Biodivers Conserv (2011) 20:2365–2378
DOI 10.1007/s10531-011-9989-z

ORIGINAL PAPER

Which habitats of European importance depend on agricultural practices?

Lubos Halada · Doug Evans · Carlos Romão · Jan-Erik Petersen

Received: 21 August 2010 / Accepted: 13 January 2011 / Published online: 6 February 2011

Abstract The aim of this paper is to identify the habitat types listed in the Habitats Directive Annex I that require low-intensity agricultural management for their existence. We assessed the link between the Annex I habitat types and agricultural practices in order to identify habitat types that depend on the continuation of agricultural practices or whose existence is prolonged or spatially enlarged via blocking or reducing the secondary succession by agricultural activities. 63 habitat types that depend on or which can profit from agricultural activities—mainly grazing and mowing—were identified. They are classified into 2 groups: (1) habitats fully dependent on the continuation of agricultural management; (2) habitats partly dependent on the continuation of agricultural management. This paper also briefly discusses habitat types for which either doubts remain on their dependence on agricultural management, or the relation to extensive farming practices exists only in part of their area of distribution in Europe or under certain site conditions, respectively. Assessments of the conservation status of habitats of European Importance by 25 EU Member States in 2007 showed that habitats identified by us as depending on agricultural practices had a worse status than non-agricultural habitats.

Keywords Agricultural management · Favourable conservation status · Grazing · Habitats Directive · High Nature Value Farmland · Mowing · Natura 2000 · Ostermann list

This paper is a contribution to the work of identifying areas of High Nature Value Farmland currently in progress in Europe.

L. Halada (✉)
Institute of Landscape Ecology, Slovak Academy of Sciences, Branch Nitra, Akademická 2, P.O. Box 22, 949 01 Nitra, Slovakia
e-mail: lubos.halada@savba.sk

D. Evans
European Topic Centre on Biological Diversity, Muséum national d'Histoire naturelle, 57 rue Cuvier, FR-75231 Paris, Paris Cedex 05, France

C. Romão · J.-E. Petersen
European Environment Agency, Kongens Nytorv 6, 1050 Copenhagen K, Denmark

Abbreviations

CAP	Common Agricultural Policy
CEC	Commission of the European Communities
EEA	European Environment Agency
EU	European Union
HNVF	High Nature Value Farmland
JNCC	Joint Nature Conservation Committee
JRC	Joint Research Centre of the European Union
UNEP	United Nations Environment Programme

Introduction

Agricultural land covers about 50% of Europe's total land surface, which gives agriculture an important role in the maintenance of biodiversity. Varying farming traditions, combined with specific soil and climate conditions have resulted in diverse and highly characteristic agricultural landscapes, often with a rich flora and fauna (Vos and Meekes 1999; Pärtel et al. 2005; EEA 2006; Pedroli et al. 2007). Very low-intensity agricultural management can also increase the overall biodiversity of a habitat—for example grazing and cultivation gives rise to the Iberian dehesa landscapes with a highly diverse mosaic of habitats supporting greater biodiversity than the related climax woodland from which it originated (Beaufoy 1998). The favourable conditions for maintaining the biological and landscape diversity of farmland were historically created by traditional agricultural systems that usually represented low-intensity land use systems (Bignal and McCracken 1996; Plieninger et al. 2006). The most valuable habitats of agricultural land are usually connected with the long-term continuation of the appropriate management (Ihse and Lindahl 2000).

The recognition of the importance of agricultural land from a biodiversity perspective led to the inclusion of its conservation as an explicit objective of relevant strategies and conventions at European or EU levels including the Pan-European Biodiversity and Landscape Strategy, the Bern Convention and the European Landscape Convention. The concept of High Nature Value Farmland (HNVF) was developed during the 1990s via a number of workshops (Baldock et al. 1993; Beaufoy et al. 1994; EEA 2004). The Kiev commitment (UN/ECE 2003) specified deadlines for the identification of HNVF areas and the application of biodiversity—sensitive management for a substantial proportion of these areas. Consequently, the EEA and UNEP have formulated a definition of the HNVF areas and developed methods for identifying HNVF areas on a pan-European scale (EEA/UNEP 2004). This was subsequently refined on the basis of joint work between the JRC and EEA (Paracchini et al. 2008).

High nature value farmland is defined as "those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern, or both" (Andersen 2003). Three types of HNVF areas are distinguished: (1) farmland with a high proportion of semi-natural vegetation; (2) farmland with a mosaic of low intensity agriculture and natural and structural elements, such as field margins, hedgerows, stonewalls, patches of woodland or scrub, and small rivers; (3) farmland supporting rare species or a high proportion of European or world populations.

The Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora; EC 1992) and the Birds Directive (79/409/EEC on the conservation of wild birds) are the main pillars of the nature and biodiversity policy of the European Union. Their annexes list habitats and species of European importance and the Directives represent the basis for the development of an EU-wide network of protected sites known as Natura 2000, aiming to assure the long-term survival of Europe's most valuable and threatened species and habitats. The species listed in Annexes II and IV of the Habitats Directive are highly relevant for identification of the HNVF areas of the 3rd type (see previous paragraph) while habitats listed in Annex I are important mainly for identification of the 1st type of HNVF. The first list of Annex I habitat types that depend on low-intensive farming was published by Ostermann (1998). He analysed the 198 habitat types then listed on Annex I and identified 28 habitat types "whose Favourable Conservation Status is likely to be threatened by the abandonment of rural practices" and Table 2 in Ostermann (1998) is often called the "Ostermann list".

