CONSERVATION OF THE WET MEADOWS IN SOUTH-EASTERN SLOVENIA

Igor ZELNIK*

Izvleček
Na mokrotnih travnikih je zaradi velike raznolikosti ekoloških gradientov in človekovega delovanja v času in prostoru nastala zanje značilna izredno visoka biodiverziteta v okviru vrst, ekosistemov, krajin in regij. To še posebej velja za mokrotne travnike na območju JV Slovenije, ki je na prehodu med dinarsko in panonsko regijo, zato smo prav to območje podrobneje proučili. Da bi relativno dobro ohranjeno naravno dediščino ohranili tudi v bodoče, bi morali te travnike varovati v sklopu krajin in ekoloških mrež, ki bi jih funkcionalno povezovale na regionalnem nivoju.

Abstract
In wet meadows a fairly high degree of biodiversity that is their characteristic was created within the scope of species, ecosystems, landscapes and regions due to the large variety of ecological gradients and human activity in time and space. This fact is especially true of the wet meadows in south-eastern Slovenia, which are at the interface between the Dinaric and the Pannonian region; therefore this area has been studied in detail. In order to maintain a relatively well-preserved natural heritage in future, these meadows should be protected within the scope of landscapes and ecological networks, which would functionally connect them on the regional level.

Ključne besede: mokrotni travniki, ohranjanje, biodiverziteta, ekosistem, krajina, krajinska ekologija
Key words: wet meadows, conservation, biodiversity, ecosystem, landscape, landscape ecology.

1. INTRODUCTION

Wet meadows are among endangered ecosystems in Slovenia (Seliškar 1996). This problem is growing more and more obvious and serious, as many meadows have been destroyed in just a three-year period, since we started our research. Besides, a lot of effort has been put into restoration of the wet meadows in several European countries (Hölzel & Otte 2003, Prach 1996, Straškrabová & Prach 1998, Joyce & Wade 1998, Bissels & al. 2004, McCrea & al. 2001, Grootjans & al. 2002), despite the fact that restored meadows rarely reach the species number of the natural ones, even in decades. So, according to this, it would be the best and the cheapest way for wet meadows in Slovenia to be maintained.

Wet meadows are wetlands where the communities with predominant herbaceous plants thrive on occasionally flooded soil (Keddy 2000). Temporary flooding excludes mesophilous species, while drier growing seasons exclude hygrophilous species, and thus specific plant communities were established. Wet meadows as well as wetlands in general are ecosystems that depend on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate (Keddy 2000) and are recognized thanks to hydromorphic soils and hygrophilous vegetation.

Due to different site conditions in the area of south-eastern Slovenia (Fig. 1), communities of the alliance *Deschampsion* Horvatić 1930, which is characteristic for central Croatia (Horvatić 1939), na-

* Institute of Biology, Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Novi trg 2, p. b. 306, SI-1001 Ljubljana, izelnik@zrc-sazu.si

mely the Pannonian region, thrive besides the meadow communities of the alliance *Molinion* Koch 1926, which is characteristic for the major part of Slovenia. These ecosystems are part of either forested landscapes such as the Krakovo forest (Fig. 3), or non-forested landscapes such as Jovsi (Fig. 2), and both are classified into the suggested (ARSO 2001) exceptional landscapes of the Pannonian region. The importance of the Krakovo forest is also supported by thriving of the forest community *Pseudostellario europaeae-Quercetum roboris*, which is a Pannonian element and in view of nature-conservation also an exception thanks to the uniqueness as well as the naturalness of vegetation. According to the European criteria the mentioned landscapes are also recognized as special and of great importance to the protection of birds (Polak 2000; Božič 2003), for example; moreover, they are to be classified into the Ramsar sites (ARSO 2001, Sovinc 2001).

As the wet meadows represent a dynamic interface between terrestrial and aquatic environment, their biodiversity is high. Here thrive some of the most species-rich plant communities in the world at small-scales (Joyce 2001). At the same time they are also anthropogenic ecosystems that need management for their maintenance.

2. OVERVIEW OF THE PROBLEMATICS OF INTEGRATED BIODIVERSITY CONSERVATION

Wet meadows contribute a great deal to biodiversity. As they are mostly situated in plains, which are under great pressure due to the intensive agricultural land-use, and are also densely populated, there is a danger that short-term socio-economical interests would cause the disappearance of wet meadows from the cultural landscape. For instance, the fertile Krško plain is nowadays one of the most important agricultural areas in Slovenia (Perko & Orožen Adamič 1998). Due to the intensification on the one hand, and the abandonment of land that is unprofitable for agriculture on the other – especially after Slovenia has joined the EU – such meadows could disappear. They are to be replaced by either, swamps and other hygrophilous forest types, or by improved meadows and arable land. In NE Slovenia, vast reclamations by drainage with a view to intensification were carried out in the Pesnica and Ščavnica valleys in the past decades (Perko & Orožen Adamič 1998) and thus the whole area of the Pesnica valley was completely transformed. Impoverishment and loss of the landscape's value afflicted a vast area (Ogrin 1997) so wet meadows disappeared as well. Apart from that, due to the heavy and clayey soils and maintenance of drainage network, the costs of intensive agriculture are much higher here than on average, which considerably reduces the profitability of such land-use, and these areas will most probably be abandoned after Slovenia has joined the EU (Ogrin 1997). However, every type of agricultural practice should be adapted to local soil characteristics (Plachter 1996).

