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MANAGEMENT of Natura 2000 habitats
Semi-natural dry grasslands (*Festuco-Brometalia*)
6210

Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

EUROPEAN COMMISSION

environment

The European Commission (DG ENV B2) commissioned the Management of Natura 2000 habitats. 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)

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6210 | Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites)


The habitat in the Alto Garda Bresciano Regional Park (Italy) Photo: ERSAF

62 - Semi-natural dry grasslands and scrubland facies

EUNIS Classification:
E1.2
Perennial calcareous grassland and basic steppes

* Priority habitat

Summary

Festuco-Brometalia grasslands, present in almost the entire European continent, are among the most species-rich plant communities in Europe and contain a large number of rare and endangered species. This habitat includes dry to semi-dry grasslands and scrubland, occurring from the planar to the mountain level on calcareous to neutral substrates. Calcareous grasslands play a major, but not always well-recognised or understood role for society (production, employment), the environment and biodiversity. The grasslands are key habitats for many species: herbs, grazing animals, butterflies and reptiles, and many birds.

Birds of prey such as *Falco biarmicus* (lanner falcon), *Pernis apivorus* (Honey buzzard), *Circaetus gallicus* (short-toed eagle) and *Circus pygargus* (Montagu's harrier) use these grasslands as hunting areas during the breeding season; many passerines, such as *Emberiza hortulana* (ortolan bunting), *Sylvia nisoria* (barred warbler), *Lullula arborea* (woodlark) and *Lanius collurio* (red-backed shrike) use this environment for nesting and roosting, while other birds breed in these grasslands, as *Burhinus oedicnemus* (stone curlew). The invertebrate fauna, particularly butterflies, associated with this habitat is also noteworthy.

Pressure on grassland habitats is steadily increasing, mainly due to abandonment or change in use. The total area of grassland in the EU fell by an average of 12% between 1975 and 1998, with increases in only a few areas. In the areas where the habitat is still present, the lack of management results in a continuing decrease in range of the many species that depend on it. Active management of the habitat includes grazing, cutting or a combination of both. In rural areas, grazing is important both to the local economy and to maintain the aesthetic value of grassland sites for the benefit of the local community. Grassland management objectives will vary from site to site and within one site different goals may be set for different areas; a balanced approach is to see the primary goal as maintenance of the main plant communities, along with the main features of importance to animals, such as areas of bare soil, scattered bushes and scrub margins.

Since the habitat features, conservation values and context (history and development) differ considerably between the various countries and biogeographical regions, it is important, when planning the management for the habitat, to take into account the following general aspects which will allow sensible management decisions to be taken:

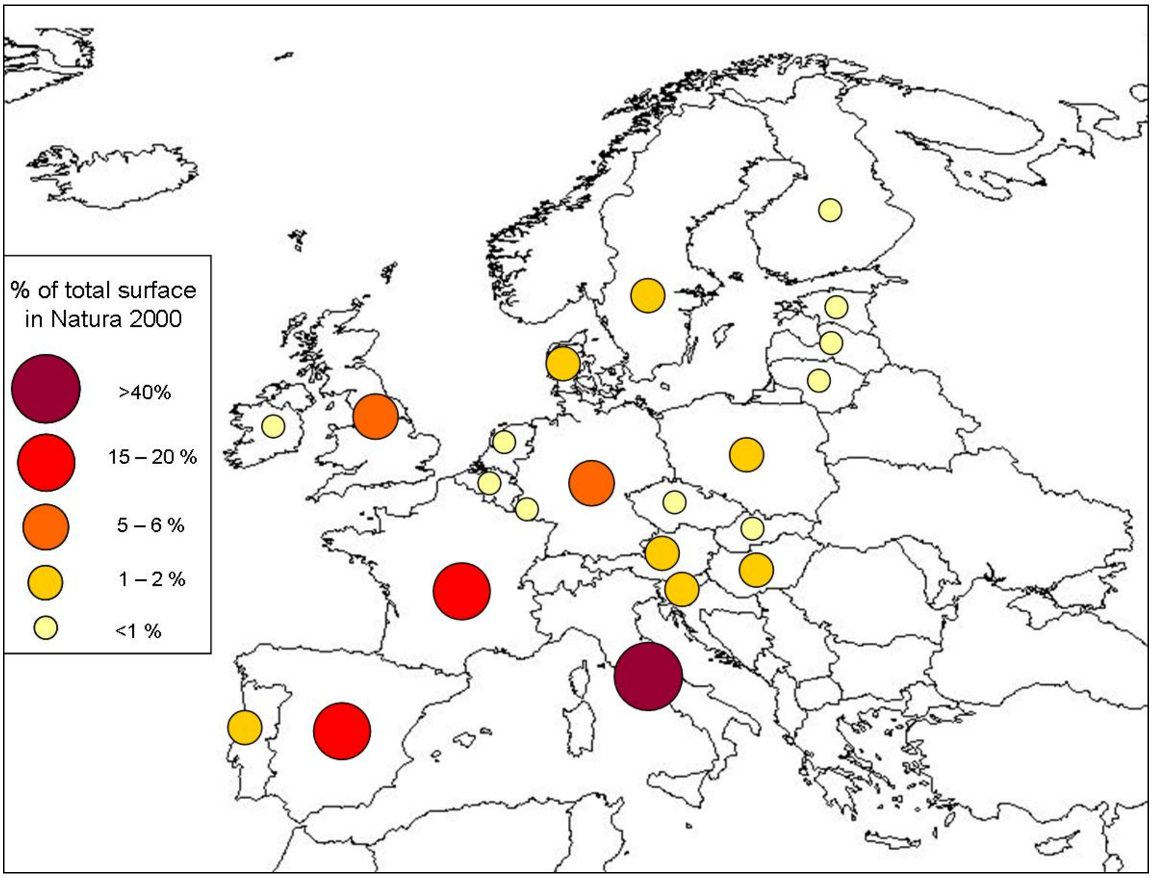
- Site-specific objectives and targets as regards the conservation status of species;
- Local/regional land use and livestock husbandry traditions, practices and techniques – today's conservation values are often the result of the land use and grazing regimes of the past.

1. Description of habitat and related species

Distribution

This habitat includes dry to semi-dry grasslands and scrubland occurring from the lowland to the mountain level and occurring on calcareous to neutral substrates (DET 2005a, ARPA Emilia-Romagna 2006, Lasen and Wilham 2004, Pihl *et al.* 2001).

Calcareous grasslands are present in almost the entire European continent (Royer 1991, Essl 2005). The dry types are mainly concentrated in South and South East Europe (EEA 2001). The Mediterranean biogeographic region has the highest percentage of significant dry grassland habitat areas (see Table below).



Percentage distribution of the total surface of dry grasslands in Natura 2000

Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites) in Natura 2000 sites

The following data have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover indicated for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Biogeographical region	Nº of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Mediterranean	460	261,998	43.96
Continental	1,538	148,558	24.93
Atlantic	328	90,058	15.11
Alpine	284	76,973	12.91
Boreal	277	10,064	1.69
Panonica	80	8,322	1.40
Countries	Nº of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Italy	576	256,115	42.96
France	423	104,641	17.54
Spain	170	97,897	16.42
United Kingdom	62	33,419	5.60
Germany	924	31,079	5.24
Portugal	9	9,676	1.62
Slovenia	14	7,970	1.33
Denmark	79	7,371	1.23
Sweden	164	6,800	1.14
Austria	44	6,781	1.13
Hungary	52	6,608	1.10
Poland	37	6,227	1.04
Estonia	79	5,518	0.92
Czech Republic	57	4,812	0.82
Slovakia	82	4,261	0.71
Ireland	33	3,335	0.56
Latvia	25	1,336	0.22
Belgium	72	1,126	0.19
Finland	25	458	0.08
Lithuania	20	228	0.04
Luxemburg	15	227	0.04
Netherlands	5	87	0.02
TOTAL	**2,967**	**595,973**	**100**

*Note: According to the national list of habitats included in the 92/43/CE EU Directive (Habitats Directive), Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites) are also present in Bulgaria and Romania.*

Main habitat features, ecology and variability

The grasslands of the 6210 habitat are among the most species-rich plant communities in Europe in terms of the number of plant species they support per unit area. The calcareous grasslands of North-West Europe, for instance, host up to 80 plant species/m^2 (WallisDeVries *et al.* 2002). They also contain a large number of rare and endangered species (Werner & Spranger 2000), including the priority species *Pulsatilla slavica*, listed in Annex II of the Habitats Directive and the early gentian *Gentianella anglica* as well as various bryophytes and lichens (JNCC 2007a). The invertebrate fauna associated with this habitat, particularly butterflies, is also noteworthy (JNCC 2007a) and includes a number of species listed in the Habitats Directive, such as *Maculinea arion* (Large Blue, Annex IV) (Colas & Hébert 2000).

The habitat is considered a priority type (6210*) only if it is an important orchid site (EC 2007a). Important orchid sites are sites that are important on the basis of one or more of the following three criteria:
(a) the site hosts a rich suite of orchid species;
(b) the site hosts an important population of at least one orchid species considered not very common on the national territory;
(c) the site hosts one or several orchid species considered to be rare, very rare or exceptional on the national territory.

The community type is characterised by a wide variety of grasses and herbs, in which there is at least a moderate representation of calcicolous species (that prefer calcium rich soil) (JNCC 2007a; Pihl *et al.* 2001). Some species are associated with tall-growing vegetation, others with woodland fringes and gaps; other species are more typical of open grassland with both tall and short vegetation (Pihl *et al.* 2001).

Important plant species occurring in this habitat are: *Artemisia santonicum*, *Artemisia pontica, Suaeda corniculata*, *S. pannonica*, *Lepidium crassifolium*, *Puccinellia peisonis*, *Puccinellia limosa, Aster tripolium*, *Salicornia prostata*, *Camphorosma annua*, *Plantago tenuiflora*, *Juncus gerardii*, *Plantago maritima, Cyperus pannonicus*, *Pholiurus pannonicus*, *Festuca pseudovina, Achillea collina, Scorzonera cana, S. parviflora, Petrosimonia triandra, Peucedanum officinale, Halocnemum strobilaceum, Frankenia hirsuta, Aeluropus littoralis, Limonium meyeri, Limonium gmelinii, Nitraria shoberi, Carex distans, C. divisa, Taraxacum bessarabicum, Beckmannia eruciformis, Zingeria pisidica, Trifolium fragiferum, Cynodon dactylon, Ranunculus sardous, Agropyron elongatum, Halimione verrucifera* (syn *Obione verrucifera*), *Lepidium latifolium, Leuzea altaica* (syn *L. salina*)*, Iris halofila, Triglochin maritima, Hordeum hystrix, Aster sedifolius. Scorzonera austriaca* var. *mucronata, Festuca arundinacea* ssp. *orientalis* (EC 2007). In Bulgaria, the endemic *Limonium bulgaricum* and other plants as *Scorzonera laciniata, Camphorosma monspeliaca* can be found in this habitat (Kavrakova *et al.* 2005). Other important species are *Crypsis acuelata, Heleochola schoenoides, Chenopodium chenopoiodes, Puccinellia distans, Carex stenophylla, Ranunculus pedatus, Salsola soda, Schoenoplectus tabernaemontani, Trifolium angulatum, Plantago schwarzenbergiana.*

Ecological requirements

The habitat is found on thin, well-drained, infertile lime-rich soils that have developed from a variety of limestone bedrocks (JNCC 2007a; Rodwell *et al.* 2007).

This habitat type contains several clearly different vegetation types. The most important differentiating factor is the water supply (Essl 2005), but the structural and floristic characteristics of the habitat are also strongly influenced by climatic factors, topographic features, soil conditions and management practices, in particular the intensity of grazing (Ellenberg 1986; JNCC 2007a). For instance, in submontane and montane zones, altitude brings some relief from summer heat and drought (Rodwell *et al.* 2007) and the sub-montane character of the vegetation is shown by the presence of northern/upland species; some stands support arctic-alpine rarities (JNCC 2007a).

The close link between the variation within these grasslands and those in climate and soils is shown by the clear geographic sequence across Europe from more mesophytic swards on less drought-prone soils in the Atlantic zone through to steppic grasslands and steppes on very arid soils in the extreme continental climate of the region stretching from SouthEast Europe to the Urals (Rodwell *et al.* 2007).