Since the publication of the 'Ostermann list', Annex I of the Habitats Directive has changed significantly. These changes are related to the enlargement process of the European Union and the resulting enlarged geographical coverage of the Habitats Directive. The accession countries (10 new Member States in 2004 and 2 in 2007) proposed new habitat types that after discussion and approval by the Habitats Committee were added to Annex I of the Habitat Directive. After the most recent changes on 1st January 2007, Annex I now contains 231 habitat types. During discussions related to EU enlargement the description of some existing habitats were also revised (European Commission 2007).

In recent years, several problems with the use of the 'Ostermann list' have been reported—with some missing habitats and others incorrectly added. This, together with the changes to Annex I mentioned above led to this revision of the 'Ostermann list'.

Recently the results of reports delivered by Member States to the European Commission under Article 17 of the Habitats Directive have become available and this allows an examination of the conservation status of Annex I habitats dependent on agriculture.

Methods

The Habitats Directive's Annex I lists 231 habitat types, the vast majority of them are terrestrial and coastal habitats. Virtually all of them can be affected by agriculture activities—either in a positive or a negative way. This paper focuses on the habitat types that meet one of the following criteria:

- their existence depends on the continuation of appropriate agricultural activities
- their existence is maintained or spatially enlarged by agricultural activities which block or reduce secondary succession
- the habitat type contains both natural and semi-natural habitats, the second requiring agricultural management for their existence

"Agricultural activities" are principally grazing and mowing, other agricultural practices (e.g. tilling) are less important for the biodiversity maintenance as they usually represent bigger disturbance of habitats or are applied more rarely.

An expert assessment approach was used for evaluation of the link between individual habitat types and agricultural practices. The authors of the paper classified individual habitat types taking into account literature data and comments of experts listed below in the acknowledgements. This approach and also the final selection is necessarily subjective

to some degree—relevant information simply does not exist for all habitats across their complete range in Europe. Moreover, the boundary between habitat types requiring agricultural management and those that do not is sometimes not clear and can be different in different parts of Europe. There are also potential differences due to varying interpretations of the habitats by the Member States (Evans 2006).

The habitats nomenclature and coding follows the Habitat Directive Annex I (version 1.1.2007) and European Commission (2007).

The EU Member States are requested by Article 17 of the Habitats Directive to report an assessment of conservation status for each Annex I habitat type present in their territory for each biogeographical region in which it occurs every 6 years (CEC 2009). The 2007 Article 17 reports include assessments of conservation status of species and habitats for all members of the EU except Bulgaria and Romania in one of four classes following a definition of 'Favourable Conservation Status' given in the Habitats Directive. The classes are 'Favourable', 'Unfavourable-inadequate', 'Unfavourable-bad' and 'Unknown'. Assessments for each biogeographical region were taken from http://biodiversity.eionet.europa.eu/article17. These were based on the country reports following a standard method described on the same website. This information is used to compare the conservation status of habitats depending on agricultural management with other habitat types.

Results and discussion

The application of criteria described in the methodology resulted in the identification of 63 habitat types of European importance that depend on agricultural activities or can profit from them (Table 1). Habitats fully and partially dependent on continuation of agricultural management are distinguished as follows.

1. *Habitats fully dependent on agricultural management*. This group contains semi-natural habitat types established under regular—usually low-intensity—agricultural management. The species composition has been subject to selection over many decades or centuries and corresponds both to the site conditions and to type and intensity of human management. Both cessation of this management and significant changes in the management intensity result in (usually irreversible) changes in the habitat structure and species composition leading to a change to other habitat types. This group contains 23 habitat types, mainly meadows and pastures (16 habitat types). However, also some habitats classified in European Commission (2007) as sand dunes (2 types: 21A0 and 2340), heath and scrubs (4 types: 4010, 4020, 4030 and 4040) and forest (1 type: 9070) were found to be fully dependent on agriculture. Noted as 'D' on Table 1.

2. *Habitats partly dependent on agricultural management*. The habitats in this group profit from agricultural management measures because they either prolong the existence of the habitat or enlarge/maintain an enlarged area of habitat distribution. The prolongation of the habitat existence is usually linked with blocking/reducing secondary succession. The removal of biomass from wetlands (fens, red beeds) by mowing decreases biomass accumulation and thus reduces the speed of secondary succession. This practice represents a typical example of agricultural measures that prolong the existence of a habitat type. The removal of shrub and woodland in the vicinity of alpine grasslands or natural xero-thermophilous grasslands on shallow soils has enlarged pastures and the continuation of grazing of certain intensity maintains this habitat type in the enlarged area. Abandonment of grazing leads to the invasion of pastures by shrubs/trees and a change to a shrub- or woodland habitat type or to simplification of their structure associated with a decrease of

Table 1 List of the Habitat Directive Annex I habitats depending on agricultural practices