Thanks to the exceptional diversity of species and ecosystems, which was created as a result of environmental factors and of human activity, several plant communities developed in wet meadows and they should be preserved not only as individual plots of land, but within the scope of the cultural landscape as well. The approaches on the ecosystem and on the landscape level are the only way to protect a complex multitude of species and processes (Franklin 1993), that is to say, biodiversity. Biodiversity, either between different landscapes or within an individual landscape, is a value (Anko 1998). Thus we should be aware of the landscape level as the approach, which is important for the protection of biodiversity, and also completes the traditional protection of nature both on the species and on the site level (Anko 1999). The concept of the ecosystem management has not been considered as valuable until recent times, and the fragility of the whole landscape is becoming an issue (Anko 1999).

Harris (1984) and Franklin (1993) claim that the approach of the landscape mosaic, namely a sufficient number of reserves as well as their size and suitable distribution in a landscape, is probably the only way that can ensure the conservation of biodiversity on all levels. At the same time, while we are trying to preserve the integrity of communities, the genetic variability within the species should be ensured as well. Numerous patches, which are suitably close to each other, are important to maintain genetic diversity. In general, more numerous and denser distribution of suitable habitats in the sense of 'stepping stones' is of strategic importance for conservation. Many elements of diversity are not capable to adapt to big reserves, which are fairly distant from one another; the system of patches and corridors with the existing natural genetic-flows among populations is ideal (Franklin 1993).

However, the reserves and other protected are-

as should not represent the only way to maintain biodiversity (Franklin 1993), although these areas are places of extremely high biodiversity and generally also the core areas of the ecological network (ARSO 2001) as well as a source of biodiversity, which expands beyond their limits into the unprotected part of a landscape. Limiting only to the protected areas can cause the creation of more or less natural islands among strongly degraded areas, which are thus not connected with one another. The matrix, which is mostly unprotected part of a landscape and where every system of reserves is incorporated, not only dominates the majority of areas, but also covers the potentially most productive sites; therefore the care of conditions in a matrix and management on the landscape level are essential (Franklin 1993). That improves the connectivity in a landscape, thus facilitating the migrations among the reserves. Unfortunately, the fragmentation of ecosystems and the isolation of populations are one of the consequences of modern land-use (Plachter 1996).

3. LANDSCAPE ECOLOGY OF THE WET MEADOWS

3.1 Structure and function

Wet meadows are parts of forested or agricultural landscapes, which were created in marshy areas and flood-plains. The soil water content is very high there and predominant soil types, almost impermeable for water, are amphigley, hipogley or riverine soil. Soil plays the major role in the creation and functioning of vegetation and the landscape. Thick layers of clays from Pleistocene as well as marshy light soil had been preserved in one half of the Krško plain, in Zakrakovje, Krakovo and in the northern part of the Brežice field (Pleničar & Premru 1977), so gleyic soils were formed and swamps still exist there (e.g. the Krakovo forest and Dobrava). This forested landscape had been preserved there due to heavy swampy acidic nutrient-poor soil (Perko & Orožen Adamič 1998), which is unsuitable for agriculture. Besides, low terrain inclination as well as impermeable clayey soil prevented people from draining the area despite their numerous attempts. It was around 1820, when Ressel carried out the measurement of forest surfaces and their division into sections, among which draining ditches were then dug (Hudoklin 2000). Thus a unique forested landscape with oak and hornbeam forests was found there.

Wet meadows and tall-forb vegetation, which is classified into the order *Molinietalia,* became established in the area after the woods of the mentioned communities had been cut down. They are found in heavy, wet, damp or alternately damp soil, where precipitation water perches for longer time during the period of abundant precipitations and the process of gleying takes place.

In other areas, where fertile brown soils had been created on subsequent gravel deposits, forests were mostly cut down and a forested landscape was transformed into a densely populated agricultural landscape, which consists of fields and intensively cultivated meadows of the order *Arrhenatheretalia*, while the eutrophic flood-meadows of the order *Potentillo-Polygonetalia* and willow stands (Šilc 2003) exist in regularly flooded zones along watercourses.

In the past decades the process of the intensification of agriculture included draining and fertilizing of the sites where communities of the order *Molinietalia* thrive, so their surface has decreased significantly, and some of them are currently even on the verge of extinction. The management intensity has, namely, a greater influence on plant species composition than the content of water in soil. The oligotrophic ecosystems are fairly dependent on human activity, which should be neither excessive nor lacking in its intensity. (Ellmauer & Mucina 1993)

Due to the exceptional diversity of species and ecosystems within landscapes in wet plains, which is a consequence of the gradients of abiotic factors (e.g. water, nutrients and soil reaction) as well as human activity, many plant communities developed not only in wet meadows but in the surrounding forests as well. As many as 10 plant communities, consisting of more than 230 vascular plant species and subspecies, were found in the extensively cultivated wet meadows (Zelnik 2003, 2004): *Gentiano pneumonanthes-Molinietum litoralis, Junco conglomerati-Betonicetum officinalis* (*Nardo-Juncetum conglomerati), Angelico-Cirsietum oleracei, Scirpetum sylvatici, Dactylorhizo majalis-Scirpetum georgiani, Agrostio-Juncetum conglomerati, Succisello inflexae-Deschampsietum caespitosae, Bromo-Cynosuretum cristati, Triseto-Centaureetum macroptili, Caricetum vulpinae.*

Species as well as the communities should be preserved within the scope of the cultural landscape. Cultural landscapes, in particular depend heavily on human factors (Anko 1999).