Moreover, a study carried out on Central European semi-dry grasslands shows that species composition changes considerably along the North West - South East gradient across Central Europe (Willems 1982) according to the geographic position and the climatic variables (precipitation and temperature). In areas characterized by a Suboceanic climate, these grasslands contain Subatlantic species; by contrast, in the drier areas, semi-dry grasslands contain several species of Continental distribution or Continental steppe species (Illyés *et al*. 2007).

Variation within the habitat vegetation is also significantly related to human activites. Where exploitation levels are reduced, calcareous grasslands typically become dominated by coarse grasses and plants of smaller stature become correspondingly scarcer (JNCC 2007a). Shrub species (e.g. *Crategus spp.* hawthorn, *Rosa spp.* rose, *Prunus spinosa* blackthorn, *Corylus avellana* hazel and other species) may become established where utilisation is at sufficiently low intensity, and may eventually form patches of scrub (JNCC 2007a, Provincia di Prato 2007b). Transitions to scrub and woody vegetation, developing with the relaxation of management, are also part of the 6210 Habitat (DET 2005a, Rodwell *et al.* 2007).

Grassland-scrub transitions provide important habitats for a wide range of rare and local species and where scrub is present on calcareous grasslands, a greater range of breeding bird species generally occur (Crofts & Jefferson 1999). It is important to note that scrub occurrence is rarely related to the presence of orchid species (Pihl *et al.* 2001).

In Denmark, for example, this habitat type dominates on calcareous moraine slopes along current and former coastlines, in river valleys, and in lateral moraine formations. The important orchid sites are most abundant on the calcareous soils on Møn, central Sjælland, and in Himmerland. The type is almost exclusively found north and east of the limit of the last glaciation, where it occurs in most undulating landscapes (Pihl *et al.* 2001).

In Italy the habitat, mostly secondary, is concentrated in the Alps (Lasen 1989, Feoli Chiappella & Poldini 1993, Cerabolini 1996, Frisinghelli *et al.* 1996) and the central Apennines (Biondi *et al.* 1995, MATT 2003), where *Mesobromion* is the commoner grassland formation (Lombardi & Viciani 2003).

In Austria, to give one more example, this grassland vegetation, present at sub-mountain and hill elevations, has a greater distribution in the dry valleys of the central Alps. Semi-dry grasslands have a wider distribution and greater frequency, while dry grasslands appear above all in the Pannonic region, in the East Alpine fringe and in the InnerAlpine dry valleys (Essl 2005).

Main subtypes identified

The 6210 habitat type includes a wide range of grasslands communities which are generally assigned to the phytosociological class *Festuco-Brometea* (EC 2007a, DET 2005a). This class of grasslands and steppes occurs on free-draining, impoverished and calcareous to somewhat lime-poor soils (Rodwell *et al.* 2007). More specifically, the habitat consists of plant communities belonging to two orders within the *Festuco-Brometea* class: the steppic or subcontinental grasslands (*Festucetalia valesiacae* order) and the grasslands of more oceanic and sub-Mediterranean regions (*Brometalia erecti* or *Festuco-Brometalia* order). In the latter case, a distinction is made between primary dry grasslands of the *Xerobromion* alliance and secondary (semi-natural) semi-dry grasslands of the *Mesobromion* (or *Bromion*) alliance with *Bromus erectus* (EC 2007a).

Festucetalia valesiacae

The *Festucetalia valesiacae* order includes the most steppic features of the habitat, with *Festuca valesiaca* and *Stipa capillata* (DET 2005a). The order is the counterpart of the *Festuco-Brometalia* in the truly continental parts of Europe, in the shift from the sub-Atlantic to the sub-Continental zone (Rodwell *et al*. 2007). It includes transition vegetation between Central European semi-natural dry calcareous grasslands and Eastern European primary steppe vegetation (Oberdorfer & Korneck 1978, Rūsiņa 2006).

Characteristic species are (EC 2007a): *Adonis vernalis, Euphorbia seguierana, Festuca valesiaca, Silene otites, Stipa capillata, S. joannis*.

Xerobromion

The *Xerobromion* grasslands are more xeric, that is, climatically and/or edaphically limited to dry areas (Essl 2005). This alliance contains xerophilous open grasslands with a real sub-Mediterranean feel (Rodwell *et al*. 2007). They are permanent communities, located as they are on extremely dry sites, often exposed to the South, where the growth of shrubs and scrub is limited by excessive slopes, by rocky soil, by fires and by soil erosion (Provincia di Vicenza 2006). These dry grassland areas are therefore arid in summer, with a warm microclimate (LIFE 2002/NAT/D/8461). Several authors have used the differences in microclimatic conditions to explain the small-scale vegetation mosaic of dry grasslands (Janišová 2005). The grasslands of *Xerobromion* are generally rather rare but interesting from a floristic point of view (Lasen & Wilham 2004).

Characteristic species (EC 2007a): *Bromus erectus, Fumana procumbens, Globularia elongata, Hippocrepis comosa.*

Mesobromion

A large part of the European calcareous grasslands are *Mesobromion* communities (Werner & Spranger 2000). This alliance is confined to semi-dry communities in the oceanic parts of western and central Europe.The *Mesobromion* grasslands develop on less rocky locations and those on deeper soils are usually characterised by their rich orchid flora (Lasen & Wilhalm 2004).

Except where they occur on rocky outcrops with very fragmentary, shallow and drought-prone soils, the calcareous grasslands of Europe are anthropogenic vegetation types that have replaced various kinds of calcicolous forest on lime-rich bedrocks and more permeable surfaces (Rodwell *et al*. 2007). These communities of *Mesobromion* are semi-natural communities: natural communities that have been transformed as a result of human agricultural or pastoral activity (extensive grazing or mowing, but no fertilisation) in which natural species are dominant and which remain as they are only as long as moderate human impact (mowing, grazing) is exerted (EFN & RDSNC 2001). After the abandonment of these traditional agro-pastoral practices, they are susceptible to scrub invasion (BFN 2006, Vecchiettini *et al*. 2007) and semi-natural communities become natural communities through natural succession.

The composition of *Mesobromion* appears to have stabilised after centuries of human pressure. It is usually dominated by *Bromus erectus*, which is particularly suited to calcareous, dry and sunny soils (Provincia di Vicenza 2006), has good abilities to spread after fires (Pignatti 1982) and is resistant to grazing.

Characteristic species (EC 2007a): *Anthyllis vulneraria, Arabis hirsuta, Brachypodium pinnatum, Bromus inermis, Campanula glomerata, Carex caryophyllea, Carlina vulgaris, Centaurea scabiosa, Dianthus carthusianorum, Eryngium campestre, Koeleria pyramidata, Leontodon hispidus, Medicago sativa* ssp. *falcata, Ophrys apifera, O. insectifera, Orchis mascula, O. militaris, O. morio, O. purpurea, O. ustulata, O. mascula, Polygala comosa, Primula veris, Sanguisorba minor, Scabiosa columbaria, Veronica prostrata, V. teucrium*.

Species that depend on the habitat

Plants

Gentianella anglica (JNCC 2007a)
Early gentian is an annual rare plant endemic to the UK, occurring in calcareous grassland, mainly on steep, South-facing slopes, which receive longer periods of sunlight and where soil depth is very shallow (2-5 cm) and hence fertility is very low (WCC 1999). At most of its localities the vegetation falls into habitat 6210. It grows on bare ground or in thin turf that is kept open by a combination of grazing and trampling by livestock on thin, droughty soils. In dense turf it becomes shaded out and is unable to compete with other more vigorous species. There has been a marked decline in *G. anglica* since 1970, largely because of the ploughing and fertilising of old chalk grassland and the abandonment of grazing on some of the remaining grasslands. For instance, Stewart *et al*. (1994) states that "most fragments of surviving grasslands are unsuitable as the cessation of traditional grazing regimes has allowed rank grassland and scrub to replace the closely grazed grasslands required by this species. There is also a difficulty within fragmented sites in balancing the requirements of this species with other species worthy of conservation." (JNCC *et al* 2007b).

*Pulsatilla slavica** (ŠOPSR 2008)
This plant, a symbol of the Slovak flora, is a West Carpathian endemic species. It is a fully protected and highly endangered species, which grows on limestone rock in submontane and mountain regions, only in Slovakia's Western Carpathians and in the Khokholov valley in Poland. It occurs on well-drained soil, on rocky hillsides with xerothermic shrub and grass vegetation, pastures, relict pinewoods, rock apertures, and rarely in limestone beech forests from the upland to the sub-alpine belt (250 – 1750 m altitude). At lower altitudes the main threat is invasion by trees (mostly *Pinus sylvestris* and *P. nigra*) and some expansive herbs. Quarrying and afforestation can also endanger habitats.

Orchids typical of 6210*
The ecology and reproductive biology of orchids are particularly sensitive to ecological changes, due to their dependence on particular environmental conditions and to their tight links with pollinating insects and to the presence of mycorhizal fungi.

Orchid seed germination is considered extremely difficult, as it is based on the symbiosis with specific fungi (CFA 2007). The reproductive strategy of the orchids is characterised by their abundant production of small seeds, which provide an enormous capacity for dispersal but carries the cost of very limited competitive ability in the juvenile phase: many European autochtonous orchids stabilise with success only in oligotrophic environments, characterised by high light intensity, a condition which is found mostly within *Mesobromion* grassland vegetation (CFA 2007) where the orchids are associated with short grasslands.

Conversely the orchid species are supplanted by more powerfully growing plants at locations with plenty of water and nutrients (LIFE2002/NAT/D/8461). Hence, the critical factors in the long-term maintenance of an orchid population are not just seed production but also their chance of becoming established (CFA 2007, Pihl *et al*. 2001) and the causes of their decline is as likely to be agricultural abandonment as absolute habitat destruction (Crofts & Jefferson 1999).

Birds

These grasslands provide the ideal habitat for many threatened or rare bird species, including many which are listed in Annex I of the Birds Directive.

Birds of prey as *Falco biarmicus* (lanner falcon), *Pernis apivorus* (honey buzzard), *Circaetus gallicus* (short-toed eagle) and *Circus pygargus* (Montagu's harrier) use the grasslands as hunting areas during the breeding season and it is therefore important to assure the presence of the animal on which they feed, such as meso-mammals and gallinaceous birds (MATT 2003). An abundant food supply is a key requirement for raptors that winter on dry grassland. All these raptors require large, open areas for hunting with suitable taller vegetation for roost sites (Croft & Jefferson 1999).

Many passerine species, listed and not in the Directive, including *Emberiza hortulana* (ortolan bunting), *Sylvia nisoria* (barred Warbler), *Lullula arborea* (woodlark) and *Lanius collurio* (red-backed shrike) use this environment for nesting and roosting (LIFE04NAT/IT/000173) and have slipped into an unfavourable conservation status due to changes in agricultural practices during the latest decades.

Other birds breed in these grasslands, for instance, the *Burhinus oedicnemus* (stone curlew).

Loss, fragmentation and deterioration of the habitat through changes in agriculture, has a direct impact on bird species. Lack of management due to agricultural abandonment, or the intensification of farming, including the increased use of pesticides, artificial fertiliser and slurry, result in lower numbers of invertebrates. A reduced availability of this important winter food source leads to a widespread and ongoing decrease in the EU range of many bird species, such as red-backed shrike, honey buzzard, short-toed eagle and Montagu's harrier.

Unintentional human disturbance during the breeding season is responsible for some breeding failures for many of these bird species and is a further cause of decline (i.e. lanner falcon, ortolan bunting) (EC 2007b)

Related habitats

Transitions between calcareous grasslands and heath, acid grassland, scrub and woodland communities are widespread (JNCC 2007a).

<u>2130 *Fixed coastal dunes with herbaceous vegetation (grey dunes)</u>
There is a transition towards communities of *Mesobromion* in the following cases: old mesophile grasslands of dune slacks and inner dunes (*Anthyllido Thesietum*), frequently in mosaic with communities of *Salix repens* and particularly developed on the west face of the dunes; grasslands with *Himantoglossum hircinum* of the dunes in the De Haan area (EC 2007a).

<u>6110 Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi* and 6280 Nordic alvar and Precambrian calcareous flatrocks</u>
Flatrock habitats occurring on very thin soil layers rich in pioneer communities.

<u>6120* Xeric sand calcareous grasslands</u>
Dry, frequently open grasslands on more or less calciferous sand fall within type 6120. The sandy-soil types can be considered as type 6120 if the sand is calcareous whereas the moraine type can be considered as type 6210 (Pihl *et al*. 2001).