Code	Habitats name	D	P	M
1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)		×	×
1340	Inland salt meadows		×	
1530	Pannonic salt steppes and salt marshes		×	×
1630	Boreal Baltic coastal meadows		×	
2130	Fixed coastal dunes with herbaceous vegetation (grey dunes)		×	×
2140	Decalcified fixed dunes with *Empetrum nigrum*		×	×
2150	Atlantic decalcified fixed dunes (*Calluno-Ulicetea*)		×	×
2160	Dunes with *Hippophaë rhamnoides*		×	×
2170	Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*)		×	×
2190	Humid dune slacks		×	
21A0	Machairs	×		
2250	Coastal dunes with *Juniperus* spp.		×	
2310	Dry sandy heaths with *Calluna* and *Genista*		×	×
2320	Dry sandy heaths with *Calluna* and *Empetrum nigrum*		×	×
2330	Inland dunes with open *Corynephorus* and *Agrostis* grasslands		×	×
2340	Pannonic inland dunes	×		
4010	Northern Atlantic wet heaths with *Erica tetralix*	×		
4020	Temperate Atlantic wet heaths with *Erica ciliaris* and *Erica tetralix*	×		
4030	European dry heaths	×		
4040	Dry Atlantic coastal heaths with *Erica vagans*	×		
4060	Alpine and Boreal heaths		×	×
4090	Endemic oro-Mediterranean heaths with gorse		×	
5120	Mountain *Cytisus purgans* formations		×	×
5130	*Juniperus communis* formations on heaths or calcareous grasslands		×	
5210	Arborescent matorral with *Juniperus* spp.		×	×
5330	Thermo-Mediterranean and pre-desert scrub		×	×
5420	*Sarcopoterium spinosum* phryganas		×	
5430	Endemic phryganas of the *Euphorbio-Verbascion*		×	
6110	Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*		×	×
6120	Xeric sand calcareous grasslands		×	
6140	Siliceous Pyrenean *Festuca eskia* grasslands		×	
6150	Siliceous alpine and boreal grasslands		×	
6160	Oro-Iberian *Festuca indigesta* grasslands		×	
6170	Alpine and subalpine calcareous grasslands		×	
6180	Macaronesian mesophile grasslands		×	
6190	Rupicolous pannonic grasslands (*Stipo-Festucetalia pallentis*)	×		
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)	×		
6220	Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*	×		
6230	Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and sub-mountain areas, in continental Europe)	×		
6240	Sub-pannonic steppic grassland		×	
6250	Pannonic loess steppic grasslands	×		

Table 1 continued

Code	Habitats name	D	P	M
6260	Pannonic sand steppes	×		
6270	Fennoscandian lowland species-rich dry to mesic grasslands	×		
6280	Nordic alvar and precambrian calcareous flatrocks	×		
62A0	Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)	×		
62C0	Ponto-Sarmatic steppes		×	×
62D0	Oro-Moesian acidophilous grasslands		×	×
6310	Dehesas with evergreen *Quercus* spp.	×		
6410	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)	×		
6420	Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion*		×	
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels		×	×
6440	Alluvial meadows of river valleys of the *Cnidion dubii*	×		
6450	Northern boreal alluvial meadows	×		
6510	Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)	×		
6520	Mountain hay meadows	×		
6530	Fennoscandian wooded meadows	×		
7140	Transition mires and quaking bogs		×	×
7150	Depressions on peat substrates of the *Rhynchosporion*		×	×
7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*		×	×
7230	Alkaline fens		×	
8230	Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*		×	×
8240	Limestone pavements		×	
9070	Fennoscandian wooded pastures	×		

Legend D habitat type fully dependent on agricultural management, *P* habitat partially dependent (usually agricultural management blocks secondary succession). *M* relationship with extensive farming practices holds true for only some sub-types or for part of their distribution

species richness and the loss of sensitive species (especially weak competitors). This group contains 40 habitat types including habitat types dependent on site conditions, either substrate type (sandy, salty, rocky, shallow, wet soils) or climatically. Habitats with certain presence of shrubs are classified in this group as well. Noted as 'P' on Table 1.

Table 1 contains 26 Annex I habitats depending on agricultural practices that were listed by Ostermann (1998) and 37 habitat types not included on Ostermann's list. One newly listed habitat type (1630) belongs to coastal and halophytic habitats, eleven habitat types (2130, 2140, 2150, 2160, 2170, 2190, 2250, 21A0, 2310, 2320, 2330) to coastal sand dunes and inland dunes, four (4010, 4020, 4040 and 4090) to temperate heaths and scrub, five (5120, 5210, 5330, 5420 and 5430) to sclerophyllous scrub, twelve (6120, 6150, 6190, 6240, 6250, 6260, 6280, 62A0, 62C0, 62D0, 6430, and 6440) to natural and semi-natural grassland formations, three (7150, 7210, 7230) to raised bogs and mires and fens and one (8230) to rocky habitats and caves. Four habitat types (6190 Rupicolous Pannonic grasslands—*Stipo-Festucetalia pallentis*, 62A0 Eastern sub-Mediterranean dry grasslands—*Scorzoneratalia villosae*, 62C0 Ponto-Sarmatic steppes and 62D0 Oro-Moesian

acidophilous grasslands) were not included on Annex I when Ostermann's (1998) paper was published as they were added in 2004 and 2007.

Out of 63 habitat types selected (Table 1), 41 habitat types clearly meet the selection criteria. For a further 22 habitat types either doubts remained concerning their dependence on agricultural management or their relation to extensive farming practices exists only in part of their distribution area in Europe or in certain site conditions, respectively (noted as "M" on Table 1). These habitat types are briefly discussed below.

Notes on selected habitat types

1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*). The habitat type includes habitats ranging from short, species-poor swards associated with heavily, often sheep-grazed salt marshes to lightly or historically ungrazed ones (Doody 2008). For centuries salt meadows have been utilised for grazing and/or mowing resulting in low growing and species-rich vegetation. The intensity of grazing by domestic livestock or mowing is particularly significant in determining the structure and species composition of the habitat type. Cessation of management results in the development of tall plant species (Søgaard et al. 2007; JNCC 2007). The latter is actively pursued in the conservation strategy for parts of the German national park on the Wadden sea.