3.1.1 Human activity as a cause of high biodiversity

In lowlands of temperate climate almost all European grasslands are the result of human activity, and only regular mowing or grazing can prevent the succession (Ellenberg 1996). Only very limited areas of natural grasslands can be found in very wet soils, where water hinders the growth of woody species. In one soil type a variety of different vegetation types can be found, depending on space/time variation and human activity (Farina 1998).

A great deal of biodiversity was thus created because of land-use, which caused such degradations in the environment as the transformation of forests into agricultural land or taking away nutrients from grassland ecosystems by mowing, for example. Despite this degradative nature, historic land-use patterns resulted in an increase of biodiversity on the species and on the ecosystem level (Plachter 1996). Maximum species richness in Germany was reached between 1800 and 1850, at the same time the ecosystem diversity was at its maximum, therefore, this period frequently is considered to represent the reference state by conservationists in Central Europe (Plachter 1996). Since then, the number of native plant species has been dropping rapidly due to changes in the cultural landscape (Plachter 1996). But unfortunately loss of species threatens ecosystem functioning and sustainability (Tilman & al. 1996). Higher species diversity within the plant community (α-diversity) enables its better functioning; that is to say, a better functioning of the ecosystem as well as its higher sustainability and stability, because the sources such as nutrients are better utilized in grassland communities with high species diversity (Tilman & al. 1996; Joyce 2001).

3.1.2 Biodiversity on different levels

According to Article 2 of The Convention on Biological Diversity (CBD), "biological diversity" can be treated on the following levels, namely on the genome level (within an individual species), on the species level (between different kinds of species or within an individual community / ecosystem), on the ecosystem level (between different kinds of communities / ecosystems) and on the landscape level (between ecological complexes, namely landscapes (UNEP 1992). Numerous authors (e.g. Whittaker 1972, 1973, Westhoff & van der Maarel 1973, Vitousek & Hooper 1994, Hobbie & al. 1994) designate the species diversity of either a certain stand / community or a site / ecosystem as α-diversity, while the diversity between different communities or ecosystems, which is a result of the gradients of environmental factors and/or the consequence of a land-use pattern in a landscape, is designated as β-diversity. The changing of combinations concerning environmental factors and geomorphology creates numerous specific conditions under which different kinds of ecosystems are created, so γ-diversity (within the scope of a region) can be fairly high.

Even the very little changes of topography cause changes of soil characteristics (Farina 1998). The water gradient is thus relatively diverse due to microtopography and the soil type (texture), which in combination with fairly diverse human influences (e.g. cutting and littering down the woods, mowing and fertilizing frequency of grasslands, draining … etc.) led to the creation of a rather high degree of γ- and β-diversity in the study area. The soil water regime varies significantly in the course of the year. There are floods on the one hand and severe dry periods on the other, however the conditions in both cases are stressful. Anyway, the biodiversity of plant species is higher in drier and wetter sites (Harris 1984). The plants characteristic of dry (*Festuco-Brometea*) and acidic (*Nardetalia*) meadows, as well as mires (*Scheuchzerio-Caricetea fuscae*) thrive here in the same meadow. The characteristic that all mentioned ecosystems have in common is that they are oligotrophic. Those sites are less fertile for they are rarely fertilized, while hypoxic conditions hinder the mineralisation, and thus the species diversity as well as the number of rare species is higher because of the reduced competition in those oligotrophic ecosystems. The nutrient-supply is also the essential indicator of the state of any ecosystem (Plachter 1996).

3.1.3 Relatively high net primary production and quick pulsating of phytomass

As other types of wetlands, wet grasslands are rather productive ecosystems in view of the net primary production (NPP). In wet grasslands the annual increase of phytomass is 1.2 kg / m^2 (Ajtay & al. 1979 *op. cit* Haberl 1995), which is just slightly lower than the average increase in forests, but 2.4 times higher than the increase in dry grasslands that are also extensively cultivated and can be compared to them regarding the amount of work and material input. The great importance of the quantity of available

water is thus evident. This fact was already put to profitable use by farmers from the western part of the Drava field at the beginning of the 20th century, when they tried to lead the water from streams over permeable soil to dry grasslands by a special drainage-irrigation network (Baš 1937) and thus changed them into productive improved meadows.