<u>6230* Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)</u>
In areas where the calcareous content has been wholly or partially washed out (pH 6-7) the community type represents a transitional stage towards type 6230; in such cases, the species composition will determine the appropriate classification (Pihl *et al*. 2001).

6240 * Sub-pannonic steppic grasslands
Steppic grasslands, dominated by tussock-grasses, chamaephytes and perennials of the alliance *Festucion valesiacae* and related syntaxa. These xerothermic communities are developed on Southern exposed slopes on rocky substrate and on clay-sandy sedimentation layers enriched with gravels. They are partially of natural, partially of anthropogenic origin (EC 2007a). They include dry, thermophilous and continental areas, characterised by the influence of entities with Mediterranean–steppic distribution. The guide species of reference, distinguishing them from other dry grassland types, could be considered to be *Stipa capillata* (Lasen & Wilham 2004).

6270* Fennoscandian lowland species-rich dry to mesic grasslands
This habitat is comprised of semi-natural grasslands of similar physiognomy but with few or no calcicolous plant species, primarily on nutrient-poor soils on gneiss or granite bedrock in the Nordic countries.

62A0 Eastern sub-mediterranean dry grasslands (*Scorzoneratalia villosae*)
This habitat is comprised of semi-natural grasslands of similar physiognomy but with some Illyrian and Mediterranean grasslands species.

6410 *Molinia* meadows on peaty or clayey-silt-laden soils
Transitions towards the subtype found on neutro-alkaline to calcareous soils may occur in depressions, along lake and river shore-lines etc.

6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) and 6520 Mountain hay meadows
These are semi-natural habitats, whose maintenance depends on human activity. They are nutrient rich, mesic, regularly mowed and manured in a non-intensive manner. Without manuring and when mowing is carried out more than once a year, they tend to develop towards *Mesobromion* grasslands (habitat 6210) (Lasen & Wilham 2004).

7230 Alkaline fens
In fresh beach ridge hollows and at the edge of calcareous fens the 6210 community type may be in transition towards type 7230 (Pihl *et al*. 2001).

Ecological services and benefits of the habitat

In general, calcareous grasslands provide important benefits for society (production, employment) and the environment and biodiversity, although these benefits are not always well-recognised or understood. The grasslands are key habitats for many species: herbs, grazing animals such as deer and rodents, butterflies and reptiles, and many bird species (EEA 2001). Moreover, while soils under intensively managed crops are poor at carbon sequestration; pastures can sequester 0.3 – 0.6 tonnes of carbon per hectare per year (DEFRA 2007).

The 6210 habitat type, visibly rich in species (flowering plants, insects, raptors) also has a high recreational value. This grassland type has long been an important feature for landscape painting and the appreciation of the countryside. Grasslands such as steppes are the homes of ancestors to several of the now most widespread crops, garden bulbs, several spices and medicinal plants (EEA 2001).

Some unimproved limestone grasslands are particularly appealing ecological and landscape assets, which provide an insight into the general need for biodiversity conservation (GWT 2000).

Trends

Semi-natural dry grasslands, which were once widespread in Europe, are now a scarce and threatened habitat (JNCC *et al* 2007a), which has been pushed back into isolated residual areas in the past decades (LIFE 2002/NAT/D/8461). The total area of grassland in the EU fell by an average of 12% between 1975 and 1998, with increases in only a few areas (EEA 2001).

The pressure on grassland habitats is steadily increasing, mainly due to the abandonment of use or changes in use (EEA 2001). The grasslands are undergoing a progressive qualitative and quantitative regression and the natural evolution of the vegetation will result in the near-disappearance of the habitat (LIFE99NAT/IT/006229) in many sites. The remaining areas have become extremely fragmented, mostly confined to calcareous outcrops or steep slopes, where forest development is retarded (Butaye *et al*. 2005).

In Denmark, for instance, the general trend of deterioration in the habitat type is illustrated in the remapping in 1989 of slopes originally mapped by Böcher and Fredskild in 1940 and 1951 (Feilberg 1990). The gentle slopes originally supporting closed herbaceous vegetation had subsequently changed significantly. One third of the slopes were completely overgrown with woody plants; many of the other slopes had been invaded by *Arrhenatherum elatius* (tall meadow oat). Most slopes exhibited an obvious decline in the species associated with nutrient-poor soils and the invasion of typical farmland species was frequently observed (Pihl *et al*. 2001).

The habitat is now rare in Denmark and has declined tremendously because of the cultivation, planting, fertilisation and scrubbing over of dry grasslands throughout the last 200 years. This decline is illustrated by the decline in the characteristic species, *Orchis ustulata* (dark-winged Orchid), which used to be known from about 50 localities, but is now only known to occur at two localities in Jutland (Ejrnæs *et al*. 1998).

In Austria this type of habitat has suffered a significant reduction in extent as a result of abandonment of use, scrub/vegetation encroachment and fertilisation (Essl 2005).

In the UK the area of calcareous grassland has suffered a sharp decline over the last 50 years: an assessment of chalk grassland in Dorset found that over 50% had been lost between the mid-1950s and the early 1990s (UK Biodiversity Group 1998). Calcareous grassland is now primarily restricted to steep slopes on limestone associated with dry valleys or dales and scarp slopes where agricultural improvement has been impractical (Crofts & Jefferson 1999).

In Belgium, urbanisation, abandonment of grazing and fertilisation since World War II have resulted in a dramatic decrease in the grassland area (Butaye *et al*. 2005).

Threats

The main causes of decline in calcareous grasslands are irrational grazing, afforestation and succession, land-use changes, abandonment.

Unregulated grazing

Grazing by domesticated farm animals was, and in many places remains, a key factor in sustaining dry calcareous grasslands in many parts of Europe, so changes in stock grazing will always affect this habitat (Rodwell 1992) and are the major reason for its unfavourable condition (Rodwell *et al*. 2007, Pihl *et al*. 2001).

Moreover grasslands, which have survived as a result of presence of livestock are often managed in a way which is not ecologically rational, mostly due to pressures on farm labour. In many instances grazing is carried out in a way, which produces areas, such as those with the most appetizing swards, where pressure from grazing is excessive, and other areas where there is little or no pressure (Provincia di Prato 2007b).

Overgrazing, especially during the summer, implies excessive nibbling, trampling and poaching, causing both soil erosion and a decrease in species-richness and structural diversity, with a loss of tall herbs and an increase of invasive thorny species of little appeal to livestock (LIFE04NAT/IT/000173, Buglife 2007).

Linked to overgrazing is the eutrophication that threatens some sites. The habitat depends on the maintenance of impoverished soil conditions for the particularly striking richness of species; supplementary feeding of livestock produces an excess of manure, and therefore the increase of the level of nutrients (Pihl *et al*. 2001; Rodwell *et al*. 2007).

Undergrazing results in tall rank grasslands and a loss of biological diversity. Coarse grasses such as *Brachypodium* pinnatum (tor-grass) previously kept in check by grazing have become dominant over large areas of chalk and limestone. When tor-grass invades a species-rich sward, the nature conservation interest of the site usually declines due to a reduction in species numbers and diversity (Crofts & Jefferson 1999). The dominance of *Brachypodium pinnatum* is attributed to changes in soil nutrient usability (specifically increased availability of nitrogen), increased litter deposition and reduced lighting availability. However, it is not clear whether increasing dominance of *Brachypodium pinnatum* is the result of the increased nitrogen levels or whether increased nitrogen levels are the result of increased litter deposition of *Brachypodium pinnatum* (Bobbink *et al*. 1988, Hurst & John 1999).

Abandonment and succession to woodland

A decline in the old grazing regimes (mountain summer pasturing) and of transhumance (annual migrations of grazing flocks) or their disappearance has led to the abandonment and disappearance of large areas of grassland (EEA 2001, LIFE99NAT/IT/006229, Provincia di Vicenza 2006). These dry warm locations have poor soils and are low in nutrients, so they are of little importance for present-day agriculture (LIFE 2002/NAT/D/8461).

Abandonment of agro-pastoral activities results in the development of “scrubland facies” (LIFE 2002/NAT/D/8461), represented by thermophile scrub with an intermediate stage of the thermophilous fringe vegetation (*Trifolio-Geranietea*) (EC 2007a). *Festuco-Brometea* grasslands evolve towards formations such as *Rosa* spp., *Amelanchier ovalis* and in succession towards more complex forest formation. This process of evolution can take from 10 to 15 years for the formation of scrub and 70 or more years for the succession to woodland (DET 2005a).

Scrub encroachment is the most frequently documented cause of change in 6210* sites. Scrub invasion is considered to be an acute threat because it can result in an increase in soil nutrients and a decline of richness in grassland species (Buglife 2007) as the succession progresses. Thus many sites are becoming overgrown and many orchid populations are so small that their long-term survival is uncertain (Pihl *et al*. 2001).

It is to be noted that although abandonment and the succession to woodland is considered to be a threat to calcareous grassland, the Annex I habitat 6210 includes scrub margins within its definition. This fringe vegetation can be very species-rich and suitable for the occurrence and development of orchids. In particular, certain rare orchids, like *Himantoglossum hircinum* and *Orchis militaris*, are actually associated with such transitional vegetations (Rodwell *et al*. 2007). However, without intervention it is likely to develop rapidly into species-poor dense scrub (JNCC *et al* 2007a), resulting in the disappearance of the habitat (LIFE 99NAT/IT/006229). It is not, therefore, advocated that scrub should be allowed to colonize at the expense of existing semi-natural grassland of high nature conservation value (Crofts & Jefferson 1999).

Weeds invasion

A weed may be defined as a species, which is undesirable to the purpose/objective of grassland management. Under certain conditions some plants species (e.g. thistle, bracken, ragwort, etc.) can excessively multiply, quickly replacing communities that have a greater conservation value (Pearson *et al*. 2006). These plants are highly competitive, often toxic, and once established they produce a heavy shade in the growing season, which discourages other plant species (including orchids) to establish (Crofts & Jefferson 1999).

Agricultural improvement

While on one hand there is a growing tendency to abandon the least accessible areas, on the other there is an intensification of exploitation of grasslands easily accessible to mechanical means. The consequent intensification of agricultural practices - nutrients input by fertilization and herbicide application - causes a transformation in species-poorer grassland types (Essl 2005), such as lowland hay meadows and mountain hay meadows (6510, 6520) (Lasen & Wilham 2004) and into other less valuable habitats.

The conversion of dry calcareous grassland to arable by the application of chemical fertilisers, together with ploughing and reseeding on soils sufficiently deep for cultivation has resulted in drastic eutrophication (Rodwell *et al*. 2007).

Land use change

Change of use of grassland areas depends on the land-use policies of different countries, reflecting, for example, national plans for the conversion of grasslands to forests (EEA 2001). The habitat is often converted to various other kinds of grassland, with a rise in herbage productivity but a consequent reduction in species richness and a convergence from what were originally locally-distinctive grasslands into the sort of improved mesotrophic grassland that is ubiquitous (Rodwell *et al*. 2007). This leads to a decline in the specialist flora and fauna found in this habitat (RSPB 2004b).

Airborne nitrogen deposition

Increased nitrogen availability, caused by atmospheric deposition, and climate change, is probably of major importance in a number of European calcareous grasslands. The habitat vegetation is characterised by many species of low stature, which require nutrient-poor soil status (Ellenberg jr. 1988). It is thus to be expected that these species-rich grasslands will be affected by increased atmospheric nitrogen input (Wellburn 1988, Liljelund & Torstensson 1988, Ellenberg jr. 1988).

Atmospheric deposition of nitrogen compounds destabilises the normal competition between plant species (EEA 2001). In particular, the effects of nitrogen enrichment result in a strong reduction in species diversity and in a change in the vertical structure of the grassland vegetation. This is caused by an enhanced growth of some non-indigenous, more competitive 'tall' grasses, especially of stress-tolerant species, which have a slightly higher potential growth rate and more efficient nitrogen utilisation (Werner & Spranger 2000).

Other local factors affecting the habitat

Human activities: development activities such as mining and quarrying, road building, house building and landfill can destroy or fragment and isolate remaining sites. The quarrying of limestone and other calcareous bedrocks is a local but significant factor resulting in the loss of calcareous grasslands. In Slovakia, recent urban expansion has had a direct impact on the habitat.