2130 Fixed coastal dunes with herbaceous vegetation (*grey dunes*). This habitat type (and also following types 2140–2170) were traditionally grazed and do undergo succession to scrub/forest, or at least become species-poorer without light grazing. The grazing of fixed dunes has a long history in northwest Europe, for centuries the dunes have been used by farmers as pasture for their cattle (De Bonte et al. 1999; Houston 2008a). Historically, grazing has been the single most significant land management activity for maintaining the open character of fixed dunes (Houston 2008a) and their dynamics (Søgaard et al. 2007). De Bonte et al. (1999) reported that the total number of plant species observed as decreasing since 1960 showed a considerable increase after grazing reintroduction in 1990, the tall grasses were suppressed and increase of open-sand, moss-, lichens- and low grass vegetation resulted in more fine-grained grassland pattern.

2140 Decalcified fixed dunes with Empetrum nigrum. This habitat has a long history of grazing by livestock (JNCC 2007), the nature of dune heath varies considerably depending on site conditions and grazing intensity. Grazing helps to maintain the open nature of the vegetation, which would otherwise develop into scrub and woodland (O'Keeffe et al. 2008; JNCC 2007).

2150 Atlantic decalcified fixed dunes (*Calluno-Ulicetea*), *2160 Dunes with Hippophaë rhamnoides, 2170 Dunes with Salix repens ssp. argentea* (*Salicion arenariae*). These habitat types belong (together with the two previous habitat types) to group of fixed dunes needing grazing for maintenance of habitat heterogeneity, species diversity and blocking of secondary succession. O'Keeffe et al. (2008) and JNCC (2007) noted agricultural improvement, overgrazing by cattle, modification of cultivation practices, undergrazing (leading to scrub encroachment) and abandonment of pastoral systems as the principal pressures on these habitats.

2190 Humid dune slacks. Under-grazing and scrub development belong to threats of this habitat. Without the disturbance of grazing, or damage caused by anaerobic conditions in very wet slacks, the biomass increases, organic matter accumulates and the nutrient status of the soil increases. This results in increasing dominance of tall grasses and shrubs

(including *Calamagrostis epigejos* and *Salix repens*) and the decline of the typical slack specialists of the species-rich phase (Houston 2008b).

2250 Coastal dunes with Juniperus spp. Continued grazing is normally necessary to maintain the typical fixed dune communities, a more widespread problem is undergrazing, leading to invasion by coarse grasses and scrub. Grazing is necessary also to support juniper regeneration (Picchi 2008).

4060 Alpine and Boreal heaths. This habitat type is often grazed and both overgrazing and grazing abandonment or under stocking are considered as threats by Bensettiti et al. (2005). The long-term maintenance of the habitat does not always require active management. For instance, in Sweden and Finland, with a land use history primarily linked to reindeer grazing, this habitat is mostly under passive management, while in the Czech Republic no interventions are recommended (Zaghi 2008).

5120 Mountain Cytisus purgans formations. Moreira et al. (2008) consider grazing using moderate livestock densities as beneficial for the habitat and maintenance of extensive grazing is considered as good management. Bensettiti et al. (2005) recognized that only some forms of habitat benefit from grazing.

5210 Arborescent matorral with Juniperus spp. Two basic types of this habitat can be distinguished: primary matorral developing under natural evolution and the secondary matorral requiring active management (Calaciura and Spinelli 2008).

5330 Thermo-Mediterranean and pre-desert scrub. Grazing represents suitable management for maintenance of this habitat type. Bensettiti et al. (2005) suggest grazing for some subtypes and no intervention for other subtypes. Free ranging livestock grazing was recognized to be beneficial for the habitat also by Moreira et al. (2008).

62C0 Ponto-Sarmatic steppes. The habitat type includes both natural and semi-natural grasslands (Tzonev et al. 2005). Enyedi et al. (2007) concluded that "management, probably by creating bare surfaces and preventing litter accumulation, had the strongest effect on the species composition and abundance in the grasslands. Abandoned grassland stands had lower diversity and evenness compared to continuously grazed stands".

62D0 Oro-Moesian acidophilous grasslands. This unit contains habitats both of primary and secondary origin. Rusakova (2009) stressed influence of grazing intensity to the species composition of habitat—high intensity leading to ruderalisation while not sufficient grazing intensity resulting in scrub and tree encroachment.

6430 Hygrophilous tall herb fringe communities of plains and of the montane to alpine levels. This habitat type contains both natural and semi-natural habitats, some types can be maintained only by mowing or light grazing, e.g. JNCC (2007) reported abandonment of pastoral systems as the threat to habitat. Viceníková and Polák (2003) included continental tall-herb communities of humid meadows (EUNIS habitats unit E5.423) that require at least occasional mowing in this habitat type. Similarly, Chytrý et al. (2001) recommend mowing each 2–3 years for stands of the alliance *Veronico longifoliae Lysimachion* which they include in this habitat.

7140 Transition mires and quaking bogs. Some (drier) types were traditionally grazed at low intensity and if not managed, they will quickly become woodland. Matulevičiūė and Rašomavičius (2007) consider the prohibition of mowing and grazing of mires after World War II as the main reason of their overgrowth in the Žuvintas Nature Reserve (Lithuania).

7150 Depressions on peat substrates of the Rhynchosporion. Mowing and grazing belong to traditional management practices of this habitat type and their abandonment, especially on dried-out peatland, has led to invasion of both herbaceous and ligneous species, to the detriment of pioneer communities (Stallegger 2008).

