attribute rationale and other comments***	***Specified limits***
A2. Quality of *Molinia* meadow grassland (cont.d)	• At least 5 of the following positive indicator species are present: *Molinia caerulea, Cirsium dissectum, Carum verticillatum, Succisa pratensis, Potentilla erecta, Lotus uliginosus, Galium palustre, Senecio aquatilis, Erica tetralix, Carex pulicaris, Carex hostiana.* • *Molinia caerulea* cover is between 25 and 80%. • *Juncus* species are <33% cover. • *Cirsium dissectum* is present. • *Carum verticillatum* is frequent. • Grass species excepting *Molinia* <33%; *Ranunculus repens* <5%; *Senecio jacobaea* <5%; *Rumex acetosa* <5%. • *Trifolium repens, Urtica dioica, Cirsium* species (excluding *C. palustre* and *C. dissectum*), bracken, tree or scrub species (over 30 cm in height) and bramble are absent. • Vegetation height is between 12-25 cm at the end of the grazing season (autumn). Height is measured by visual estimation. The lower limit for the presence of *Succisa pratensis* is based on the requirements of Feature 1: marsh fritillary. Limits for sward height in the late summer/ autumn have also been modified to ensure marshy grassland with a suitable vegetation structure is available for the marsh fritillary population.	
Performance indicators for factors affecting the feature		
Factor	***Factor rationale and other comments***	***Operational Limits***
F1. Livestock grazing	See Feature 1, F2 Light summer grazing is defined as cattle and/or ponies at an approximate rate of 0.3 – 0.4 SU/ha/year for the period April to October (level per site may need slight adjustment to achieve desired vegetation mosaic between 12-25cm for the marsh fritillary).	*Upper limit*: The *eu Molinion* grasslands will be subject to light summer grazing by cattle and/or ponies at least 4 in every 5 years. *Lower limit*: As upper limits
F2. Hydrological regime	The marshy grassland communities are strongly influenced by the quantity and base status of the groundwater. Reductions in the quality and quantity of the water in the springs and watercourses feeding the site may lead to a loss of marshy grassland or changes in species composition. Conversely, reduced/impeded drainage may lead to ground-water stagnation and a different change in species composition, e.g. increased abundance of rushes.	No limits set. Pending a fuller understanding of current situation and habitat requirements.
F3. Adjacent land use	Two of the component SSSIs lie close to current or proposed industrial sites. These may have indirect effects on the hydrological regime (see above).	No limits set. May need to be considered in the future.

Other factors considered include
Owner/occupier objectives - Some owners/occupiers of the land may have an interest in securing some financial/agricultural/'horsiculture' benefit from the land. This return could be optimised by the agricultural improvement of the land, e.g. by installing new drainage, fertiliser application, or re-seeding; however these operations would cause significant long-term damage to the *eu-Molinion* marshy grassland. This factor will be controlled through management agreements and the SSSI legislation. An operational limit is not required.

The site-specific Performance Indicators were developed and field tested during June 2006 by Tracey Lovering, SAC Monitoring Officer, West Region and were agreed by Nigel Stringer (NS), Site Manager. Based on CSM guidance (2004).

4.3 Conservation Objective for Feature 3: Marshy grassland

Vision for Feature 3

To be developed.

4.4 Conservation Objective for Feature 4: Unimproved neutral marshy grassland

Vision for feature 4

To be developed.

5. ASSESSMENT OF CONSERVATION STATUS AND MANAGEMENT REQUIREMENTS

This part of the document provides:

- A summary of the assessment of the conservation status of each feature.
- A summary of the management issues that need to be addressed to maintain or restore each feature.

5.1 Conservation Status and Management Requirements of Feature 1: Marsh fritillary butterfly Euphydryas (Eurodryas, Hypodryas) aurinia

Conservation Status of Feature 1:

Marsh Fritillary

In 2004, Butterfly Conservation surveyed the marsh fritillary populations on all accessible fields at Caeau Ffos Fach SSSI and Broad Oak and Thornhill Meadows (excluding two inaccessible fields: Greengrove at Caeau Ffos Fach SSSI and Thornhill at Broad Oak and Thornhill Meadows). Western fields at Caeau Lotwen SSSI were initially surveyed in 2005. Access permission to survey was withheld for Eastern field (Caeau Lotwen SSSI). The Butterfly Conservation Reserve at Caeau Ffos Fach SSSI and Western fields at Caeau Lotwen SSSI have been monitored annually since the initial surveys and monitoring is planned to continue for at least the life of the Mynydd Mawr Project.