Nowadays this high annual increase of biomass could be used in the following way: cut litter would be distributed in fields and thus the fertility of soil there would be improved. In this way, wetlands in the broader sense could also serve as a 'sinkhole' of organic matter from the eutrophic environment (e.g. watercourses and fields); apart from that, mown and transported biomass would help to incorporate the mentioned matter in the biomass of field crops (*see* Donath & al. 2004).

The pulsating of phytomass is a characteristic difference from the adjacent ecosystems and considerably influences the diversity of animal species. The pulsating of phytomass is much quicker in a meadow than in a forest. Relatively open mineral cycles and quick mineralization are typical of grasslands (Vos 1992). The quantity of phytomass is low and its structuredness is rather weak in comparison with a forest. The complexity of food-webs is simplified to a high degree, while man more or less takes possession of the second, the third and the fourth trophic levels of the ecosystem and thus excludes competitors, namely fauna (Anko 1998), the biodiversity of fauna is therefore lower than in a forest. The complexity of webs in a forest is high due to a large stock of richly structured phytomass (Anko 1998). The dependence on artificial energy inputs, which restrain the succession with woods, is typical of grasslands. The diversity of species and ecosystems is artificially intensified and thus it is much higher than in a forest or in utterly simplified monocultures.

3.2 Changes of function and structure

Because of the general shortage of energy and products, the spectrum of use was much broader in the 19th century than today (Plachter 1996). Historic agricultural land-use systems were optimised towards concentrating nutrients – the minimum factor of production – on fields, and so numerous oligotrophic forests (littering) and grasslands were created away from settlements on that account. This resulted in nutrient transfer within the landscapes; much of the high level of biodiversity resulted from these nutrient gradients (Plachter 1996). The mentioned flow of matter does not exist anymore due to the massive use of mineral fertilizers. Additionally, there was a general reduction of biodiversity of wet meadows in the past few decades because of the intensified agricultural use, namely the increased use of fertilizers (Joyce 2001). Due to the intensification of meadows the plant species composition could change in a short time and it could become similar to the common lowland improved meadow that can be found anywhere in Central Europe. The fact that the mentioned oligotrophic ecosystems are put in danger is reflected in the exceptionally high proportion of species, which thrive in oligotrophic sites (oligotrophytes) and appear on red lists of endangered species (Plachter 1996).

On the other hand, after the abandonment of wet meadows, species-poor communities establish, which consist of species such as: *Filipendula ulmaria, Phalaris arundinacea, Deschampsia cespitosa, Scirpus sylvaticus, Carex gracilis, Molinia caerulea* (Rosenthal 1992). Those competitively stronger species build monodominant stands and inhibit the settlement of the later-successional species. Only in case of considerable intensification of management type, do strong changes in vegetation appear during a period of 3 to 5 years, the number of species increases and the meadow with *Caltha palustris* develops (Rosenthal 1992). The major reason for the mentioned fact is frequent interference of the internal nutrient cycle, which occurs in those species, by regular removal of the aboveground biomass.

Typical meadow species such as: *Succisa pratensis, Senecio aquaticus, Myosotis palustris* and *Agrostis canina* are adapted to mowing. These species depend on mowing, which takes place 2 to 3 times a year; otherwise, tall-growing species – strong competitors – are predominant and they spread rather quickly in fertile soil. A better light regime also enables a higher number of niches as well as the growth of different species, which is a condition for high diversity.

4. CONSERVATION OF WETLANDS UP TO THE PRESENT, EXAMPLES AND SUGGESTIONS

The Ramsar Convention, namely »The Convention on Wetlands of International Importance, Especially as Waterfowl Habitat« was ratified in the year

1971. Article 2 of the convention binds its members – Slovenia also joined them in 1991 – to determine their suitable locations as internationally important wetlands (UNESCO 1994), comprising wet grasslands as well.

The total area of wetlands, protected by the Ramsar Convention, is proportionally the smallest in Slovenia, because the sites (e.g. the Sečovlje salt works and the Škocjan caves) cover only 0.05 % of the territory surface, while in Central European countries their share often exceeds 1 % of the territory surface (MOP RS & Ramsar Bureau 2001). So, the area of protected sites and wet meadows among them should increase in the future.

The programme of »Pan-European Biological and Landscape Diversity Strategy« (Council of Europe 1995) among others includes also the following action themes:

- AT 7: It is necessary to support the conservation and restoration of wetlands to maintain and spread the ecological network. Wetlands should be used according to the principles of wise use.
- AT 8: Grasslands with high biotic/landscape diversity should be given precedence.
- AT 9: It is necessary to protect all types of forests, especially alluvial forests and virgin forests as well as old cultural forest areas and riparian forest corridors.

The protection of all that was mentioned could only be realized with the help of suitable management of cultural landscapes.

One of the goals of the Council of Europe is the establishment of the Pan-European Ecological Network to ensure the conservation of ecosystems, habitats, species and landscapes of European importance (Silvestrini 2001). This network will consist of: core areas (providing optimal quality and quantity of space), corridors (ensuring appropriate connectivity between core areas) and buffer zones (protecting core areas and corridors from harmful external influences). The Slovenian Law on Conservation of Nature (2004, article 32) foresees the existence of the ecological network in Slovenia as well.