7210 Calcareous fens with Cladium mariscus and species of the Caricion davallianae. Muller (2002) noted that this habitat was usually managed by low-intensity grazing and its abandonment leads to *Phragmites* and *Cladium* fallows, colonized by *Salix* shrubs. JNCC (2007) listed abandonment of pastoral systems under threats to this habitat. It is possible that the dependence on grazing and/or mowing varies from region to region.

8230 Siliceous rock with pioneer vegetation of the Sedo-Scleranthion or of the Sedo albi-Veronicion dillenii. This habitat type covers both natural and secondary habitats, the secondary stands were created by grazing by domestic animals and can be maintained by sheep or goats grazing (Chytrý et al. 2001).

Habitats of the 'Ostermann list' that were not retained

In our opinion, two habitat types listed by Ostermann (1998), 4070 Scrub with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuti*) and 9260 *Castanea sativa* woods, do not depend on agricultural management.

4070 Scrub with Pinus mugo and Rhododendron hirsutum (Mugo-Rhododendretum hirsuti). We did not include this habitat type, listed in the 'Ostermann list' (Ostermann 1998), as it does not meet the criteria that we specified in the methodology and we consider that this habitat type does not depend on agricultural activities. It forms a natural vegetation belt between upper forest and alpine vegetation zones. The habitat does not depend on agricultural management, on the contrary, its distribution is often controlled by grazing and related activities. Cutting and burning of scrub is frequently the main source of damage, usually indirectly linked with grazing. The abandonment of grazing leads usually to the spontaneous restoration of this habitat on suitable sites.

9260 Castanea sativa woods. A typical forest habitat type, it is native in the Mediterranean region (e.g. Arianontsou et al. 1996). The species is, however, regarded as naturalised throughout a large part of the European Union (EEA 2007b). The native forest stands do not depend on agricultural practices, but the Interpretation manual of European habitats European Commission (2007) clearly includes old established plantations with semi-natural undergrowth in this habitat type. These plantations which are planted are important for nut production in Italy, Portugal and Spain (EEA 2007b). In the last few decades commercial chestnut growing has declined and most orchards have been coppiced (Pezzi et al. 2006). We do not consider this habitat to be dependent on agriculture because existing stands of *Castanea sativa* woods retain their main features without agricultural management.

Conservation status of habitats of European importance

Taking into account the dependency of agricultural habitats on certain management measures, it is generally recognized that agricultural habitats are amongst the most threatened. This was confirmed by the assessment of conservation status of habitat types that was done by 25 EU Member States in 2007 as required by Article 17 of the Habitats Directive. Figure 1 summarises the results of this assessment and it clearly shows that agricultural habitats have been assessed by the Member States as having a poor conservation status, contrarily to non-agricultural habitats. Table 2 shows that there is much variation between the seven biogeographical regions with the Atlantic and Pannonic regions having no or very few agricultural habitats assessed as 'favourable'. It should be

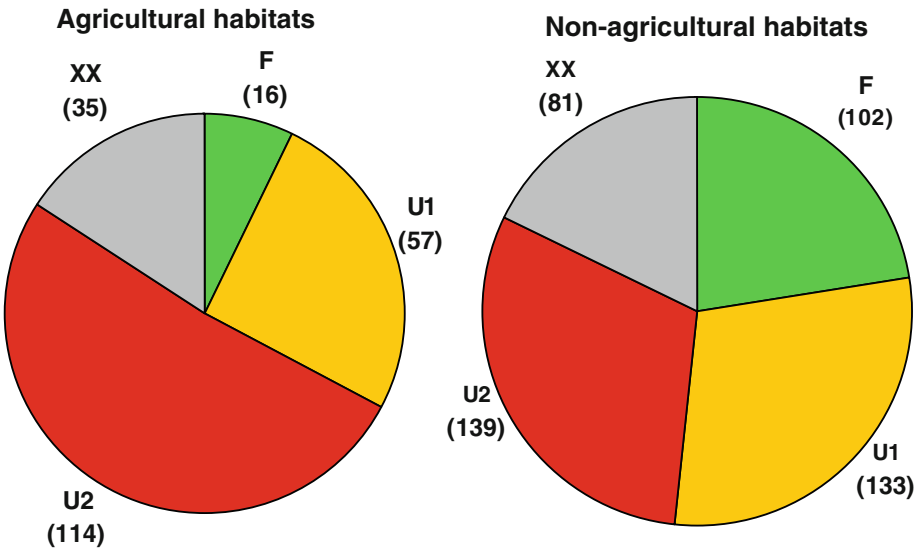

Fig. 1 Assessments of conservation status for agricultural (*left*) and non-agricultural (*right*) habitats for all biogeographical regions. *F* indicates 'Favourable', *U1* 'Unfavourable-inadequate', *U2* 'Unfavourable-bad' and *XX* 'Unknown'. *Numbers* indicate the number of assessments in each category

Table 2 Assessments of conservation status of agricultural habitats for biogeographical regions (%)

Conservation status	Biogeographical region						
	ALP	ATL	BOR	CON	MAC	MED	PAN
Favourable	13.3	0.0	6.3	12.0	28.6	2.8	4.2
Unfavourable—inadequate	33.3	16.3	31.3	26.0	42.9	30.6	12.5
Unfavourable—bad	36.7	67.4	59.4	56.0	28.6	16.7	79.2
Unknown	16.7	16.3	3.1	6.0	0.0	50.0	4.2
Number of assessments	30	43	32	50	7	36	24

ALP alpine; *ATL* atlantic; *BOR* boreal; *CON* continental; *MAC* macaronesia; *MED* mediterranean; *PAN* pannonic. Figures show percentage of assessments in each assessment class

noted that there is a very large proportion of habitats assessed as 'unknown' in the Mediterranean region.