Recreational pressure and inappropriate recreational use bring about floristic changes associated with soil compaction and erosion (UK Biodiversity Group 1998, 1999). Thus walkers leaving paths lead to pressure by trampling of the flora and disturbance of fauna (LIFE 2002/NAT/D/8461).

Alien plants: in the rocky sites with this habitat in UK, invading alien plants are a threat. Here, bird-sown *Cotoneaster* and *Berberis* species, which can root in crevices have spread extensively over the ground, shading out and smothering the native flora (Rodwell *et al*. 2007).

Fires are a typical threat to this habitat in the Mediterranean regions, resulting in a change of floristic composition and/or in intensive post-fire erosion. In areas affected by a fire *Molinia arundinacea* tends to become dominant, reducing less biodiversity values (DET 2005b).

Climate change effects

Climate change is a future threatening factor for overall conservation status of the *Festuco-Brometalia* habitat (JNCC 2007b). Part of the character of dry grasslands comes from drought-resistance or, in some cases, dependence on the shortage of water to maintain the distinctive floristics and structure of the vegetation. However the prospect of climate change with more severe drought episodes still poses a particular threat for those plant communities, which are already in regions or on topographies, which have a highly xeric character (Rodwell *et al*. 2007).

Models predict a potential increase in the climatic envelope for calcareous grasslands (Walmsley *et al*. 2007) and calcicolous grasslands (JNCC 2007b) although their spread is limited by geological and edaphic constraints.

The response of the calcareous grassland plant community to climate change appears to be related to the history of the grassland. Early-successional calcareous grasslands composed of fast-growing or short-lived species are more likely to be affected by climate change than older calcareous grasslands. Deep-rooted herbs and short-lived ruderal species will increase on calcareous grasslands under drought, while grasses will only increase if rainfall increases, which is unlikely (Brown *et al*. 1998). The plant community composition of calcareous grasslands will therefore experience an increase in herbaceous and ruderal species as the climate changes (JNCC 2007b).

Milder winters might also affect the phenology of growth in calcareous grasslands (Rodwell *et al*. 2007). Early spring will cause the decrease in the number of species occurring on calcareous grassland, as vernal species are out-competed. However, the prospects of lowland calcareous grasslands are difficult to define, with some modelling suggesting that they have low sensitivity to climate change, while experimental research shows significant shifts in the botanical composition of the habitat. Temperature, rainfall and CO_2 levels have all been shown to affect the nitrogen dynamics of calcareous grasslands (i.e. summer drought will increase nitrogen mineralisation rates), but the results are complicated, since the drivers interact with each other (JNCC 2007b).

2. Conservation management

General recommendations

Considering the natural tendency of *Mesobromion* grassland to evolve towards scrub and woodland, the management should allow for the localised recovery of nuclei of scrub and tree vegetation, in a way compatible with the autochthonous evolution series of vegetation (MATT 2003). An exception should be made for *Mesobromion* grassland which hosts precious floristic elements, such as orchids, which if left to evolve naturally would tend to disappear. In these cases management should tend to the conservation of the *Mesobromion*, preventing its natural evolution, through cutting and/or grazing.

This type of habitat should be excluded from afforestation (ARPA ER 2006, DET 2005a). As *Mesobromion* grasslands are a semi-natural vegetation, only on-going management prevents its reversion to woodland and allows the maintenance of the floristic and vegetation value of these environments (Lasen & Wilham 2004).

As the habitat features, conservation values and context (history and development) are very different between the various countries and biogeographical regions, it is important, when planning the management for the habitat, to take into account the following general aspects which will allow sensible management decisions to be taken:

- Site-specific objectives and targets with reference to the conservation status of species;
- Local/regional land use and livestock husbandry traditions, practices and techniques – the conservation values of today are often the result of the land use and grazing regimes of the past;
- Although it is often neither possible, nor appropriate nor necessary, to mimic historical management, it should if possible be informed by existing knowledge and experience.

Moreover, before making decisions on how to manage grassland it is necessary to define specific objectives for the specific area. Grassland management objectives will vary from site to site and within one site different goals may be set for different areas; a balanced approach is to see the primary goal as the maintenance of the main plant communities, along with the main features of importance to animals, such as areas of bare soil, scattered bushes and scrub margins (Kirby 1992). In addition, it is sensible to review these objectives from time to time to take into account newly acquired knowledge of the site and the changing status of grassland types and species elsewhere (Crofts & Jefferson 1999). The management indications illustrated below are intended as “good examples” of how different problems have been tackled in practice: they are not to be taken as “instructions” that can be applicable everywhere.

The management objectives for nature conservation of calcareous grasslands might include the following (Crofts & Jefferson 1999):

- maintaining the nature conservation interest of grassland communities valued for nature conservation with their component species of flora and fauna;
- limiting the establishment of undesirable robust competitive grasses and herbs;
- diversifying the grassland structure and increasing plant species richness;
- creating specific conditions for certain species;
- removing/checking scrub invasion and, where possible, enhancing its ecological interest;
- retaining some areas of unmanaged grassland, if appropriate.

The objective of grassland conservation management should be to provide variety in structure and composition both on a macro and micro scale (Crofts & Jefferson 1999), favouring different structural elements forming a mosaic of longer and shorter grass, of shrubby vegetation and small bare areas that will benefit different forms of wildlife (RSPB 2004b). Insects, for instance, need open areas alternating with scrub areas, on a scale of one square meter, while birds or mammals need more extended areas, on the scale of one hectare (Croquet & Agou 2006). The desirable sward structure or mosaic of structures for a particular grassland site will depend on the particular nature conservation objectives.

It is also recommendable that fertilisers and supplementary fodder are not used on this habitat, because the application of fertiliser decreases species-richness, enhancing the ability of competitive species to thrive and increasing the standing crop (Crofts & Jefferson 1999). To maintain high species diversity, fertilisation has to be avoided (Werner & Spranger 2000, Lasen & Wilham 2004, Essl 2005).

Active management

Semi-natural grasslands require low intensity or extensive management to maintain their nature conservation value. Grazing and mowing maintain grassland communities by (Crofts & Jefferson 1999):

- restricting the growth of shrub and tree species by removing their growing points;
- preventing coarse grasses and tall herbs from achieving dominance by giving low growing species a chance to compete;
- removing leaf litter that may further suppress plant growth and increase the soil nutrient status;
- allowing seedlings of short-lived species to become established in the gaps in the grassland produced by grazing animals.

Whether grazing or mowing is the most appropriate regular management for high quality calcareous grasslands is a not straightforward question (Butaye *et al.* 2005). In an experiment on the effects of several management regimes (grazing, mowing, and non-intervention) on the biodiversity of Dutch chalk grassland, grazing resulted in the highest level of biodiversity, non-intervention in the lowest level (ca. 42 and 15 spp./m^2, respectively) (During & Willems 1984). Moreover, grazing proved to be more efficient than mowing in countering the effects of increased nitrogen levels (Butaye *et al*. 2005). Nevertheless, although most studies recommend grazing as the most appropriate management for calcareous grasslands, Fischer & Wipf (2002) found that in the upper sub-alpine region, calcareous grasslands that have been traditionally mown were favoured by mowing, rather than by grazing. Therefore, when defining appropriate management regimes, history and the nature of the community are very important variables (Grime *et al*. 2000, Britton *et al*. 2001).

Meadows host different animal and plant species from pastures. Only 40% of the species are to be found in both grassland types, as the majority has adapted to a specific agricultural practice. Although aftermath grazing is a common and wide-spread practice in late summer or autumn, this mixed use - both mowing and grazing - is not always desirable from a biological point of view, as it tends to produce a decrease in those characteristic species which are linked to only one of the practices, thereby favouring less demanding and therefore more banal species (Pearson *et al*. 2006).

For the same reason, where there has been no previous history of mowing, then the likely effects on the nature conservation interest of a change from grazing to mowing need to be evaluated. This may be particularly critical for invertebrates. The invertebrate species present will be in fact those whose life cycles fit with the existing long-established management regime. In a similar manner conversion from meadow to permanent pasture is likely to result in changes in plant species composition (Rodwell 1992). Early flowering species, which rely on seed production for maintenance of populations, will be reduced or eliminated by such change. If there is any doubt, the precautionary approach of avoiding changes in long-established management should be adopted in order to fulfil nature conservation objectives (Crofts & Jefferson 1999).

Grazing

Semi-natural calcareous grasslands are used for either grazing or hay cutting or a combination of both. In rural areas, grazing is important both to the local economy and for its role in maintaining the aesthetic value of grassland sites for the benefit of the local community. Calcareous grasslands tend to be low productivity systems, which produce lower yields of digestible herbage, and so they are usually maintained by grazing rather than mowing (Crofts & Jefferson 1999, JNCC 2007a).

Conservation grazing is becoming increasingly used to maintain wildlife sites (RSPB 2004b) and it is the preferred option when managing for invertebrates (Crofts & Jefferson 1999).

Except at very high stocking densities, grazing removes plant material more gradually than cutting. This can give more mobile invertebrates a chance to move to other areas within the grassland (Crofts &

Jefferson 1999). Ungrazed areas are important for the shelter or over wintering of microfauna (Pearson *et al*. 2006). Grazing also has other benefits. Moderate trampling can be beneficial: the hoof action of heavy animals, such as cattle, breaks up the litter layer and tramples and crushes coarse vegetation (Crofts & Jefferson 1999). In addition, animal hooves create a certain amount of bare ground. This is important for the life-cycle of many invertebrates and also for types of plant that require bare ground in order to germinate and establish (RSPB 2004b).

Grazing animals promote the recycling of nutrients in the grassland ecosystem. Nutrients are added in the form of dung and urine. This can result in a net import of nutrients and can cause problems for grasslands of conservation interest, which have a much lower nutrient budget. However areas that have received dung and urine may be avoided by livestock for some time and this can result in patches of taller vegetation among shorter turf, which may benefit some invertebrates. Dung itself is a very valuable invertebrate habitat. Moreover grazing stock can transport some of the less mobile species to new areas. Finally, there is the occasional piece of carrion (Crofts & Jefferson 1999), important for many invertebrate species and for raptors too.

Studies made on the impact of pastoral activities on calcareous grasslands in Bourgogne show that in spite of an increase in floristic diversity, the repercussions on the entomofauna can be both positive and negative, depending on the pastoral practices (Croquet & Agou 2006).

<u>Grazing regime.</u> The biological features of a grassland are profoundly influenced by, and in many cases fundamentally determined by, the grazing regime imposed upon it. The options for establishing an appropriate grazing regime for conservation are based on a number of different parameters:

- stock type (cattle, sheep, ponies, etc.)
- grazing periods (season of grazing)
- stocking rates
- duration of grazing (time for which grazing is allowed)
- grazing system (sequence and pattern of grazing events).

The way in which these parameters interact with each other to affect the grassland is often complex, making accurate predictions of outcome more difficult. However this also means that a desired result can often be achieved using a variety of regimes.

<u>Animal type.</u> Grasslands swards are maintained with different grazing animal types throughout Europe: cattle, horses, sheep, goats (EEA 2001). All the stock types, at low stocking densities, produce the kind of patchy structure and mixed height grasslands that form the conservation objective for many grazing regimes. It is the pattern and scale of the vegetation mosaic, which are most likely to differ according to choice of stock (Crofts & Jefferson 1999): different animals create different types of microhabitat. Cattle are generally better than sheep at creating and maintaining structurally diverse grassland of benefit to invertebrates. Cattle pull grasses up as they graze, creating a tussock structure; sheep create a tightly grazed turf (RSPB 2004b). However, very dry pastures in Southern Europe generally are more suitable for sheep than for cattle grazing, as the former can better withstand the extreme conditions. Sites grazed by horses and ponies can be structurally varied and can support unusually diverse invertebrate faunas due to the patchy effect created by grazing (Crofts & Jefferson 1999).

All animals graze selectively. Favoured elements of the vegetation are eaten first while less desirable plants are left until last, or not grazed at all. There is considerable variation between different types of animals regarding which plant species they favour - selective grazing of some species of plant can lead to overgrazed areas (Crofts & Jefferson 1999). Some animals are more selective than others of different herbage and this trait can be used when managing for a particular species (RSPB 2004b). The selection and rejection of certain plant species in preference to others by grazers can play a key role in maintaining species richness and determining the structure and floristic composition of the grassland: grazing limits the ability of competitive coarse grasses to achieve dominance by continually removing their additional biomass (Crofts & Jefferson 1999).