The number of larval webs recorded at the Butterfly Conservation Reserve (Caeau Ffos Fach SSSI) have declined, from 69 in 2004, to 2 in 2007. However, 2007 was recorded as a particularly poor year for the marsh fritillary, due to the very wet weather throughout the summer. Hibernation may have occurred earlier than usual in 2007 (usually the end of September or early October) which may have preceded the usual survey period. Survey may therefore have missed the peak period for larval web counts. The numbers of larval webs recorded at Western fields (Caeau Lotwen SSSI) have been very low at each survey, ranging from 1 to 3 webs, and have been limited to the more westerly of the two fields.

The conservation status of the marsh fritillary feature at Caeau Mynydd Mawr SAC and its component SSSIs is assessed as *Unfavourable - Unclassified* because:

a. the marsh fritillary larval web density falls well below the target of 200 webs per hectare, and
b. the extent of available Good Condition habitat falls below the accepted limit of 6 ha.

Marsh Fritillary habitat

A survey to evaluate the habitat condition of all marsh fritillary habitat in the Mynydd Mawr area lying within a 1 km radius from post-1990 records (using the landscape boundary definition in Fowles, 2005) was undertaken in 2004-2005 by Deborah Sazer, Butterfly Conservation Project Officer for the Mynydd Mawr Marsh Fritillary Project.

Butterfly Conservation mapped 2.2 ha of Good Condition habitat within the SAC, along with 10.7 ha of Suitable Condition habitat. The area of Suitable habitat within the component SSSIs of the SAC included 0.3 ha Suitable Over-grazed, 8.2 ha Suitable Under-grazed and 2.3 ha Suitable Sparse. A further 4.05 ha of Potential (rank) habitat was mapped within the SAC; this habitat has the potential to revert to Suitable Condition habitat if managed for marsh fritillary (usually through the introduction of suitable grazing stock and suitable grazing levels).

Management
The component parts of the SAC are subject to a variety of management techniques.

Caeau Ffos Fach SSSI
The Butterfly Conservation Reserve has been severely undergrazed for a number of years (low level of winter pony grazing). However, cattle were introduced at the recommended grazing level of 0.3 LU between June and October 2006. Scrub clearance is carried out annually by winter volunteer work parties.

Median Farm has been grazed year-round by a small number of ponies. The rest of the holding has been sold recently, and the future management of this site is uncertain.

Greengrove Farm has not been managed for a number of years and is so severely overgrown that it has been impossible to gain physical access, due to the thick band of bramble, etc around the boundaries.

Broad Oak and Thornhill Meadows SSSI
Broad Oak western field has been managed by a hay cut and periodic aftermath cattle grazing, as agreed in the management agreement. Broad Oak eastern field was severely overgrazed by cattle and possibly ponies when surveyed in 2004.

Access permission was not agreed for Thornhill Meadows, so no assessment of management was possible.

Caeau Lotwen SSSI
Western Fields are being grazed by Welsh cobs at the acceptable level of 0.3 LU between April and October.

Eastern Field has not been surveyed for marsh fritillaries, as permission was not given. It appears to have little *Succisa pratensis*, and so is unlikely to contain breeding habitat for the marsh fritillary. However, it has an important role to play in providing nectar sources, and thus linking the metapopulation to other suitable sites. The management appears to be irregular – in 2006 it was overgrazed, in 2007 the grazing level was lighter.

Management Requirements of Feature 1

The current status of the feature is unfavourable. The principle reasons for this are neglect, inappropriate grazing, and possibly past agricultural improvements in some of the Management Units – see above.

All fields should be grazed by ponies or cattle; at a level that will achieve a sward between 12 and 25 cm at the end of the grazing period. This usually corresponds to 0.3-0.4 LU per ha within the period April and November. There will be annual variations depending on weather conditions, e.g. the stock should come off earlier if the autumn is particularly wet, to avoid poaching; or there may be insufficient grazing available in April in some years.

Caeau Ffos Fach SSSI

- Butterfly Conservation Reserve: the recent introduction of cattle grazing at the recommended grazing level of 0.3 LU in 2006 is ideal, and should be maintained.

- Median Farm should ideally only be grazed in summer to avoid problems with poaching and selective overgrazing by ponies. However, the minimum requirement is for a continuation of the current timing and level of pony grazing.

- Greengrove Farm requires scrub clearance and the re-introduction of grazing. Access to the site was not possible to assess the extent of restoration required.