Discussion

As mentioned above, much of the biodiversity in Europe is found on, or adjacent to, farmland and is therefore considerably affected by agricultural practices (Hoffmann et al. 2001; EEA 2007a). Agriculture in Europe underwent significant transformations during the second half of the 20th century. Intensification of agriculture, beginning in the 1950s to the 1970s in different parts of Europe (Robinson and Sutherland 2002; Hopkins and Holz 2006; Young et al. 2007) was accompanied by broad land use changes of the rural landscape, leading to its homogenisation and fragmentation of natural and semi-natural habitats (Jongman 2002). This intensification of agriculture took place in parallel to the

abandonment of less productive or remote areas (e.g. MacDonald et al. 2000). Often a polarisation of agricultural land use can be observed: both intensively used and abandoned areas can be found in the same region (MacDonald et al. 2000; Jongman 2002). The negative consequences of the above mentioned processes on biodiversity of agroecosystems and landscapes have been documented in many studies (e.g. Rosenthal and Müller 1988; Kornaś and Dubiel 1991; Linusson et al. 1998; Beaufoy 1998; Vos and Meekes 1999; Jongman 2002; Pärtel et al. 2005).

Economic incentives, agricultural policy measures, environmental legislation, research and farm advice as well as consumer behaviour are the key mechanisms through which society can influence the shape and intensity of farming. The reforms of the EU Common Agricultural Policy (CAP) in the last 10 years have largely cut the link between farm income support and agricultural production. While funding has not increased substantially, the range of agri-environment policy tools available to EU Member States has widened due to reforms of the EU Rural Development Policy as part of the CAP (EEA 2007a).

However, the Article 17 reports show that despite these measures, habitats linked to agriculture, at least those noted on Annex I of the Habitats Directive, are not in a favourable conservation status and in fact are less favourable than non-agricultural habitats.

Muller (2002) demonstrated the diversity of the optimal agricultural management practices required to ensure the good conservation status of different types of habitats. Local or regional success in the conservation and maintenance of HNVF has been reported. One can also consider the development of organic farming as a success story as it has expanded rapidly since the beginning of the 1990s, with 7.76 million ha in the European Union (ca 4.5% of the utilised agricultural area of the EU-27), managed organically in 2008 (Eurostat 2010).

Nevertheless, although a European policy priority, many HNV farming systems and their associated biodiversity and cultural value are under increasing threat, either from intensification of farming practices or from the abandonment of farming altogether. Regions with a high proportion of such HNVF do not appear to be particularly targeted by agri-environment schemes, nor do they have a high share of organic farming (EEA 2006). Recent analysis confirms that the distribution of general agricultural support payments as well as of agri-environmental support schemes does not match well with the regional share of HNVF in total farmed area (EEA 2010).

A preliminary map of the HNVF areas for Europe (HNV map) was published by the EEA (2007a), together with observation that the Kiev target of identifying HNVF in the pan-European region by 2006 had only partly been met and the achievement of Kiev's second target—favourable management in place by 2008—is also unlikely to be realised. During 2007 and 2008 an updated HNVF map was prepared by JRC and EEA in consultation with European experts (Paracchini et al. 2008). The CORINE Land Cover map was used as a background, completed by additional information such as distribution of species and habitats in Natura 2000 sites and distribution of butterflies and farmland birds. It is expected that the delineation of HNVF areas will continue at the national level, with more detailed data. The identification of the Annex I habitat types depending on agricultural management is presented in this paper could contribute to this process.

Conclusions

The conservation of habitats depending on agricultural practices is a difficult, but inevitable part of the conservation of biodiversity. Species of agriculturally managed habitats

are adapted to certain disturbance regimes and often require such regimes for their existence. The low-intensity management practices that formed the rich biodiversity of European agricultural landscapes for centuries became unprofitable during recent decades and they are continuously disappearing—due to both intensification of agriculture and abandonment of unprofitable land. However, agriculture has an irreplaceable role in the maintenance of these habitats at large spatial scales. The last reforms of the CAP (2000 and 2003) provided a framework for a better utilisation of agricultural activities for non-production functions of agriculture, including biodiversity conservation.

The definition and application of agri-environmental programmes represent important steps in the right direction. However, it seems they do not specifically target areas with higher abundance of habitats important for biodiversity conservation. Therefore, we consider the delineation of the High Nature Value Farmland areas important. Identification of regions that are important for biodiversity conservation is a potentially important policy tool as it can lead to better targeted application of measures for maintenance of habitat and species depending on agricultural management. The identification of 63 habitat types of European importance depending on agricultural practices made in this paper aims at contributing to further development of the High Nature Value Farmland concept and its practical application.

Acknowledgments The authors wish to thank to Gabriela Augusto, Panayotis Dimopoulos, Axel Ssymank for comments on the selection of habitat types depending on agricultural practices and to Maria Luisa Paracchini and Peter Veen for comments to manuscript. The paper is based on the research supported by the European Environment Agency and the Slovak grant agency VEGA (project No. 2/0166/08 "Assessment of the agro-environment programs contribution to conservation and maintenance of rural landscape diversity").