Cattle differ greatly from sheep in that they prefer to eat longer grass and they cannot graze as selectively. Goats can either graze or browse; donkeys are similar to ponies in that they graze selectively. Rabbits will not graze tall grasslands, are highly selective grazers and at moderate densities they produce a patchy mosaic of small areas nibbled to different heights.

Trampling effects also vary by species. The physical pressure exerted on grassland by sheep is estimated to be 0.8 to 0.95 kg per cm^2 and by cattle to be 1.2 - 1.6 kg per cm^2 (Spedding 1971).

The species of livestock has however a minor effect when grazing pressure is his; damage, in the form of an overall reduction in plant species richness, was found at sites heavily grazed by both horses and cattle (Crofts & Jefferson 1999).

Introducing alternating grazing between different species of livestock into habitats where it is not usual has negative impacts. Many characteristic plant species that have adapted to grazing by a specific animal tend to disappear when the type of animal is changed, as they become vulnerable to a different way of grazing (Pearson *et al*. 2006).

However, mixed grazing can at times be beneficial, since it may create different grassland structures depending on the grazing preferences of the different animals; the food preferences of the different grazers are unlikely to coincide. The regime may require them to be grazed separately: cattle, for example, can be used to graze off tall late season grasslands initially, to be followed by sheep or ponies once the grassland height has been reduced to a level that these other grazers can cope with more effectively.

Different sources of grazing need to be identified and assessed separately so that only the most appropriate adjustments are made (Crofts & Jefferson 1999).

Cattle	**Sheep**
Best suited to maintain grasslands - not selective: good impact for a great variety of species; - almost no damage to turf. Young animals, with less weight, are particularly suited.	Best suited only for least productive and very dry areas: - very selective (they turn down tufted grassland; - risk of damaging turf. To limit negative impact: - short periods of pasturage, followed by long pauses (at least 8 weeks); - limit the number of animals. Sheep are lighter and more agile than cattle and may be more appropriate for grazing on steep slopes (Crofts and Jefferson 1999).
Goats	**Horses and ponies**
Particularly suited for scrub surfaces: - not very selective; - they prefer to browse woody plants. In order to avoid damage from excessive exploitation, they should be allowed to graze only in specific spots and for a limited period of time.	Pasture by horses and ponies represents a difficult task: - they are very selective; - they browse the plant basis; - they can damage turf with their weight and trampling.
Donkeys	
Donkeys are small, much lighter than horses and ponies of equivalent height and they are suitable for grazing on steep slopes. Moreover they are easy to manage (LIFE03NAT/IT/000147) and useful for controlling infesting plant species (Crofts and Jefferson 1999). In addition donkeys are not selective and are resistant to lack of water and severe temperatures.	
Mixed grazing	
Mixed pasture by cattle and goats or by sheep and goats could be suitable where there is a gradual increase of scrubs, only if time and number of goats is limited.	

Based on: Pearson et al. 2006.

Grazing periods. Grazing of pastures can take place at any time of year including periods when plants are growing, flowering or setting seed. As a result, some species found in hay meadows are generally absent or reduced in dominance in grazed swards owing to their intolerance to grazing (Hopkins 1990).

The attractive elements of semi-natural grassland are most visible in the absence of summer grazing when plants and animals are able to complete their life cycles undisturbed by large herbivores. Therefore, delaying the onset of grazing until sometime after the end of the growing season will allow plants in the sward to flower, seed and start senescing (Crofts & Jefferson 1999).

On the other hand, grazing during spring and summer may prevent plants from establishing: flower heads may be eaten so preventing the seed source establishing and, in the winter, soil may become poached by hooves (RSPB 2004b). It also reduces structural variety and feeding sites for flower feeding invertebrates (in their flowering period dry grasslands represent an excellent source of nectar and pollen for many insects), which may have a detrimental impact on invertebrates.

However cattle or ponies grazing in summer help to break up stands of bracken *Pteridium aquilinum*. Good results are obtained if the animals are introduced soon after the young shoots have begun to emerge, and can be kept on the site at least until the fronds begin to senesce.

Grazing in the winter is less damaging to invertebrates, which are usually overwintering in the base of tussocks. Moderate trampling breaks up the litter layer exposing ground for colonising by annuals the next spring. Moreover, winter grazing can be beneficial for invertebrates as poaching will produce exposed soil of value during the summer.

Winter grazing may provide more effective maintenance for grasslands of low productivity, where the residual biomass is not excessive and can be largely removed in most years by a combination of grazing and/or cutting. Even in grasslands of low fertility however, winter-only grazing will usually still allow scrub to encroach (Crofts & Jefferson 1999).

<u>Stocking rates.</u> Grazing pressure is a measure of the amount of vegetation that a given number of grazing animals of given species and size are expected to obtain from an area of grassland during the time for which they are grazing it. When grazing pressure is allowed to exceed the carrying capacity of the grassland it would normally result in damage to the sward's ecological and productive character and this is equivalent to the concept of overgrazing (Crofts & Jefferson 1999). It is decisions regarding numbers of grazers and the length of time for which they remain on the site that will determine the outcome of the grazing regime (Crofts & Jefferson 1999).

To evaluate the livestock load it is useful to carry out a survey of pasture vegetation (LIFE97 NAT/IT/004145). The essence of maintenance grazing lies in ensuring that each year's production has been removed before the start of the next growing season.

The annual yield of plant biomass sets the upper limit for the grazing pressure that can be sustained by a particular sward. Conservation objectives generally require stocking levels that are lower than the carrying capacity of the grassland. This allows a significant proportion of the sward's annual production to escape being grazed by livestock so that it can enter other food chains (e.g. invertebrate herbivores or decomposer communities) or enhances the structured diversity of the habitat. This would need stocking levels to be reduced well below the theoretical carrying capacity of the sward in order to ensure that sufficient vegetation remained ungrazed during the growing season for meeting conservation objectives (Crofts & Jefferson 1999).

Nonetheless, in many cases it is not possible to define the optimum successional stage and hence stocking density in practice (Pihl *et al*. 2001). In small habitat units it can be particularly difficult to strike a balance in grazing intensity that avoids both scrub invasion and overgrazing. It is uncertain whether this management alone is sufficient to counteract further scrub invasion (Pihl *et al*. 2001).

The table below provides examples of stocking levels that have been found to be effective in conserving existing semi-natural calcareous grasslands on shallow soils. It may be necessary to increase stocking rates on sites with deeper soils such as in valley bottoms. The table shows how longer duration with cattle or sheep compensate for lower numbers of animals in achieving the same overall level of stocking.

Table 1. A guide to stocking levels for lowland calcareous grassland (number of animals per hectare) (Nature Conservancy Council 1986)

No of grazing weeks per year	S	C
2	60	15
4	30	8
6	20	5
8	15	4
10	12	3
12	10	2.5
14	8.5	2
16	7.5	2
20	6	1.5
24	5	1
36	3.5	1
52	2.5	0.5
Annual Stocking Rate LU/ha/yr	0.25	

S=sheep	C=cattle
*c*60kg LW	*c*250kg LW
LU = Livestock Unit	
LW = Liveweight	

Note: Four adult ewes (each 60kg live weight) are taken to be equivalent to one yearling beef store (240kg live weight). Each beef animal is therefore equivalent to approximately 0.5 LU and each sheep to 0.125 LU. The number of animals that can theoretically graze throughout the 52 weeks of the year is equivalent to the annual stocking rate when converted to LU/ha.

Grazing duration. It is assumed that the inverse relationship between stock numbers and duration of grazing is directly proportional (as for example in the table above). However, this is only true as long as the rate of sward production remains constant. This means that in terms of the sward's carrying capacity the potential stocking levels will be higher in summer than in winter because in summer the vegetation continues replacing itself while it is being grazed, while by winter the sward has ceased production. However, this does not apply in dry regions of Southern Europe where summer is a period of no growth and thus of lower carrying capacity.

Short periods of intense grazing may be appropriate in situations where problem weed species exist. However, the effect of short periods of heavy grazing on grassland in general is likely to be catastrophic for some invertebrate species that are dependent on continuity of grassland structure over their entire life cycle. It will be least harmful in winter when most above ground insects are in a dormant phase of their life cycle. The same annual grazing pressure can still be achieved by using a lower stocking rate but only if it is maintained over a longer period of time; the desired grassland structure is still achieved but more time is given for invertebrates to re-distribute (Crofts & Jefferson 1999).

Grazing system. The grazing system is the routine, organised sequence for moving grazing stock over an area of pasture. The various grazing systems can, in essence, be simplified down to two fundamental strategies: set stocking and rotational grazing, which can also be combined.

Set stocking system. The existing semi-natural grassland occurs where the primary form of land-use is extensive grazing (Crofts & Jefferson 1999). The survival of the ecological character of these semi-natural habitats, which have been maintained by low-input, extensive livestock systems, should be a key concern for conservationists (Tubbs 1997). At low stocking rates, set stocking allows the ungrazed parts of grassland to develop phenologically, thus providing many more ecological niches for animal species to exploit (flowers, seeds, standing and fallen dead material) (Crofts & Jefferson 1999). By maintaining low stocking rates, invasive plant species will be controlled whilst maintaining the invertebrate fauna that depend on the grasses (RSPB 2004b).

Stocking density can be adjusted as required, usually being reduced as the season progresses and grassland productivity declines. The location of any drinking trough will influence grazing patterns in extensive grazing systems (Crofts & Jefferson 1999). A scarce water supply produces a concentration of animals in the areas in which it is located, with a consequent local decline in the grasslands, both as feed for livestock and in terms of natural value (Provincia di Prato 2007a).

Where grazing or trampling threatens particularly valued plant species, it could be necessary to create special areas in order to protect these species from grazing pressure (Colas & Hébert 2000).

It is indeed possible to improve the composition and the quality of grassland swards, encouraging the regeneration of rare and threatened plants that are characteristic of this habitat, by fenced exclosures.

Effects of extensive grazing on grassland vegetation (Colas & Hébert 2000)

- reduction of the average height of the vegetation;
- increase of the number of facies, that can go from short, sparse patches to tall, dense ones;
- increase of species diversity, particularly because of the appearance of long-lived or annual plant species;
- control or supression of invasive grasses (*Brachypodium pinnatum, Bromus erectus*);
- restriction of the expansion of nitrophilous species, except on resting areas;
- next to no disturbance to the microfauna.

Rotational grazing is where the area for grazing is divided up into compartments (fields, paddocks or strips) or where the flock or herd is under the active management of a herder and the stock is moved to fresh grazing units at appropriate intervals. The animals are moved to new areas at regular and frequent intervals, progressing around the whole grazing area in a structured sequence. They return to graze the initial area when the grassland will have recovered its full productive capacity, but not yet started to flower (Brockman 1988).

Rotational grazing can be used to achieve conservation management goals, particularly when short grasslands are required to maintain the more specialised communities, which depend on them, and when the grassland area is scattered over many separate sites. This approach often works best on sites requiring winter grazing, since the objective is simply for the animals to graze as much as possible of the past seasons growth. Once this is done the grassland is ready for the onset of the new season's production (Crofts & Jefferson 1999).

For containment and in order to create several zones where the grazing will be carried out in turn, fencing for livestock is suitable. The kind of fences used (e.g. barbed wire, wooden palings, type of gates, etc.) should to be agreed with the herders (LIFE97 NAT/IT/004145). In mountain sites, where small pasture areas (less than 10 ha) are found in otherwise wooded areas, it could be helpful, in order to facilitate the movement of the livestock, to use temporary and wide band fences fixed to wooden posts spaced out with plastic posts. A LIFE Nature project showed that low-tension electric fences powered by solar panel are easy to manage, not too expensive and allow the use of non-polluting energy (LIFE03NAT/IT/000147).

Mowing and cutting

Mowing and cutting are methods of managing grasslands for hay (hay meadows). As well as in locations where it is traditional, mowing can be considered as an alternative to use of livestock in situations where grazing, while preferred, is not a practicable option (Crofts & Jefferson 1999).

Like grazing, regular mowing prevents the dominance of robust competitive grasses, herbs and the establishment of shrubs and trees, maintaining a grassland community in perpetuity (Crofts and Jefferson 1999).

The maintenance of greater structural diversity in grassland may be necessary for conserving particular assemblages or rare species of invertebrate (Kirby 1992). Mowing does not create the same mosaic of habitat conditions as grazing. A mown grassland has little structural variety and so is of less value for invertebrates than a well-grazed area (Crofts & Jefferson 1999).