Broad Oak and Thornhill Meadows SSSI

- Broad Oak western field is currently cut for hay, which is inappropriate management for marsh fritillary. Extensive grazing by cattle or ponies at the recommended grazing level and timing is appropriate. Hay cuts are traditional in some of these fields however increasing pressures on land-use have led to a demise in the land available for marsh fritillary. In the current fragmented landscape, this potential butterfly site is crucial to the maintenance of the Caeau Mynydd Mawr metapopulation and a change in management is required.

- Broad Oak eastern field: The grazing level should be reduced to / maintained at 0.3-0.4 LU between April and October.

- Thornhill Meadows should be grazed by cattle or ponies at the recommended level, with no hay or silage cut.

Caeau Lotwen SSSI

- Western Fields should continue to be grazed by ponies or cattle at the current level of 0.3-0.4 LU between April and October.

- Eastern Field should be grazed by cattle or ponies at the recommended level, with no hay or silage cut.

Future Monitoring

The Mynydd Mawr Marsh Fritillary Project is seeking to increase the level of positive management for the marsh fritillary metapopulation. Annual larval webs counts will be used to assess condition and status of the marsh fritillary, supplemented by adult counts. Habitat condition assessment within each management unit of the SAC will inform the effectiveness of management measures coupled with larval web counts.

5.2 Conservation Status and Management Requirements of Feature 2: *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (EU Habitat Code: 6410)

Conservation Status of Feature 2
See above re: Feature 1, marsh fritillary habitat condition.
The current status of the feature is either *Unfavourable - Unclassified*.

Management Requirements of Feature 2
See above re: Feature 1, marsh fritillary management requirements.

All the habitat management requirements for the *Eu Molinion* grassland will be met through the appropriate management of marsh fritillary (Feature 1)

Future Monitoring
See above re: Feature 1, marsh fritillary habitat condition monitoring

5.3 Conservation Status and Management Requirements of Feature 3: Marshy grasslands

Conservation Status of Feature 3
To be completed.

Management Requirements of Feature 3.
See above re: Feature 1, marsh fritillary management requirements.

All the habitat management requirements for the mesotrophic neutral grasslands will be met through the appropriate management of marsh fritillary (Feature 1)

6. ACTION PLAN: SUMMARY

This section takes the management requirements outlined in Section 5 a stage further, assessing the specific management actions required on each management unit. This information is a summary of that held in CCW's Actions Database for sites, and the database will be used by CCW and partner organisations to plan future work to meet the Wales Environment Strategy targets for sites.

Unit Number	CCW Database Number	Unit Name	Summary of Conservation Management Issues	Action needed?
1	001046	Caeau Ffos Fach (Butterfly Conservation Reserve)	The site is owned and managed by Butterfly Conservation and has been severely undergrazed for a number of years. Cattle were introduced at the recommended 0.3LSU/ha between June and October 2006. Scrub clearance is carried out annually in the winter by volunteer work parties. The site is in unfavourable recovering condition.	Yes
2	001047	Caeau Ffos Fach (Median Farm)	The field has been grazed year round by a small number of ponies. The holding has been sold recently and the new ownership and future management is uncertain. Land to the south of the field has been granted outline planning permission for light industrial use. The site is in unfavourable condition.	Yes
3	001048	Caeau Ffos Fach (Greengrove Farm)	The field has been unmanaged for a number of years and is so severely overgrown that it has been impossible to access due to the thick band of brambles/scrub around the boundary. A management agreement has lapsed and needs renewing. The site is in unfavourable condition.	Yes
4	001049	Broad Oak & Thornhill (Broad Oak)	A management agreement was drawn up in the late 1980's and prescribed a hay cut and aftermath grazing. This comes to an end in June 2008 and needs re-negotiating and amending to a suitable grazing regime. The east field was severely overgrazed by cattle and ponies when surveyed in 2004. The site is in unfavourable condition.	Yes
5	001050	Broad Oak & Thornhill (Thornhill)	Thornhill meadows have been suitably grazed in the past, but recent attempts to access the site have met with refused access. A condition assessment has therefore not been possible.	Yes
6	001051	Caeau Lotwen (Western Fields)	Ownership of the site has recently changed hands, and a new management agreement was negotiated in 2007. The site will be grazed by Welsh cobs at an acceptable level - 0.3LSU/ha between April and October. The site is in unfavourable recovering condition.	No
7	001052	Caeau Lotwen (Eastern Field)	Caeau Lotwen eastern fields have been suitably grazed in the past, but recent attempts to access the site have met with refused access. A condition assessment has therefore not been possible. Little scabious is present on the site, and it is likely to be used mainly as a feeding resource. Management appears to be irregular - overgrazed in 2006, but at lighter levels in 2007.	Yes

7. GLOSSARY

This glossary defines the some of the terms used in this **Core Management Plan**. Some of the definitions are based on definitions contained in other documents, including legislation and other publications of CCW and the UK nature conservation agencies. None of these definitions is legally definitive.