References

Andersen E (ed.) (2003) Developing a high nature value farming area indicator. Internal report. EEA, Copenhagen, 76 pp

Arianontsou M, Delipetroll P, Dimopoulos P, Econornidoli E, Karagiarnakidou V, Konstaittinides P, Panagiotides P, Paititsa M, Tsiourlis G (1996) Habitat types present in Greece. In: Directive 92/43 EEC. The Greek habitat project natura 2000: an overview. Thessaloniki, p 413

Baldock D, Beaufoy G, Bennett G, Clark J (1993) Nature conservation and new directions in the common agricultural policy. Institute for European Enviromental Policy London, Arnhem

Beaufoy G (1998) The EU Habitats Directive in Spain: can it contribute effectively to the conservation of extensive agro-ecosystems? J Appl Ecol 35:974–978

Beaufoy G, Baldock D, Clark J (1994) The nature of farming: low intensity farming systems in nine European countries. Institute for European Environmental Policy London, 66 pp

Bensettiti F, Boullet V, Chavaudret-Laborie C, Deniaud J (2005) "Cahiers d'habitats" Natura 2000. Connaissance et gestion des habitats et des espèces d'intérêt communautaire. 4. Habitats agropastoraux. MED/MAP/MNHN. Éd. La Documentation française, Paris. volumes 1 et 2: 452 p. et 486 p

Bignal EM, McCracken DI (1996) Low-intensity farming systems in the conservation of the countryside. J Appl Ecol 33:413–424

Calaciura B, Spinelli O (2008) Management of Natura 2000 habitats. 5210 Arborescent matorral with *Juniperus* spp. European Commission, Technical Report 2008 10/24, 21 pp

CEC (2009) Report from the Commission to the Council and the European Parliament. Composite report on the conservation status of habitat types and species as required under Article 17 of the habitats directive. COM/2009/0358 final, 17 pp. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0358:EN:NOT

Chytrý M, Kučera T, Kočí M (eds) (2001) Katalog biotopů České republiky (Habitat Catalogue of the Czech Republic) (in Czech). Agentura ochrany přírody a krajiny ČR, Praha, 304 pp

De Bonte AJ, Boosten A, van der Hagen HGJM, Sýkora KV (1999) Vegetation development influenced by grazing in the coastal dunes near The Hague, The Netherlands. J Coast Conserv 5:56–68

Doody JP (2008): Management of Natura 2000 habitats. 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*). Technical report 2008 02/24. European Commission, Brussels, 27 pp
EC (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. http://ec.europa.eu/environment/nature/legislation/ habitatsdirective/index_en.htm
EEA (2004) High nature value farmland. Characteristics, trends and policy challenges. EEA Report No 1/2004. EEA, Copenhagen
EEA (2006) Integration of environment into EU agriculture policy - the IRENA indicator-based assessment report. EEA Report 2/2006, Copenhagen, 60 pp
EEA (2007a) Europe′s environment. The fourth assessment. EEA, Copenhagen, p 452
EEA (2007b) European forest types. Categories and types for sustainable forest management reporting and policy. EEA Technical report No. 9/2006, Copenhagen, 111 pp
EEA (2010) Distribution and targeting of the CAP budget from a biodiversity perspective. Technical report No 12/2009. EEA, Copenhagen
EEA/UNEP (2004) High Nature Value farmland. Characteristics, trends and policy challenges. EEA report No.1, 2004. EEA, Copenhagen, UNEP ROE, Geneva, 26 pp. http://reports.eea.europa.eu/report_2004_1/en
Enyedi MZ, Ruprecht E, Deák M (2007) Long-term effects of the abandonment of grazing on steppe-like grasslands. Applied Vegetation Science 11(1):55–62
European Commission (2007) Interpretation manual of European Union Habitats. EU27. European Commission, DG Environment, Brussels, p 142
Eurostat (2010) Area under organic farming increased by 7.4% between 2007 and 2008 in the EU-27. Statistics in focus 10/2010, 11 pp
Evans D (2006) The habitats of the European Union habitats directive. Biology & Environment: Proceedings of the Royal Irish Academy 106(3):167–173
Hoffmann LB (ed) (2001) Agricultural functions and biodiversity—a European stakeholder approach to the CBD agricultural biodiversity work programme. ECNC Technical report series, European Centre for Nature Conservation, Tilburg, p 191
Hopkins A, Holz B (2006) Grassland for agriculture and nature conservation: production, quality and multifunctionality. Agronomy Research 4:3–20
Houston J (2008a) Management of Natura 2000 habitats. 2130 *Fixed coastal dunes with herbaceous vegetation ('grey dunes'). Technical report 2008 04/24. European Commission, Brussels, 30 pp
Houston J (2008b) Management of Natura 2000 habitats. 2190 Humid dune slacks. Technical report 2008 05/24. European Commission, Brussels, 24 pp
Ihse M, Lindahl C (2000) A holistic model for landscape ecology in practice: the Swedish survey and management of ancient meadows and pastures. Landscape and Urban Planning 50:59–84
JNCC (2007) Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. JNCC, Peterborough. Available from www.jncc.gov.uk/article17
Jongman RHG (2002) Homogenisation and fragmentation of the European landscape: ecological consequences and solutions. Landscape Urban Plan. 58:211–221
Kornaś J, Dubiel E (1991) Land use and vegetation changes in hay meadows of the Ojcow National Park during the last thirty years. Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich 106:208–231
Linusson AC, Berlin GAI, Olsson EGA (1998) Reduced community diversity in semi-natural meadows in southern Sweden, 1965–1990. Plant Ecol 136:77–94
MacDonald D, Crabtree JR, Wiesinger D, Dax T, Stamou N, Fleury P, Gutierrez-Lazpita J, Gibton A (2000) Agricultural abandonment in mountain areas of Europe: environmental consequences and policy response. J Environ Manage 59:47–69
Matulevičiūė D, Rašomavičius V (2007) European Habitats and their status in surroundings of Lake Žuvintas. Ekologija. Vilnius 53(2):6–12
Moreira F, Pinto MJ, Henriques I, Marques T (2008) The importance of low-intensity farming systems for fauna, flora and habitats protected under the European "Birds" and "Habitats" Directives: is agriculture essential for preserving biodiversity in the Mediterranean region? In: Veritas RI (ed) Biodiversity research developments. Nova Science Publishers, New York, pp 87–115
Muller S (2000) Appropriate agricultural management practices required to ensure conservation, biodiversity of environmentally sensitive grassland sites designated under Natura 2000. Agriculture. Ecosyst Environ 89:261–266
O'Keeffe C, Lynn D, Weir G, Valverde FF, Roller J (2008) The status of EU protected habitats and species in Ireland. National Parks and Wildlife Service, 135 pp
Ostermann OP (1998) The need for management of nature conservation sites designated under Natura 2000. J Appl Ecol 35:968–973