Table 2. Differences between mowing and grazing (Crofts & Jefferson 1999)

Attribute	Cutting	Grazing
Removal of bulk and biomass	Yes	Yes
Maintenance of low nutrient status of the soil	Yes, if all cuttings are removed	Yes, but there will be some nutrient return through dunging/urination
Creation of open ground and gaps to provide regeneration niches, habitat for invertebrates etc. (Gaps are necessary to recruit new individuals into the grassland and to maintain/enhance species richness)	No	Yes, if by hoof action of cattle, ponies, donkeys and sheep
Selection and removal of particular species (see also below)	No selection takes place	Yes, selection takes place with important effects: selective control of palatable species, favoring of unpalatable species and favoring of low-growing, less accessible species
Creation of patchiness in vegetation	No	Yes, unless stocking is very heavy. This results from the selectivity outlined above
Selection of flower and seed heads	No, all may be removed, or allowed to remain, depending on the timing of cutting	Yes, selectivity depends on type of stock and timing of grazing
Gradual patchy removal of the biomass over time	No, sudden and uniform	Yes
Creation of structurally varied grassland (patchy, tussocks, lawns, bare areas, etc)	No	Yes, unless stocking is very heavy and continuous
Creation of dense and mattressy grassland	Can occur with regular close cutting	Can occur with heavy and continuous grazing, particularly by sheep

Mowing/cutting management methods are distinguished by (Pearson *et al*. 2006):
- timing;
- frequency;
- distribution;
- methods.

Timing of cutting. Cutting dates for hay made from semi-natural grasslands without the use of artificial fertilizers are likely to be later than those for more productive meadows to ensure reasonable crop yields and to maintain their nature conservation value. Management of meadows for nature conservation normally involves a single late cut for hay. The dates will substantially vary according to location and the nature of the wildlife interest (Crofts & Jefferson 1999).

Late cutting can be useful (Pearson *et al*. 2006):

- to protect animal species that need a highly structured vegetation for feeling and refuge, in particular birds and insects
- so that late-flowering plants can set seed

Early cutting can be useful:

- where there is a rich vegetation, that would otherwise start to decompose
- to slow down the development of alien species

Sustained early hay cutting is known to reduce species richness in meadows (Smith 1994). Cut should not take place before breeding birds have hatched or populations of "desirable" characteristic plant species, which depend on seed production for regeneration have set seed. Furthermore occasional late hay cut (late August/September) (e.g. 1 year in 5) is practical on sites, which support late-flowering species (Crofts & Jefferson 1999).

Frequency of cutting. The *Mesobromion* grasslands are generally mown once a year-sometimes even once every two years - due to their low productivity (Pearson *et al*. 2006), although more mesic and productive grasslands can stand two cuts (Rodwell *et al*. 2007). More than one cut in a year may be necessary to simulate the former grazing management where this is no longer possible.

Wells & Cox (1993) demonstrate that cutting more than once a year maximises the species diversity of chalk grassland. In contrast, a single cut, while maintaining species-richness, produces coarser grassland where upright brome *Bromopsis erecta* are abundant and calcareous grassland herbs are at reduced frequencies. It is stressed that the above study concentrates on the botanical interest of chalk grassland (Crofts & Jefferson 1999). As a general rule, therefore, the mowing should not be possibly carried out more than once or at the most twice, because more frequent mowing limits the possibilities of development for many animal and botanical species (Essl 2005).

Distribution of cutting**.** It is advisable to avoid cutting the whole of a grassland area at one time, but to spread the timing of the operation so as to avoid damaging the microfauna. Reptiles, insects and spiders move either very slowly or not at all and it is therefore important to leave uncut areas where they can take refuge. Spread cutting dates also prolong the pollination phase of plants and the availabilty of nectar and pollen. For that reason it is sensible to exclude from cutting a small proportion (ca 5-10%) of the total area, cutting it in the following summer. This should be done every year with a different part of the surface, on rotation, going back to any particular uncut patch of land every 4-6 years (Pearson *et al*. 2006).

Methods. If possible it would be better to use cutter bar mowers. The use of rotary mowers kills many more animals, which have to way to escape. The use of rotary mowers needs to be combined with a change in the usual height of cutting (8 - 10 cm) and a shift to cutting from the inside towards the outside if the escape of animals from the meadow is to be facilitated (Pearson *et al*. 2006).

Very low cutting heights should be avoided, as there is a likelihood of excessive "scalping" resulting in the creation of bare patches in the grassland. These provide favourable areas for the invasion of undesirable species. Conversely, some small-scale disturbance may be necessary for seed germination and may be beneficial for invertebrates. It is advisable to avoid using forage press machines, which cause great damage to the fauna (at least 30 to 60% mortality of bees).

Where a grass crop is cut but there is no intention to use it for winter feed, or when cutting is undertaken purely for nature conservation purposes, cut material should nevertheless generally be removed to avoid nutrient enrichment of the grassland. Some authors also considered that smothering by unremoved cuttings will depress species-richness (Crofts & Jefferson 1999).

Managing scrub

Abandoned grasslands can be invaded by different scrub species in some cases creating a variant of the 6210 habitat: scrub on limestone grassland (RSPB 2004c). Therefore, although looked upon as an invader of important grassland sites and both costly and time-consuming to control, the individual species collectively known as "scrub" are important habitats in their own right, as long as the balance with open grassland is retained. Management measures should aim at keeping scrub encroachment below 20% of the total surface (Pearson *et al*. 2006).

The problematic species are usually *Crataegus monogyna* (hawthorn), *Prunus spinosa* (blackthorn), *Ligustrum vulgare* (privet), *Viburnum lantana* (wayfaring-tree), *Ulex europaeus* (gorse), *Cornus sanguinea* (dogwood) (RSPB 2004b) and *Buxus sempervirens* (box). These scrub types are often considered to have low intrinsic value as they are commonplace, have low species-richness, are often of recent origin and are easily recreated, although decisions about removal should be taken on site-by-site basis. In Nordic countries, for instance, at least *Crataegus* spp. and to some extent also *Prunus spinosa* are not considered as problematic species. Other scrub types are of particular nature conservation value in that they are rare, support uncommon shrub species or are relatively rich in woody species (Crofts & Jefferson 1999).

To offset scrub colonisation and maintain the desired balance, it is possible to remove some older stands because long-established scrub results in the accumulation of nitrogen in the plant biomass as well as in the enrichment of the soil in nutrients. When trees and scrub are removed, shoots will often sprout from roots and stumps and should be removed. Sometimes the operation need only be done once, then followed by grazing or mowing (Pearson *et al*. 2006). At other times, further and complementary cutting measures, using machines, or further mulching (LIFE04NAT/IT/000173) and hoeing are needed in the first years (Essl 2005). Where it is not possible to 'move' scrub in this way, it is advisable to use browsing and/or rotational cutting to maintain stands. Encouraging scrub to 'move' around a site will retain age and structural diversity (RSPB 2004c,d). In any case, and in particular when eutophication is strong, the area will take many years to return to flower-rich grassland (RSPB 2004d).

Where practical, it is advisable to diversify large, evenly aged scrub patches, for instance, by cutting a section at a time – 1/15th each year or 3/15ths every third year, for example. Adjacent sections of scrub can be cut in sequence to benefit wildlife with poor dispersal abilities. This helps by providing successive areas of the species' favoured habitat (RSPB 2004d). Where scrubs have begun to recolonize, seedlings should be removed immediately, as heavy infestations are harder to eradicate. The check for new plants should be carried out the following spring, and hand-weeded or lifted as appropriate (RSPB 2004d).

The aim should be to have a mix of scrub in succession present, from plants like bramble that are at ground level to more mature bushes that have trunks. Insects benefit from a diversity of age, leafing and flowering periods. It is therefore wise to carry out an invertebrate survey before clearing fell scrub. Also, annual removal of a little scrub at different stages of development saves a lot of hard work in the long-term whilst maintaining that vitally important habitat and food source for birds (RSPB 2004b). Selective thinning of bushes ensures structure is maintained for mosses, lichens and fungi that require continuity of age, shade and humidity (RSPB 2004d).

Some scrub species – in particular, blackthorn, dogwood and privet – are difficult to remove and their stumps will sprout vigorously in response to cutting. Where necessary, and where there are no limiting factors (e.g. access, landscape or wildlife), old or unwanted scrub can be grubbed out quickly and efficiently with a digger. This removes the scrub, its roots and nutrient-rich topsoil to re-expose the mineral soil and restart natural succession. Do not use a digger where it is likely to damage wildlife: in these situations scrub will need to be cut. Stumps are important for wildlife, especially fungi and insects. They should be left, except when they regenerate or where access or maintenance, such as mowing, is required. In these cases stumps can be treated with herbicide – either by treating individual stumps or weed-wiping re-growth – followed by browsing from livestock.

Cutting of scrub is carried out in autumn or winter, in order to avoid damaging the wild fauna during the reproductive period (LIFE04NAT/IT/000173). Cutting between early September and the end of February avoids the bird-breeding season, while cutting at the end of winter allows birds and mammals time to eat any berries. Cutting can be carried out with special edge trimmers that do not damage small fauna (Pearson *et al*. 2006).

Rotational grazing may be an appropriate way of controlling scrub as long it is carefully monitored to prevent over-grazing or excessive trampling (Buglife 2007). Donkeys can browse encroaching scrub, providing useful scrub control on semi-natural vegetation. Cattle are particularly good at knocking down and opening up tall coarse vegetation such as bracken and scrub. Goats can strip bark and, if used carefully, will produce structural diversity. Sheep do not tackle areas of long grass as readily as cattle or ponies, but they are efficient browsers of low scrub, able to remove leaf material completely from selected bushes. Moreover some breeds of sheep are good at pushing through scrub, but younger animals and lighter breeds are prone to getting caught up in it. It is therefore advisable to start with a low stocking rate for the species and breed (c 0.25LU/ha), monitor the effects and adjust accordingly (Crofts & Jefferson 1999, RSPB 2004d).

Grazing alone however generally is not enough to manage scrub. A grazing regime based on winter grazing, for example, will usually need to include provision for regularly repeated scrub clearance to remove the gradual accretion of woody plants (Crofts & Jefferson 1999). Therefore in some cases it is advisable to mow in conjunction with grazing. The best time to do this depends on the wildlife present.

Insect eggs and larvae are often the most vulnerable. Avoid mowing until late summer/autumn to allow time for flower and grass seeds to drop, or late winter/early spring to give over-winter shelter for insects.

Table 3. Control measures to contain the spreading of some scrub species (Pearson et al. 2006)

Scrub	**Control measures**
Blackthorn	- first grazing in spring, when shoots are still tender and are liked to be browsed in particular by goats - and/or one cutting once a year in the vegetation period
Bramble and dog-rose	- cutting more than once in the vegetative period - and/or increase of grazing in the sectors with more problems - and/or total removal of the plants

Weed control

A weed may be defined as a species, which is undesirable to the purpose/objective of grassland management. Under certain conditions some plants species (e.g. thistle, bracken, ragwort, etc.) can excessively multiply, quickly replacing communities that have a greater conservation value (Pearson *et al*. 2006). These plants are highly competitive, often toxic, and once established they produce a heavy shade in the growing season, which discourages other plant species (including orchids) to establish (Crofts & Jefferson 1999). For this reason, the removal of the weeds should be carried out at an early stage of development when it takes little effort and can obtain easily good results. Many of these plants have already to be removed by law, therefore it is advisable to check with the national authorithy whether the species concerned is undesiderable.

Good management practices are the most important measure to prevent infestation by weeds. One of these measures, for instance, is to avoid large areas of bare land, which provide opportunities for invasion and spread of weed species. After their establishment the following measures can be implemented (Crofts & Jefferson 1999):

- hand control techniques: 'spudding' or cutting (not suitable for ragwort) at just below ground level, or/and hand-pulling (this is only really suitable on small areas), just before target weed flowers open; hand pulling needs to be undertaken over a period of several years if it is to have any effect;
- mechanical pulling or cutting: for thistles and ragwort, pulling should take place after maximum extension of the flower stalk but before seeding. Pulling will be required in successive years to reduce the extent of perennial target species. Bacon and Overbury (1998) report that in trials, the method dramatically reduced the vigour and number of flowering stems of thistle after two years. Repeated cutting (topping) may prevent seeding and reduce the vigour of weeds but it does not kill the plants and they may regenerate vigorously from the stem base. As with mown grass, cuttings should be removed from the site (Crofts and Jefferson 1999).
- targeted grazing control;
- chemical control: although manual control methods are usually most desirable, and the use of chemical products is not generally allowed, targeted herbicidal control (spot treatment, weedwiping) of such species will often be acceptable on nature conservation sites particularly where continued grazing/meadow management is essential for meeting nature conservation objectives.

