Chapter 2. Semi-natural Grassland Ecosystem Services

2.1 Defining Ecosystem Services (S. Rūsiņa)

The ecosystem services approach is used across the world to assess the importance of ecosystems for humans (Anon. 2005b). Ecosystem services are all provisions and benefits that nature provides to us on a daily basis. First of all, it ensures the circulation of matter and energy, without which life would be impossible. This is the provision of services required for human existence: food, water, wood, fuel. Secondly, they are environment regulation processes that provide us with adequate living conditions: a stable climate, flood control, erosion control, disease control, water self-purification. Thirdly, nature provides us with cultural and aesthetic values. Fourthly, ecosystems ensure the biodiversity, which is the basis of all other ecosystem services.

Semi-natural grasslands are biologically diverse and the ecologically most important part of the agricultural land. They are an important feature of the traditional Latvian rural landscape and are of significant heritage value in the tangible and intangible culture. The proportion of semi-natural grasslands in an area is an indicator of low-intensity agriculture and landscape diversity. Areas with a high concentration of semi-natural grasslands are recognised as High Nature Value Farmlands (Oppermann et al. (eds.) 2012).

In comparison with sown and improved grasslands, the semi-natural grasslands provide more high-quality ecosystem services: they store more carbon dioxide, ensure more efficient water infiltration and storage, extensive use causes less pollution, they provide cultural and aesthetical value (Benayas et al. 2009; Bullock et al. 2011) (Table 2.1.1).

The economic value of semi-natural grassland ecosystem services in Latvia has not been calculated so far. However, the calculated monetary value of Czech semi-natural grassland ecosystems provides an insight into the importance of semi-natural grasslands (Hönigová et al. 2012). In the calculation of the net present value of semi-natural grasslands, both income from semi-natural grasslands and the maintenance and restoration costs of these grasslands have been taken into account. A 3% discount (gradual reduction of value) for a period of 100 years was applied. The calculated current net value of semi-natural grasslands in the Czech Republic was from EUR 11,000 to 103,000 per hectare depending on the semi-natural grassland habitat type. Moist grasslands had the highest value in monetary terms and it was lower for dry grasslands.

2.2 Biodiversity – the Guarantee of Grassland Ecosystem Services (S. Rūsiņa, A. Auniņš)

Biodiversity has multiple roles in ensuring the grass-

Table 2.1.1. Ecosystem services of semi-natural grasslands.

Regulating services	Provisioning services	Cultural services
absorb atmosphere carbon dioxide (climate regulation), reduce the spread of invasive species, reduce soil erosion, regulate flooding intensity, reduce the probability of severe floods, maintain soil fertility, reduce water pollution, limit the spread of agricultural pests, crop pollinator habitat.	animal food that is rich in vitamins and biologically active substances, "green" dairy products rich in Omega-3 fatty acids, "green" meat, local identity products, ornamental plant varieties, grass and legume varieties for sown grasslands, livestock breeds, tourism and recreation resource, bioenergy resource, adapting to climate change, medicinal plants and their genetic diversity, seeds for the restoration and creation of species-rich grasslands, bee pastures.	material culture – ethnographic working tools, non-material culture – folk songs, beliefs, customs, traditions, aesthetic value, landscapes – heritage landscape elements, special grassland landscapes: vast floodplains, diverse wooded grassland landscapes; mosaic-type landscapes characteristic to Latvia nature and environmental education, local identity, source of inspiration for creative professions, recreation and tourism, science, research opportunities.

land ecosystem services. It includes the ecosystem regulation function (for example, providing primary biomass production and carbon dioxide capture) and at the same time is an ecosystem service itself (e.g., pollinators, medicinal plants) (Mace et al. 2012). In many cases, greater biodiversity is a guarantee of a higher quality of ecosystem service. For example, a higher number of plant species in the grassland ensures a higher number of pollinator species. The yield of hay is higher when there are more plant species in the grassland, while higher productivity ensures higher efficiency in the capture of atmospheric carbon dioxide (Bullock et al. 2011).

Semi-natural grasslands are plant communities that are most rich in species. The world record is held by semi-natural grassland in an Estonian wooded grassland landscape and in the mountains of Argentina where respectively 63 and 89 species coexist in one square metre of grassland (Kull, Zobel 1991; Wilson et al. 2012; Dengler et al. 2014). Floodplains and river valleys are particularly rich in vegetation diversity. The diversity of moisture conditions and the number of plant communities there is higher than it is possible anywhere else.

Latvia's meadows and pastures host more than 520 plant species, i.e., one-third of Latvian flora and species of other habitats also often occur there (Jermacāne 1996). The majority of rare species in the territory of Latvia are very unevenly distributed, some of them reach the border of their natural range or are close to it in Latvia (Fatare 1992). At least 100 such species are found in semi-natural meadows and pastures (about 400 such species in Latvia in total). Respectively, semi-natural grasslands are important not only for the conservation of rare species, but also for preservation of the distribution range of these species. Semi-natural grasslands are natural habitats for 33% of the plant species listed in the Red Data Book of Latvia (Andrušaitis (ed.) 2003).