The programmes of the protection of habitats in a cultural landscape, which are now being practiced in Germany (Kiemstedt 1996), also include the protection of wet meadows as well as the protection of all extensively cultivated grasslands; both of them stipulate not only the withdrawal of mineral fertilizers and pesticides as well as reductions in the intensity of management and its maintenance respectively, but also the abandonment of drainage and irrigation.

One of the important and promising ways of using wetlands is sustainable tourism. In Europe, there are many well-known cases of wetlands, where not only biodiversity is taken care of, but they are at the same time used for recreation, the promotion of sustainable tourism and cooperation with local inhabitants (Åhren 2001). There are two prominent examples among them, namely Třeboň in the Czech Republic and the Regional natural park Brenne in France. The second case is an ecological complex of ponds, reeds, grasslands, heathlands, forests and settlements, covering the surface of 1400 km^2. The Krakovo forest landscape park (40 km^2) could be arranged in a similar way and include many elements of the natural and cultural heritage.

5. CONCLUSIONS

The majority of the present wet meadows in southeastern Slovenia exist as patches in the forested landscape of the Krakovo forest, which covers 2400 ha of forests as well as almost the same area of grasslands on the verge (Hudoklin 2000), and as a matrix in the agricultural semi-natural grassland landscape covering 460 ha in Jovsi; in Slovenian territory they are both treated as exceptional landscapes of the Pannonian region, and are thus by all means worthy of protection. Above all, it is essential to prevent the process of drainage of those areas.

With regard to the fact that a complex of similar landscapes exists in plains, where more or less hydromorphic soil is predominant, it would be necessary to spread the protected area to the vaster area covering the Krakovo forest, flood-plains along the Krka as well as the lower part of the Sava river and the Sotla river with Jovsi and Dobrava in view of the protection of birds, as was suggested by Hudoklin (1993) and Sovinc (2001). We should protect the whole system of landscapes as a part of the ecological network (Birds, wet meadows and other wetlands should be protected within this scope.).

It would be sensible to protect the network of the mentioned ecosystems (Sovinc 2001), namely landscapes, which would be set in the direction of most probable migration routes of birds, from the north-east to the northern part of the Adriatic sea (Fig. 1). These wetlands would be functionally connected not only within the scope of the landscape,