Finally, it is important to stress that some of the species may also have positive qualities from a nature conservation perspective in certain situations. Weed species can support in fact diverse invertebrate faunas and may contribute to desirable habitat structure for fauna, e.g. breeding birds, or provide a food source, e.g. seeds for passerine birds (Pearson *et al*. 2006, Crofts & Jefferson 1999). Control programmes should be accurately planned, considering also the possibility to do not completely eliminate weed species: in certain cases total eradication, even if possible to achieve, would be damaging from a wildlife perspective.

Table 4. Control measures to contain the diffusion of weeds (Pearson et al. 2006)

Weed	Control measures
Bracken	- Cutting 2-3 times a year, as soon as the leaves start to unroll, followed by one cut a year once it has been brought under control. For best results cutting should commence between early June and mid-July; a second cut is made between late July and August; a final cut is made in September (LIFE97 NAT/IT/004145; Crofts & Jefferson 1999). The timing should ensure the bracken is cut at four to six week intervals throughout its growing season. - Cutting the young shoot during springtime. - And/or grazing with goats the area with weeds; ponies can take a surprising amount of live bracken, especially in late summer and early autumn when grass is low and bracken toxicity has declined (Oates & Bullock 1997); cattle grazing allied with trampling was most effective in preventing long-term bracken regrowth (Crofts & Jefferson 1999). - And/or appropriate stocking levels in pastures should both prevent initial invasion and keep bracken in check following control measures. One season's treatment alone is unlikely to give longer-term results: a real impact can be measured only over a period of 5-6 years.
Thistle	- Cutting as soon as the plants have reached a height of 5-10 cm. Avoid the dispersion of seeds.
Ragwort	- Cutting or uprooting before flowering and removal of plants so as to avoid diffusion of seeds after cutting, remembering that it is poisonous to livestock, fresh or after cutting.

Other relevant measures

Arable Reversion to Grassland

Calcareous grassland can be restored through the reversion of arable fields. In the UK there are payment incentives available to landowners for arable reversion through the Countryside Stewardship Scheme (CSS) and Environmentally Sensitive Area scheme (ESA).

A rule of thumb, a soil test should first be carried out to determine the level of nutrients in the soil. This will determine which method of reversion to opt for. If the nutrient levels are low and the land is adjacent to chalk grassland, natural regeneration with annual topping to deter seeding of problem weeds may be ideal. If nutrients are high, a crop may need to be planted to remove the nutrients, followed by hay cut, removing the cuttings, and extensive grazing. When nutrient levels have been lowered, seeding may take place using local provenance seed (RSPB 2004b).

Restoration

When calcareous grasslands have been abandoned for some time and succession towards forest has severely altered community composition, the appropriate management measures should be carried out (see paragraphs above). However, their successful restoration will not only depend on an management strategy, but also on propagule availability and favorable germination conditions (Pärtel *et al*., 1998). Thereafter, a good management will further enhance the development towards mature, seed-producing individuals (Willems & Bik, 1998).

The soil seed bank is a potential propagule source for restoration that has frequently been investigated (Akinola *et al*. 1998, Davies & Waite 1998, Kalamees & Zobel 1998). Most studies agree that typical calcareous grassland species are badly represented in the persistent seed bank. Moreover, Verkaar *et al.* (1983) showed that the majority of the seeds in calcareous grasslands were found to reach the ground within 0.5 m of the maternal plant, indicating that seed dispersal of most species is rather low.

Since many calcareous grassland species have a high habitat specificity, do not form a persistent seed bank, and have limited dispersal capacities of their own, the reintroduction of grazing by sheep and the translocation of flocks between spatially isolated calcareous grasslands seems to be a valuable alternative for successful propagule dispersal and long-term conservation of small and often spatially isolated calcareous grasslands (Butaye *et al*. 2005).

Monitoring

Monitoring of the vegetation allows a reorientation of the habitat management strategy, according to the presence of the *Festuco Brometalia* characteristic plants (LIFE97 NAT/IT/004145). An unbalanced livestock load, for instance, could vary the floristic component of the habitat (MATT 2003), easily recognisable through permanent areas or grazing pressure can be adjusted after the determination of the amount of plant material left in the standing grassland at the end of the year, more if grazing is light, less if it is heavy (Crofts & Jefferson 1999).

In grassland areas where scrubs are cut, the use of sample surveys is important to monitor the evolution of scrub vegetation and the re-colonization by the habitat vegetation (LIFE04NAT/IT/000173).

The quality of the habitat and the validity of management measures can also be assessed by using some insects and bird species as indicators of good quality, as they depend from the flora, the type of soil and the vegetation linked to this habitat (Piazzini 2006).

Protection

- Stakeholders involvement. There are often situations where local residents are not aware of the presence and/or importance of the habitat. In order to bring about the sustainable preservation and protection of these valuable grassland areas, it is desirable to carry out measures aimed at raising the awareness of local population and tourists on the value of the habitat. This can be done in a number of ways, through educational programs for schools, guided visits, seminars, publication of brochures etc. (LIFE99NAT/IT/006229, LIFE97 NAT/IT/004145, LIFE 2002/NAT/D/8461, LIFE03NAT/IT/000147).
- In some cases it might be necessary to route or block vehicles traffic, or to fence the grassland areas in order to prevent access by cars (LIFE04NAT/IT/000173). Where the site is a popular beauty spot, parking on the grassland might be prohibited to prevent damage (LIFE97 NAT/IT/004145).
- In some cases it is important to conserve the genetic pool of the most sensitive species and to avoid genetic erosion.

Special requirements driven by relevant species

Plants

Gentianella anglica. The future of this species is inextricably linked with the future of good quality unimproved grassland in the UK, particularly those habitats which are traditionally managed by grazing (JNCC *et al* 2007b). Early gentian seems in fact to prefer tightly-grazed limestone grassland.

Grassland sites grazed extensively by sheep and cattle have been found to support the best populations of this species, but sites where thin soils, summer drought and exposure combine to maintain short grassland are also suitable (Worcestershire County Council 1999). The species needs short grassland, ideally with a grassland height of no more than 5 cm in the areas immediately surrounding the plants. It also requires some degree of low-level disturbance (for instance that provided by grazing pressure on grassland) (Plantlife 2006) because critical to germination and establishment are areas of bare ground where competition is minimal (Worcestershire County Council 1999). Plants seem to thrive on sites which are grazed at the correct levels; a stocking density of about 1.5 cattle/hectare between April and October with fewer animals over the winter seems to be the optimum level, although this will alter depending on the productivity of the soil, and age and breed of cattle. When grazed extensively with cattle there is no particular need to remove stock during the flowering period (early gentian flowers in spring to early summer – April to June) (Plantlife 2006).

There is some evidence that the species can persist in the soil as seed, and therefore it has the potential to return to sites from which it has vanished. Management as above should produce optimal conditions for the return of the plant (Plantlife 2006).

Pulsatilla slavica.* Mowing or grazing once every two or three years is recommended. The results of an experiment in central Slovakia (Mackov bok) showed that mowing and burning are not sufficient for the ongoing management of *Pulsatilla* population - the number of flowering spikes declined significantly in spite of their application. They are suitable only as restoration measures for degraded localities. Grazing seems to be only feasible measure to manage viable population of the species, because it selectively removes the species competing with *Pulsatilla* and creates the gaps in the canopy where the seedlings of the species may recruit (Turis & Galvánek 2003).

Orchids typical of 6210*. Grazing is very important for the conservation of orchids (Pihl *et al*. 2001), but it is important to avoid grazing during the orchids flowering period, from May to July (ARPA ER 2006), because browsing of flower stems prevents seed production which impacts on the viability of a population. Grazing and trampling could also create problems in autumn (Pearson *et al*. 2006). Mowing should be carried out only at long intervals (Pearson *et al*. 2006).

When managing scrub it could be better, if feasible, to remove shrubs in the central part of the areas, leaving those at the margin, where scrub facies could form a natural transition with woods communities (LIFE03NAT/IT/000147). In this way it is possible to extend the area occupied by the early successional stages to woodland, which may favour the presence and spread of orchids (LIFE03NAT/IT/000147).

Weed invasion results in loss of suitable habitat by depriving orchids of light and suitable microhabitat for seed germination. The removal of weed species (e.g. *Pteridium aquilinum*, bracken, and other indicator species of nutrient enrichment such as *Lolium perenne,* rye-grass, and *Trifolium repens,* white clover) permits greater insolation of the grassland, with a direct benefit for heliophylous orchid species. Removal of weed species should however not be carried out during the orchid flowering period.

Birds

Apart from the specialist nesting or feeding requirements of certain species, there is a pronounced split in the habitat preferences of dry grassland bird species: those which require a close-cropped sward grassland, often with areas of bare ground, and those which prefer longer vegetation for nesting and/or feeding, often in association with shorter vegetation. Management of dry grasslands should aim at meeting the varying requirements of both groups of bird species by achieving an appropriate balance between areas of short and long grass (Crofts & Jefferson 1999).

For bird species listed in Annex I of the EU Birds Directive, some site-specific adjustments are to be considered:

- *Burhinus oedicnemus* can nest as late as August and so it may be necessary to delay the introduction of livestock to prevent trampling losses, though grazing is vital for this species to provide the necessary habitat structure and dung-dwelling invertebrates (Crofts & Jefferson 1999).
- *Sylvia nisoria* may suffer from heavy clearing of scrub and it might be necessary to make a site-specific prioritisation between the habitat requirements of this species and management objectives related to floristic values. But the species may also be negatively affected by over-heavy scrub growth, so a fine-tuning of the site-related management might be necessary.
- *Lanius collurio* often respond positively and quickly to removal of overgrown grassland habitats of various types but also suffers from too heavy clearing. 10-15% of a cleared area is recommended to be left with junipers and other scrub (e.g. *Prunus spinosa*, *Rosa* ssp., *Crataegus* ssp.).

Bird species, which require short vegetation for nesting sites and/or feeding areas, benefit from grazing pressure and periodic cutting/mowing that maintain a short vegetation cover, but they could be affected by these operations. Cutting should obviously not take place during the bird breeding season (April-June) or the nesting season for grassland birds (between April and August inclusive) where this is a relevant factor, to avoid disturbance to ground nesting birds. Moreover, the use of a centre-out mowing method where grasslands support important breeding bird species should be considered. This allows adult birds and their broods of chicks to escape. Use of this mowing technique is particularly helpful where it has not proved possible to delay cutting (Crofts & Jefferson 1999). Finally, an early and brief period of grazing, starting from April, followed by a long rest (at least 8 weeks) allows bird species that reproduce early to hatch a second brood after disturbance (Pearson *et al*. 2006).

Birds nesting on lowland dry grassland are particularly prone to disturbance by humans. Appropriate visitor management is essential to minimize disturbance at sites with public access (Crofts & Jefferson 1999) in particular during hatching and nesting (MATT 2003).

Cost estimates and potential sources of EU financing

Costs for active management of this habitat vary according to location and type of activity. The examples furnished below offer a general indication of costs for some types of activity based on different documents, including those produced by LIFE projects.

Grazing

The reduction of the number of animals implies a loss for the breeders, for instance in terms of less milk/cheese sold. Extra transport costs and the cost of necessary infrastructure, such as drinking troughs and temporary fences, and labour costs, should also be calculated.

The table below, from the Trento Province, furnishes an example of additional costs and income foregone resulting from the implementation of rural development commitments for the period of 2007-2013, specifically in regard to grazing (Provincia di Trento 2007).

Type of action	Description	Fixed cost	Cost per hectare	Cost per hectare for traditional activity
Looking after milk cows	1 herder for 50 LU in agri-environmental work/ 125 LU for traditional activity.	Seasonal cost for each farmer: €5000	€ 100.00	€ 40.00
Looking after heifer	1 herder for 80 LU in agri-environmental work/ 200 LU for traditional activity.	Seasonal cost for each farmer: €5000	€ 62.50	€ 25.00
Looking after – nomadic flock	1 herder for 100 LU in agri-environmental work/ 200 LU for traditional activity.	Seasonal cost for each farmer: €5000	€ 50.00	€ 25.00

The table below, taken from the Piemonte region rural development plan gives an indication of additional costs linked to the implementation of extensive grazing regimes. The costs vary also in relation to altitude (hill or mountain) (Regione Piemonte 2000).