Action A recognisable and individually described act, undertaking or **project** of any kind, specified in section 6 of a **Core Management Plan** or **Management Plan**, as being required for the **conservation management** of a site.

Attribute A quantifiable and monitorable characteristic of a **feature** that, in combination with other such attributes, describes its **condition**.

Common Standards Monitoring A set of principles developed jointly by the UK conservation agencies to help ensure a consistent approach to **monitoring** and reporting on the **features** of sites designated for nature conservation, supported by guidance on identification of **attributes** and monitoring methodologies.

Condition A description of the state of a feature in terms of qualities or **attributes** that are relevant in a nature conservation context. For example the condition of a habitat usually includes its extent and species composition and might also include aspects of its ecological functioning, spatial distribution and so on. The condition of a species population usually includes its total size and might also include its age structure, productivity, relationship to other populations and spatial distribution. Aspects of the habitat(s) on which a species population depends may also be considered as attributes of its condition.

Condition assessment The process of characterising the **condition** of a **feature** with particular reference to whether the aspirations for its condition, as expressed in its **conservation objective**, are being met.

Condition categories The **condition** of **feature** can be categorised, following **condition assessment** as one of the following[2]:

Favourable: maintained;
Favourable: recovered;
Favourable: un-classified
Unfavourable: recovering;
Unfavourable: no change;
Unfavourable: declining;
Unfavourable: un-classified

Partially destroyed;
Destroyed.

Conservation management Acts or undertaking of all kinds, including but not necessarily limited to **actions,** taken with the aim of achieving the **conservation objectives** of a site. Conservation management includes the taking of

[2] See JNCC guidance on Common Standards Monitoring http://www.jncc.gov.uk/page-2272

statutory and non-statutory measures, it can include the acts of any party and it may take place outside site boundaries as well as within sites. Conservation management may also be embedded within other frameworks for land/sea management carried out for purposes other than achieving the conservation objectives.

Conservation objective The expression of the desired **conservation status** of a **feature,** expressed as a **vision for the feature** and a series of **performance indicators**. The conservation objective for a feature is thus a composite statement, and each feature has one conservation objective.

Conservation status A description of the state of a **feature** that comprises both its **condition** and the state of the **factors** affecting or likely to affect it. Conservation status is thus a characterisation of both the current state of a feature and its future prospects.

Conservation status assessment The process of characterising the **conservation status** of a **feature** with particular reference to whether the aspirations for it, as expressed in its **conservation objective**, are being met. The results of conservation status assessment can be summarised either as 'favourable' (i.e. conservation objectives are met) or unfavourable (i.e. conservation objectives are not met). However the value of conservation status assessment in terms of supporting decisions about **conservation management**, lies mainly in the details of the assessment of feature **condition**, **factors** and trend information derived from comparisons between current and previous conservation status assessments and condition assessments.

Core Management Plan A CCW document containing the conservation objectives for a site and a summary of other information contained in a full site **Management Plan**.

Factor Anything that has influenced, is influencing or may influence the **condition** of a **feature**. Factors can be natural processes, human activities or effects arising from natural process or human activities, They can be positive or negative in terms of their influence on features, and they can arise within a site or from outside the site. Physical, socio-economic or legal constraints on **conservation management** can also be considered as factors.

Favourable condition See **condition** and **condition assessment**

Favourable conservation status See **conservation status** and **conservation status assessment.**[3]

Feature The species population, habitat type or other entity for which a site is designated. The ecological or geological interest which justifies the designation of a site and which is the focus of conservation management.

Integrity See **site integrity**

[3] A full definition of favourable conservation status is given in Section 4.

Key Feature The habitat or species population within a **management unit** that is the primary focus of **conservation management** and **monitoring** in that unit.

Management Plan The full expression of a designated site's legal status, **vision**, **features**, **conservation objectives**, **performance indicators** and management requirements. A complete management plan may not reside in a single document, but may be contained in a number of documents (including in particular **the Core Management Plan**) and sets of electronically stored information.