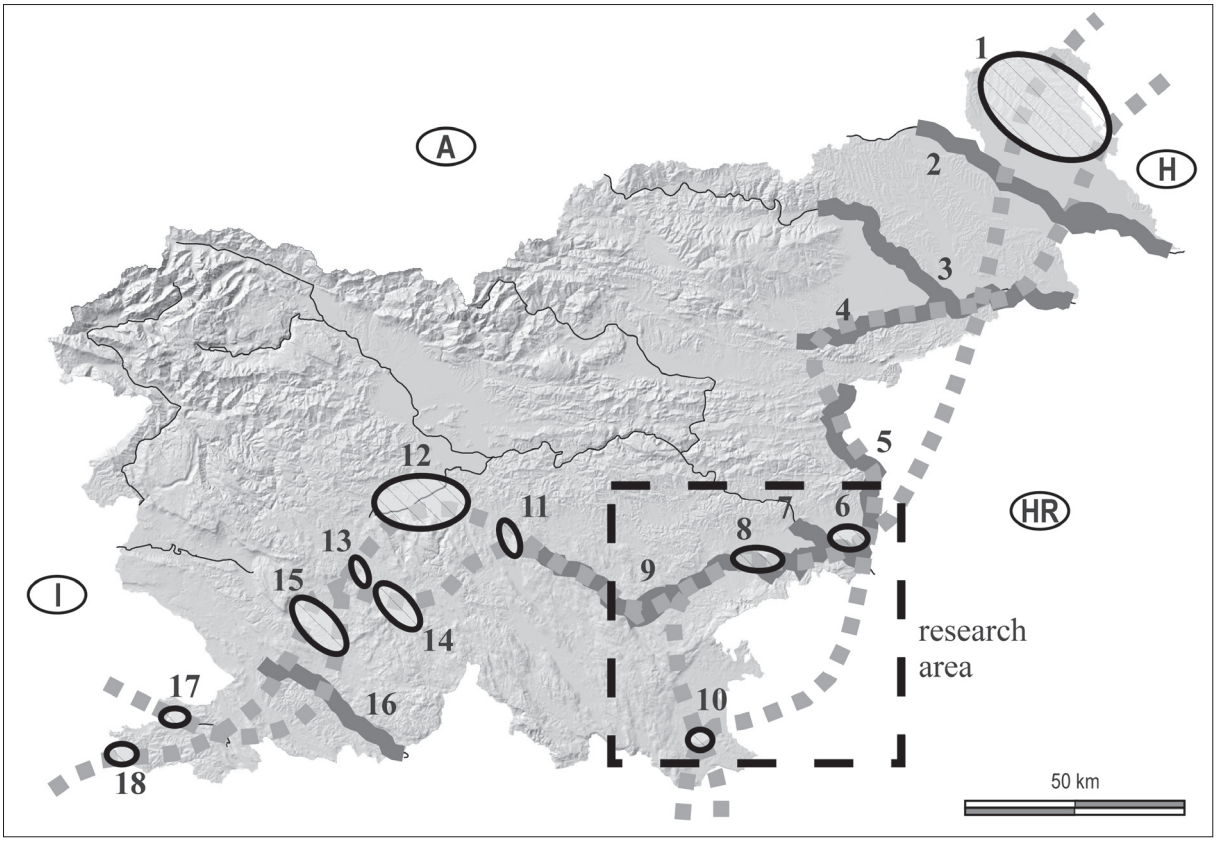

Figure 1: Suggested areas, within which the wet meadows would be preserved, and the most probable migration routes of birds which connect them: Goričko (1), the Mura (2), the Drava (3), the Dravinja (4) and the Sotla (5) rivers, Jovsi and Dobrava (6), the lower part of the Sava river (7), the Krakovo forest (8), the Krka valley (9), Landscape park Lahinja (10), the Radensko polje (11), the Ljubljana Moor (12), the Planina polje (13), lake Cerknica (14), the Nanoščica and Pivka river-basin (15), the Reka valley (16), the Škocjan bay (17) and the Sečovlje salt works (18).
Slika 1: Predlagana območja v sklopu katerih bi ohranjali mokrotne travnike in najbolj verjetne selitvene poti ptic, ki ta območja povezujejo: Goričko (1), Mura (2), Drava (3), Dravinja (4), Sotla (5), Jovsi in Dobrava (6), spodnja Sava (7), Krakovski gozd (8), dolina Krke (9), krajinski park Lahinja (10), Radensko polje (11), Ljubljansko barje (12), Planinsko polje (13), Cerkniško jezero (14), porečje Nanoščice in Pivke (15), dolina Reke (16), Škocjanski zatok (17), Sečoveljske soline (18).

but of the regions as well. In the sense of island biogeography 'stepping stones' and/or resting places as well as corridors (to some extent) are thus ensured among the islands of the reserves and connectivity is improved.

The majority of the mentioned areas have already received the status IBA (Polak 2000; Božič 2003), Jovsi is protected as a natural monument (153 ha of land is protected according to the Decree, U. l. RS, no. 38/95) and the plains in the spring area of the Lahinja river are treated as a landscape park, where several measures help to successfully maintain the cultural landscape (One of them is payment for the mowing of wet meadows, for example. (ARSO 2001)).

In future, other mentioned areas, where the reserves as well as the landscape matrix would be managed according to the principle of wise-use, could be preserved within the scope of cultural landscapes. Moreover, the ecological network of protected areas should be developed with special care for conditions in the landscape matrix, and the management on the landscape level should be organized with the help of the Law on Conservation of Nature. The connectivity in a landscape can thus be improved to a high degree; in other words, migrations from one reserve to another can be facilitated. One of the major problems concerning protected areas is their management, as is stated in the plan of management which is the basis for taking measures in view of protection and development (ARSO 2001). One of the crucial troubles concerning management is obviously also the lack of cooperation between the competent ministries,

shortage of money, knowledge, as well as communication with local communities. When solving the mentioned problem, it would be necessary not only to take into consideration the possibilities of sustainable tourism and recreation but also to ensure the source of money and animate local people for cooperation, which would be a way towards promoting our rich natural and cultural heritage – the national value and identity.

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7. POVZETEK

Ohranjanje mokrotnih travnikov v jugovzhodni Sloveniji

Mokrotne travnike v Sloveniji uvrščamo med ogrožene ekosisteme (Seliškar 1996). V številnih evropskih državah si zelo prizadevajo za njihovo restavracijo (Hölzel & Otte 2003, Prach 1996, Straškrabová & Prach 1998, Joyce & Wade 1998, Bissels & al. 2004, McCrea & al. 2001, Grootjans & al. 2002), čeprav je celo v več desetletjih težko doseči prvotno stanje. Zato je najbolje in finančno najugodneje, da ohranimo obstoječe mokrotne travnike.

Mokrotni travniki so mokriščni ekosistemi, kjer uspevajo združbe, v katerih prevladujejo zelnate rastline, ki uspevajo na občasno poplavljenih tleh (Keddy 2000). Občasno poplavljanje izločuje mezofilne vrste, sušna obdobja pa higrofilne vrste in tako so nastale specifične rastlinske združbe, značilne za mokrotna tla. Mokrotni travniki oziroma mokrišča na splošno so ekosistemi, odvisni od stalne ali periodične poplavljenosti oziroma nasičenosti površinskega sloja tal z vodo (Keddy 2000), kar ustvarja značilne ekološke razmere.

Na območju JV Slovenije poleg travniških združb zveze *Molinion* uspevajo tudi združbe iz zveze *Deschampsion*, ki je značilna za območje Hrvaške (Horvatić 1939) oziroma panonsko regijo. Mokrotni travniki so del krajin, bodisi gozdnate, kot je Krakovski gozd, ali negozdnate, kot so Jovsi. Jovsi so uvrščeni med izjemne krajine subpanonskega sveta (ARSO 2001), obe pa imata tudi v evropskem merilu velik pomen, npr. s stališča varstva ptic (Polak 2000, Božič 2003).