Activity	Costs (€/ha)
Fencing and/or looking after livestock	15
Rotation and setting up mobile and fixed fences (labour costs)	17.5
Setting up drinking troughs (labour costs)	13
Rotational grazing (labour costs) – mountain	13
Rotational grazing (labour costs) – hill	8

Another example of costs equipment needed for managing grazing in open natural environments in France (Colas & Hébert 2000)

Equipment	Costs (including taxes) (€)
goat and sheep pens	2286
cattle pens	From 1830 to 3050
Water trough, 1000 to 3000 litres	From 915 to 2745
Automatic drinking troughs	From 685 to 990
Feeding trough	457
Feeding troughs for concentrates	190
Mobile electric fences	€0.3 /meter
Electric mobile separation fences	From €0.3 to 0.46 /meter
Barbed wire fences	From €3.05 to 15.24 /meter according to conditions

A further example of the actual costs supported in Italy for grazing activities and equipment during the LIFE Natura project "Biocenosis restoration in Valvestino Corno della Marogna 2" (LIFE03NAT/IT/000147) is presented below.

Activity	Cost
Setting up electric fences for sheep (mowing along the perimeter in order to avoid electric discharges; setting wooden and plastic posts; setting up wire fence and battery powered by solar panels).	€520 /ha
Setting up electric fences for donkeys (setting wooden and plastic posts and battery powered by solar panels).	€390 /ha
Setting up drinking troughs.	€60
Rotational grazing on low to moderate elevation areas, with sheep and equines – in areas easily reachable by vehicles.	€125/ha/year (summer season May-September).
Rotational grazing on low to moderate elevation areas, with sheep and equines – in areas not reachable by vehicles.	€200/ha/year (summer season May-September)
Equipment	**Cost (including taxes) (€)**
Battery powered by solar panels.	From €500 to 700 according to the electric power
Electric fence with battery powered (storage battery, transformer and solar panel)	€720
Wire for sheep.	€1.87/metre
String for donkey fencing.	€0.11/metre
Plastic fence posts.	€2.35/each
Chestnut post (1.80 m long and 8 cm wide; peeled and pointed at the top).	€5/each
Mobile drinking troughs.	€336

Native breeds of livestock are more appropriate than imported breeds for grazing semi-natural grassland because of their ability to use poor quality pasture (Crofts & Jefferson 1999). Using native breeds, some of which are threatened with extinction, can increase incomes if the farmers benefit from rare-breed payments (Colas & Hébert 2000).

Mowing and cutting

Farming of grassland using nature conservation criteria incurs greater costs and produces lower income for the farmer. The table below gives an idea of the increase in costs when operating within a Natura 2000 site, on the base of indications from the Rural Development Plan of the Trento Province for the period 2007-13, as compared to what is required by the regional implementation of Good Agricultural and Environmental Condition (GAEC), which farmers must in any case observe.

The increase in costs is linked to the lower speed of mowing and the centre-out method to be used.

Increase of costs for dry grasslands			
Commitment	*GAEC*	*Increase of time*	*Increase of costs*
Centre-out movement Steep slope (>25%)	28 hours/ha	+ 2 hours/ha	+ €26/ha
Centre-out movement Slight slope (<25%)	8 hours/ha	+ 0,5 hours/ha	+ €6,5/ha
Low speed of mowing Slight slope	8 hours/ha	+ 0,5 hours/ha	+€6,5/ha

In steep slope conditions, to the losses of production and therefore of income, one must add the greater costs deriving from the impossibility to mechanise adequately the agricultural operations. The greater labour requirement often exceeds 100%, while the additional burden in terms of total cost exceeds on average 200 Euro/ha (Provincia di Trento 2007).

The following table shows the average times of job per hectare for mowing operations (cutting, gathering and building up of heaps in suitable areas, and removal of the organic matter), the labour costs per hours and the hourly costs for the use of the equipment according to the level of mechanization and the slope (Colas & Hébert 2000).

Operation	**Level of mechanization**	**Slope**	**Medium human labour time Required (h/ha)**	**Medium mechanical labour time required (h/ha)**	**Labour costs per hour (€/h)**	**Equipment costs per hour (€/h)**
Cutting	Manual	none - medium	29	14	6.1	2.9
		Steep – very steep	47	19.5		
	Half mechanized		6	2	5.64	12.35
	Agricultural equipment		5	4	8.54	17.68
Gathering and building up of clumps	Manual	none - medium	27.5	0	6.56	0
		Steep – very steep	27.5	0		
	Agricultural equipment		7.5	6.5	12.35	30.18
Removal	Manual	none - medium	29.5	0	6.4	0
		Steep – very steep	29.5	0		
	Agricultural equipment		8.5	4	8.69	17.23

The reduced income is linked to the decrease of the production of forage, related to the reduction of mowing, to the non-use of fertilizers and to the reduced nutritional value of hay connected to the delayed mowing period. Another reduction of income is linked to the maintenance of the shrubby area, which reduces the total forage.

The labour cost for agricultural/forestry works during the LIFE Natura project “Biocenosis restoration in Valvestino Corno della Marogna 2”, varied from a minimum of €12.63 /hour (for manual labourer), to a maximum of €16.04 /hour (for foreman), including an expense refund (LIFE03NAT/IT/000147).

Managing scrub

The costs related to this activity depend on the area actually occupied by the scrubs and to maintenance costs, in particular related to the removal of undesired shrub species (Provincia di Trento 2007).

Activities	Mantainance/m^2
Maintenance, clearing, compensation	€0.05 /m^2
Loss of minimum income	€0.05 /m^2
Loss of ceiling income	€0.52 /m^2

Weed control

Cost of weed management mainly depends on the different typology of intervention (by hand or mechanical means) and on the time taken for carry out the different types of actions. The time required for the execution of the actions is proportional to topographical conditions (slope, rocky outcrops…) that directly influence the type of usable equipment: mechanical means can be used only in areas easily reachable and with slight slopes.

The example below provides the costs related to some possible operations to remove weeds (Provincia di Trento 2007).

Manually		Mechanical means	
Type of action	**Cost per hectare**	**Type of action**	**Cost per hectare**
Manual cutting with sickle or pruning knife (infestation not above 5%)	€ 60	Elimination by mechanical means, gathering and build up of clumps in suitable areas (rate of infestation between 20 and 40%)	€ 1380
Manual removal of clumps with pickaxe, gathering and build up in suitable areas (rate of infestation not above 20%)	€ 760	Cutting of clumps, gathering and build up of necromass (rate of infestation not above 40%)	€ 1200 € 3000

Restoration

This type of costs depends mostly on the different typology of intervention and the rate of infestation.

The following table shows an example of scrub clearance costs for reclamation of neglected grassland (Provincia di Trento 2007).

Manually		Mechanical means	
Type of action	**Cost per hectare**	**Type of action**	**Cost per hectare**
Manual hedge cutting of shrubs of medium large size, build up and burning of remaining debris (rate of infestation above 50% in not mechanised areas)	€ 2600	Mechanical trimming of shrub of small dimensions (rate of infestation not above 50%)	€ 1150
		Mechanical trimming of shrubs of medium and large size with cutting of branches, uprooting of stumps, building up and burning of debris (rate of infestation above 50%)	€ 2700

A further example extracted from the Rural Development Plan of the Toscana region (Regione Toscana 2007) is presented below.

Manually		**Mechanical means**	
Type of action	**Cost per hectare**	**Type of action**	**Cost per hectare**
Manual cutting of shrubs performed on slightly-invaded areas (shrubby coverage not above 30%) with removal of debris	€ 1517	Mechanical cutting of shrubs with removal of debris (rate of infestation not above 30%)	€ 576
Manual cutting of shrubs performed on mildly-invaded areas (shrubby coverage among 30% and 60%) with removal of debris	€ 1668	Mechanical cutting of shrubs on mildly-invaded areas (shrubby coverage among 30% and 60%) with removal of debris	€ 815
Manual cutting of shrubs performed on – almost totally invaded areas (shrubby coverage above 60%) with removal of debris	€ 1741	Mechanical cutting of shrubs performed on – almost totally invaded areas (shrubby coverage above 60%) with removal of debris	€ 1049

The table below provides the medium labour time per hectare for cutting of shrubs (cutting, gathering and building up of clumps in suitable areas, and removal of the organic matter), the labour costs per hour and the hourly costs for the use of the equipment according to the level of mechanization and the slope (Colas & Hébert 2000).

Operation	**Level of mechanization**	**Slope inclination**	**Mean labour required - manual (h/ha)**	**Mean labour required - mechanical (h/ha)**	**Labour costs per hour (€/h)**	**Equipment costs per hour (€/h)**
Cutting	Manual	none - medium	34	12	6.1	4.12
		Steep – very steep	55	16.5		
	Half mechanized		28	22	9.76	64
	Agricultural equipment		5.5	5.5	8.54	28.97
Gathering and building up of heaps	Manual	none - medium	31.5	0	6.56	0
		Steep – very steep	31.5	0		
Removal	Manual	none - medium	16	0	6.4	0
		Steep – very steep	16	0		
	Agricultural equipment		32.5	2	8.69	15.85

Potential sources of EU funds

The cost issue has to be seen in the light of Article 17 of the Charter of Fundamental Rights of the European Union, which sets the principle of compensation for income foregone, and the rules concerning concurrency.

Management measures for Natura 2000 were defined in the annexes of Communication from the Commission on Financing Natura 2000 (COM 2004-0431 and its working documents). Four categories were defined with several types of activities for each of them. The two first ones concern the establishment of the Natura 2000 network and management planning, administration and maintenance of network related infrastructure. They will not be considered within the Management Models Project. The two last ones are more appropriate to this exercise and focused on active management. However the monitoring items as well as the action focusing facilities to encourage visitor access or the action related to land purchase are not relevant here. Only conservation management measures, management schemes and agreements, provisions of services and infrastructure costs will be considered here.

Concerning potential sources of EU financing, a Guidance Handbook (Torkler 2007) presents the EU funding options for Natura 2000 sites in the period 2007-2013 that are, in principle, available at the national and regional level. Furthermore an IT-tool is available on the EC web site (http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm).

By developing an IT-tool the Commission wishes to provide easier access to the information of the Guidance Handbook and create the opportunity to use the information in the framework of management planning. This document will only summarise the main tools and how they may be used specifically for the particular habitat. For the period 2007-2013, several structural funds exist (EARDF, EFF, ERDF, and Cohesion fund) with a national/regional programme based on EU and national strategic guidelines. Furthermore several project funds, interconnected or not with structural funds, can be used, such as Interreg, LIFE+, the 7th Research Framework Program (FP7) or Leader+. However some actions are not eligible for certain financial schemes, e.g. with LIFE+ recurring management is not eligible. Each Member State has identified the issues that are of most concern locally, and has prioritized EU funds in order to address these issues. The integrated use of these resources will allow financing various management actions for areas with habitats listed in the Habitats Directive and included in the Natura 2000 network.

Among the diversity of sources for EU funding, the following funds might primarily be of interest for the management models of the 6210 habitat.

- The European Fund for Rural Development (EARDF): This programme has a potential to cover several management activities that might be relevant, although the measures have to be included in the National Strategy and related Rural Development plans (RDPs) in order to be eligible on a national basis. Furthermore Leader+ projects have to be established on a national basis.

- The European Regional Development Fund (ERDF), The Cohesion Fund and Interreg: These funds might be relevant in single cases although activities related to Natura 2000 sites mostly need to be integrated in a broader development context. However, the Interreg approach is more flexible but needs a European objective and partnership. Different geographical levels were defined and all of them have their specific rules, eligibility criteria and objectives.

- The Financial Instrument for the Environment (LIFE+): The 'Nature' component of LIFE+ supports best practice and demonstration projects contributing to the implementation of the Birds and Habitats Directives but only exceptionally outside Natura 2000 sites. The 'Biodiversity' component is for demonstration and innovation projects contributing to the objectives of the Commission Communication 'Halting the loss of biodiversity by 2010 – and beyond'. Both the 'Nature' and 'Biodiversity' components focus on concrete non-recurring management actions (at least 25 % of the budget). Recurring management is not eligible under LIFE+.

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