Management Unit An area within a site, defined according to one or more of a range of criteria, such as topography, location of **features**, tenure, patterns of land/sea use. The key characteristic of management units is to reflect the spatial scale at which **conservation management** and **monitoring** can be most effectively organised. They are used as the primary basis for differentiating priorities for conservation management and monitoring in different parts of a site, and for facilitating communication with those responsible for management of different parts of a site.

Marsh Fritillary habitat categories

Good Condition habitat (GC)
Grassland where, for at least 80% of sampling points, the vegetation height is within the range of 12-25 cms and *Succisa pratensis* is present at >5% within a 50 cm radius. Scrub (>0.5 metres tall) covers no more than 10% of the area.

Suitable Condition habitat
The sum of Suitable Under-grazed, Suitable Over-grazed and Suitable Sparse habitat.

Suitable Under-grazed (SU)
Grassland where, for at least 50% of 1m radius sampling points, *Succisa pratensis* is present and vegetation height is above 25cms, or in which sward height is between 12-25cms but scrub (>0.5 metres tall) covers more than 10% of the area.

Suitable Over-grazed (SO)
Grassland where, for at least 80% of 1m radius sampling points *Succisa* is present but which is currently over-grazed such that the sward is below 12cms. This may also cover mown sites.

Suitable Sparse (SS)
Grassland with sparse (rare-occasional) *Succisa* and vegetation height less than 25cms on average. Superficially these patches may have good vegetation structure but the paucity of *Succisa* means that they are less favoured by marsh fritillaries.

Potential (Rank) (PR)
Grassland with rare Succisa which is currently under-grazed or neglected with sward >25 cm. Succisa occurs as scattered plants, usually in a rank, tussocky sward.

Available habitat
The total of Good Condition and Suitable Condition habitat.

Monitoring An intermittent (regular or irregular) series of observations in time, carried out to show the extent of compliance with a formulated standard or degree of deviation from an expected norm. In **Common Standards Monitoring**, the formulated standard is the quantified expression of favourable **condition** based on **attributes**.

Operational limits The levels or values within which a **factor** is considered to be acceptable in terms of its influence on a **feature**. A factor may have both upper and lower

operational limits, or only an upper limit or lower limit. For some factors an upper limit may be zero.

Performance indicators The **attributes** and their associated **specified limits**, together with **factors** and their associated **operational limits,** which provide the standard against which information from **monitoring** and other sources is used to determine the degree to which the **conservation objectives** for a **feature** are being met. Performance indicators are part of, not the same as, conservation objectives. See also **vision for the feature**.

Plan or project **Project:** Any form of construction work, installation, development or other intervention in the environment, the carrying out or continuance of which is subject to a decision by any public body or statutory undertaker.
Plan: a document prepared or adopted by a public body or statutory undertaker, intended to influence decisions on the carrying out of **projects.** Decisions on plans and projects which affect Natura 2000 and Ramsar sites are subject to specific legal and policy procedures.

Site integrity The coherence of a site's ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it is designated.

Site Management Statement (SMS) The document containing CCW's views about the management of a site issued as part of the legal notification of an SSSI under section 28(4) of the Wildlife and Countryside Act 1981, as substituted.

Special Feature See **feature**.

Specified limit The levels or values for an **attribute** which define the degree to which the attribute can fluctuate without creating cause for concern about the **condition** of the **feature**. The range within the limits corresponds to favourable, the range outside the limits corresponds to unfavourable. Attributes may have lower specified limits, upper specified limits, or both.

Unit See **management unit.**

Vision for the feature The expression, within a **conservation objective**, of the aspirations for the **feature** concerned. See also **performance indicators.**

Vision Statement The statement conveying an impression of the whole site in the state that is intended to be the product of its **conservation management.** A 'pen portrait' outlining the **conditions** that should prevail when all the **conservation objectives** are met. A description of the site as it would be when all the **features** are in **favourable condition**.

8. REFERENCES

Fowles, A.P. 2003. *Guidance notes for the definition and mapping of habitat quality for marsh fritillaries.* Natual Science Report. 03/5/1. Countryside Council for Wales.

Fowles, A. P. 2005. *Habitat Quality Mapping for Marsh Fritillary Populations*. Staff Science report No. 05/5/1.

Lovering, T. 2006. *Caeau Mynydd Mawr SAC Monitoring Report*. CCW Internal Report.

Smith, R.G., Stewart, B. & Pryce, R.D. 2002. *Assessment of marsh fritillary habitat at Mynydd Mawr, Cross Hands, Carmarthenshire, 2001*. CCW Contract Science. **500**. Countryside Council for Wales.