Mokrotni travniki imajo visoko biodiverziteto (znotraj vrste, medvrstno, ekosistemsko), ker so dinamični prehod med kopenskim in vodnim okoljem. Tu na zelo majhnem prostoru uspevajo nekatere izmed vrstno najbogatejših rastlinskih združb na Zemlji, obenem pa so to antropogeni sistemi, ki za obstoj potrebujejo gospodarjenje (Joyce 2001).

Varovanje biodiverzitete: Mokrotni travniki veliko prispevajo k biodiverziteti. Ker se večinoma nahajajo v nižinah, obstaja nevarnost, da jih zaradi družbenoekonomskih interesov spremenijo v intenzivno gojene kmetijske površine. Zaradi intenzifikacije na eni strani in opuščanja rabe v kmetijstvu nerentabilnih površin na drugi utegnejo tovrstni travniki izginiti iz krajine.

Zaradi izjemne pestrosti vrst in ekosistemov, ki je nastala kot rezultat delovanja ekoloških dejavnikov in človeka, se je na mokrotnih travnikih razvilo mnogo rastlinskih združb, ki bi jih lahko ohranili le v sklopu kulturne krajine. Biodiverziteta med kulturnimi krajinami in znotraj njih je namreč vrednota (Anko 1998). Pristopi na nivoju ekosistema in krajine so edini način za zaščito nepregledne množice vrst in procesov oziroma biodiverzitete (Franklin 1993). Krajinski pristop je pomemben za varovanje biodiverzitete in dopolnjuje tradicionalno varstvo narave na nivoju vrste in rastišča (Anko 1999).

V skladu s konvencijo o biodiverziteti lahko to obravnavamo na naslednjih nivojih: genomskem, vrstnem, ekosistemskem in krajinskem (UNEP 1992). Številni avtorji (npr. Whittaker 1973, Westhoff & van der Maarel 1973, Vitousek & Hooper 1994, Hobbie & al. 1994) označujejo vrstno diverziteto določene združbe oz. ekosistema kot α-diverziteto, pestrost med različnimi združbami oz. ekosistemi pa kot β-diverziteto. Številni gradienti okoljskih dejavnikov in geomorfologija ustvarjajo specifične razmere, v katerih nastanejo različne krajine, zato je krajinska γ-diverziteta lahko zelo visoka.

Zadostno število, velikost in primerna razporeditev rezervatov v krajini edino lahko zagotovijo ohranitev biodiverzitete na vseh nivojih (Harris 1984, Franklin 1993). Zavarovana območja pa ne smejo biti edina strategija za vzdrževanje biodiverzitete, ker to lahko povzroči nastanek razmeroma naravnih otokov med močno degradiranimi območji (Franklin 1993), ki tako med seboj niso povezana. Nezavarovani del krajine oz. krajinska mati-

ca prevladuje, zato sta skrb za razmere v krajinski matici in gospodarjenje na nivoju krajine nujna (Franklin 1993). Tako lahko izboljšamo povezanost v krajini. Žal pa je ena izmed posledic moderne rabe tal fragmentacija ekosistemov in izolacija populacij.

Krajinska ekologija: Mokrotni travniki so del gozdnatih in agrarnih krajin, ki so nastale na močvirnih in poplavnih ravnicah. Vsebnost vode v tleh je vsaj občasno zelo visoka, tla so večinoma tipa amfiglej, hipoglej ali obrečna. Tla imajo odločilno vlogo pri nastanku in delovanju vegetacije in krajine. Na polovici Krške ravni, v Zakrakovju, Krakovem in severnem delu Brežiškega polja, so na debelih glinastih plasteh (Pleničar & Premru 1977) nastala oglejena tla, na katerih še vedno uspevajo močvirni gozdovi. Ta gozdnata krajina se je tu ohranila zaradi težkih nerodovitnih močvirnih tal (Perko & Orožen Adamič 1998), ki so za intenzivno poljedelstvo neprimerna.

Mokrotni travniki, ki jih uvrščamo v red *Molinietalia*, so na tem območju nastali po poseku gozdov. Zaradi izjemne pestrosti vrst in ekosistemov, nastalih zaradi gradientov ekoloških dejavnikov in človekovega delovanja, se je na teh mokrotnih travnikih razvilo 10 rastlinskih združb, ki jih sestavlja preko 230 taksonov višjih rastlin (Zelnik 2003, 2004).

V zadnjih desetletjih prihaja do intenzifikacije rabe teh površin in tako so združbe reda *Molinietalia* po površini močno nazadovale. Na floristično sestavo namreč bolj kot vsebnost vode v tleh vpliva stopnja intenzivnosti rabe tal. Ti oligotrofni ekosistemi so zelo odvisni od človekovega delovanja, ki ne sme biti niti preveč niti premalo intenzivno (Ellmauer & Mucina 1993).

Vrste kot tudi združbe bi morali ohraniti v sklopu kulturne krajine, vendar so močno odvisne od antropogenih dejavnikov (Anko 1999). V srednji Evropi so v nižinskem svetu skoraj vsa travišča nastala zaradi človekovega delovanja in le stalna košnja ali paša preprečujeta njihovo zaraščanje (Ellenberg 1996).