Paracchini ML, Petersen JE, Hoogeveen Y, Bamps C, Burfield I, van Swaay Ch (2008) High nature value farmland in Europe—an estimate of the distribution patterns on the basis of land cover and biodiversity data. Office for Official Publications of the European Communities, Luxembourg, 87 pp

Pärtel M, Bruun HH, Sammul M (2005) Biodiversity in temperate European grasslands: origin and conservation. In: Lillak R, Viiralt R, Linke A, Geherman V (eds): Integrating efficient grassland farming and biodiversity. Proceedings of the 13th International Occasional Symposium of the European Grassland Federation. 29-31 August 2005, Tartu, Estonia

Pedroli B, van Doorn A, de Blust G, Paracchini ML, Wascher D, Bunce F (2007) Europe's living landscapes. Essays exploring our identity in the countryside. KNNV Publishing, Zeist/Landscape Europe, Wageningen

Pezzi G, Masi S, Ferrari C (2006): Temporal pattern over the last 200 years in the SCI Mt. Vigese (IT4050013) Northern Apennines (Italy). In: Parrotta J, Agnoletti M, Johann E (eds): Cultural heritage and sustainable forest management: the role of traditional knowledge. Proceedings of the IUFRO Conference 8–11.6.2006, Florence, 2: 503–507

Picchi S (2008) Management of Natura 2000 habitats. 2250 *Coastal dunes with *Juniperus* spp. European commission, technical report 2008 06/24, 24 pp

Plieninger T, Höchtl F, Spek T (2006) Traditional land-use and nature conservation in European rural landscapes. Environmental Science and Policy 9:317–321

Robinson RA, Sutherland WJ (2002) Post-war changes in arable farming and biodiversity in Great Britain. J Appl Ecol 39:157–176

Rosenthal G, Müller J (1988) Wandel der Grünlandvegetation im mittleren Ostetal—Ein Vergleich 1952–1987. Tuexenia 8:79–99

Rusakova V (2009): 62D0 Oro-Moesian acidophilous grasslands (in Bulgarian). In: Zingstra H, Kovachev A, Kitnaes K, Tzonev R, Dimova D, Tzvetkov P (eds) (2009) Guidelines for assessing favourable conservation status of Natura 2000 species and habitat types in Bulgaria. Izdatelstvo Bulgarian Biodiversity Foundation. Sofia: 230-234

Søgaard B, Skov F, Ejrnæs R, Pihl S, Fredshavn J, Nielsen KE, Clausen P, Laursen K, Bregnballe T, Madsen J, Baatrup-Pedersen A, Søndergaard M, Lauridsen TL, Aude E, Nygaard B, Møller PF, Riis-Nielsen T, Buttenschøn RM (2007). Criteria for favourable conservation status in Denmark. Natural habitat types and species covered by the EEC Habitats Directive and birds covered by the EEC Birds Directive. National Environmental Research Institute, University of Aarhus. NERI Technical report No. 647, 92 pp. http://www.dmu.dk/Pub/FR647.pdf

Stallegger M (2008) Management of Natura 2000 habitats. 7150 Depressions on peat substrates of the *Rhynchosporion*. European Commission, Technical Report 2008 19/24, 23 pp

Tzonev R, Roussakova V, Dimitrov M (2005) The Western-Pontic steppe vegetation in Bulgaria. Hacquetia 5(1):5–23

UN/ECE (2003) Kyiv resolution on biodiversity. Fifth ministerial conference 'Environment for Europe', Kyiv, Ukraine, 21–23 May 2003. Document ECE/CEP/108. United Nations, Economic Commission for Europe

Viceníková A, Polák P (eds) (2003) Habitats of European importance in Slovakia (in Slovak). ŠOP SR, Banská Bystrica, p 151

Vos W, Meekes H (1999) Trends in European cultural landscape development: perspectives for a sustainable future. Landscape and Urban Planning 46:3–14

Young J, Richards C, Fischer A, Halada L, Kull T, Kuzniar A, Tartes U, Uzunov Y, Watt A (2007) Conflicts between biodiversity conservation and human activities in the Central and Eastern European Countries. Ambio 36(7):545–550

Zaghi D (2008) Management of Natura 2000 habitats. 4060 Alpine and Boreal heaths. Technical report 2008 09/24. European Commission, Brussels, 24 pp