Precejšen del biodiverzitete je nastal zaradi rab, ki so povzročile degradacije v okolju, kot sta npr. krčenje gozdov ali dolgotrajno odnašanje snovi s travišč s košnjo. Pretekle rabe tal so prispevale k povečani biodiverziteti na nivoju vrst in na ravni ekosistemov. Višja biodiverziteta v okviru združbe (α-diverziteta) omogoča njeno boljše delovanje oziroma boljše delovanje ekosistema in večjo ekološko stabilnost, saj so npr. hranila bolje izkoriščena, če je vrstna raznolikost visoka (Tilman & al. 1996, Joyce 2001).

Zaradi splošnega pomanjkanja energije in pridelkov je bil razpon rab v srednji Evropi v 19. stol. precej drugačen. Na poljih so se koncentrirala hranila, na drugi strani pa so nastali številni oligotrofni gozdovi (steljarjenje) in travišča. V krajinah je obstajal močan snovni pretok. Visoka biodiverziteta je bila deloma posledica tega pretoka (Plachter 1996). Zaradi množične uporabe mineralnih gnojil danes tega pretoka snovi ni več, začela pa se je tudi splošna intenzifikacija kmetijskih površin.

Z intenzifikacijo rabe travnika se lahko že v nekaj sezonah spremeni floristična sestava in postane podobna večini nižinskih intenzivno gojenih travnikov. Ogroženost teh ekosistemov se odraža tudi v izjemno visokem deležu vrst oligotrofnih rastišč (oligotrofiti) na rdečih seznamih (Plachter 1996).

Po opustitvi rabe mokrotnih travnikov pa se razvijejo vrstno revne združbe, ki jih sestavljajo konkurenčno močnejše vrste, kot so: *Filipendula ulmaria, Phalaris arundinacea, Deschampsia cespitosa, Carex gracilis, Molinia caerulea* (Rosenthal 1992).

Ohranjanje doslej, zgledi: Ramsarska konvencija zavezuje članice za določitev primernih območij kot mednarodno pomembnih mokrišč (UNESCO 1994), med katerimi so tudi mokrotna travišča. Teh zavarovanih površin je v Sloveniji tudi relativno določenih precej manj kot v drugih srednjeevropskih državah (0,05 % površine ozemlja) (MOP RS & Ramsar Bureau 2001).

Avtorji (CE 1995) Vseevropske strategije o biotski in krajinski raznovrstnosti med drugim predlagajo ohranjanje in renaturacijo mokrišč, prednostno varovanje travišč z visoko biodiverziteto ter varovanje aluvialnih gozdov, pragozdov in obrežnih gozdnih koridorjev. Vse to bi lahko varovali le z ustreznim gospodarjenjem s kulturnimi krajinami.

Pomemben in obetaven način rabe mokrišč je trajnostni turizem. V Evropi je znanih mnogo primerov mokrišč, ki ob skrbi za biodiverziteto omogočajo tudi njihovo uporabo za rekreacijo, promocijo trajnostnega turizma in sodelovanje lokalnega prebivalstva (Åhren 2001). Na tak način bi lahko uredili krajinski park Krakovski gozd, v katerega bi lahko vključili veliko elementov naravne in kulturne dediščine.

Zaključek: Smiselno bi bilo varovati mrežo tovrstnih ekosistemov (Sovinc 2001) oziroma krajin, ki bi potekala v smeri selitvenih poti ptic, od SV proti severnemu Jadranu (slika 1). To bi omenjena mokrišča tudi funkcionalno povezovalo, ne le v sklopu krajine, temveč tudi regij. Tako bi med zaščitenimi območji s pomočjo »stopnih kamnov« in koridorjev zagotovili zadostno povezanost.

Od naštetih območij jih ima večina že status IBA (Polak 2000, Božič 2003), Jovsi so zaščiteni kot naravni spomenik, ravnice v povirju Lahinje pa kot krajinski park, kjer se kulturna krajina z različnimi ukrepi uspešno ohranja.

V bodoče bi v okviru kulturnih krajin lahko ohranjali tudi ostala navedena območja, kjer bi po načelu razumne rabe gospodarili z rezervati in s krajinsko matico. Eden glavnih problemov zavarovanih območij je njihovo upravljanje. Med ključnimi težavami pri upravljanju pa so pomanjkanje sodelovanja med pristojnimi ministrstvi, pomanjkanje denarja, znanja in komunikacije z lokalnimi skupnostmi. Pri reševanju tega problema bi bilo nujno treba upoštevati tudi možnosti trajnostnega turizma in rekreacije in to poleg vira sredstev in angažiranja lokalnega prebivalstva uporabiti tudi kot način promocije naše bogate naravne in kulturne dediščine, ki je naša nacionalna vrednota in identiteta.

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Figure 2: Wet meadows in the cultural grassland landscape of Jovsi.
Slika 2: Mokrotni travniki v kulturni traviščni krajini Jovsi.

Figure 3: Wet meadows in the forested landscape of the Krakovo forest.
Slika 3: Mokrotni travniki v gozdnati krajini Krakovskega gozda.