Grasslands are the most important living environment for many plant species. Grasses, with their diverse flora, are among the dominating species in grassland plant communities. Of all orchid family species found in Latvia 66% are found mostly in semi-natural grasslands (*Dactylorhiza* spp., *Orchis* spp., *Gymnadenia* spp.). Keeping plant communities as rich in species as possible is not always the main task of nature conservation. It is also important to preserve communities that are poor in species (e.g., heathlands and sandy grasslands where there are few species in comparison with calcareous meadows or pastures) if they are specific to the region or otherwise unique and very rare and endangered in the region. Latvia's meadows and pastures contain more than 60 different plant communities and 25% of all EU importance protected habitats found in Latvia (Kabucis (ed.) 2001; Rūsiņa 2007; Auniņš (ed.) 2013).

A third of the approximately 13,500 known invertebrate species of Latvia directly depend on grasslands.

Out of approximately 200 bird species that regularly nest in Latvia, almost one fourth are regular grassland breeders. For 15 bird species grasslands are the only or almost the only nesting habitat in Latvia. Another 30 bird species commonly feed in grasslands while nesting in adjacent areas, e.g., forest or farmsteads. During bird migration in the spring and autumn, the grasslands are used as resting and feeding places not only by bird species breeding in Latvia, but also those that do not breed

Table 2.1.2. Nutritional value of grasses in semi-natural and sown grasslands (Latvietis 2013).

Parameter	Semi-natural grassland grass	*Dactylis glomerata*	*Phleum pratense*
Dry matter content, %	18–20	22–24	20–22
Crude protein, %	2,6–2,8	3,2–3,4	3,2–3,6
Crude oils and fats, %	0,6–0,7	0,8	0,8
Crude fibre, %	4,8–5,2	6–6,4	5–7
Carotene, mg/kg	30	35–40	35–40
Vitamin E, mg/kg	50	35–40	35–40
Digestibility of organic substances, %	75	70	65
Energy, MJ for ruminants/ horses	2 / 2,1	2,3 / 2,4	2,3 / 2,2

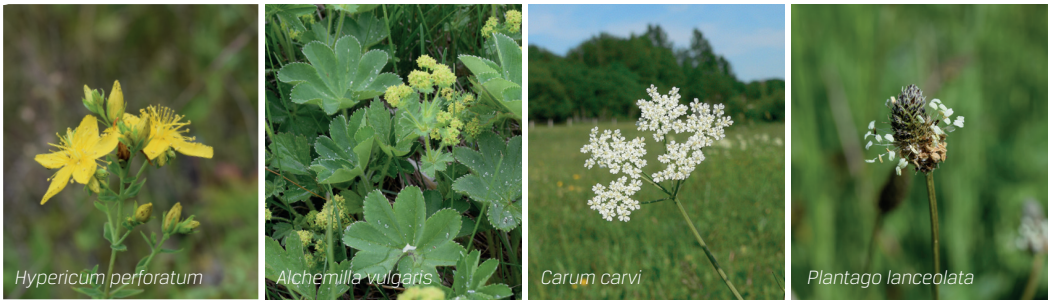

Fig. 2.3.1. Medical plant species of mesic grasslands.

here. Floodplain grasslands are especially attractive during the spring floods when large flocks of waterfowl and waders settle there.

Grasslands are used as breeding habitats by 17 bird species, the protection of which is binding on Latvia internationally (i.e., species included in Annex I of the Birds Directive), and another eight species forage here on a regular basis. During the migration season, grasslands are used by a few more species of Annex I of the Birds Directive and during spring floods they are important gathering places for waterfowl (including many species of Annex II of the Birds Directive).

The critically endangered Baltic subspecies of the Dunlin *Calidris alpina schinzii* is directly linked to the grasslands. For eight out of fifteen bird species of global conservation concern breeding in Latvia at least part of their populations depends on grasslands (IUCN 2016). Three of these species are fully dependent on grasslands in Latvia – *Acrocephalus paludicola* ("vulnerable" status according to IUCN (International Union for the Conservation of Nature) criteria), *Gallinago media* and *Limosa limosa* ("near threatened" status for both).

Significant part of the populations of *Anthus pratensis, Vanellus vanellus,* and in much lesser extent also *Turdus iliacus* ("near threatened" status for all species) nests within grasslands. *Haematopus ostralegus* ("near threatened" status) belongs to meadow waders in Europe although in Latvia it is not primarily linked to grasslands.

Numenius arquata ("near threatened" status) is presently mainly associated with other habitats (raised bogs), historically it has also been associated with grasslands. *Crex crex* had the global threat status until recently, but thanks to the species protection and grassland habitat restoration measures in recent decades, especially in Western Europe, its population has increased and its status has been changed to "least concern". Corncrake is no longer considered a globally threatened species starting from 2010.

Grasslands, especially those adjacent to water bodies and watercourses, are also very important in terms of hunting management because several game bird species nest there or use grasslands otherwise, however, the population decline of some duck species and *Tetrao tetrix* is directly attributed to the reduction of grassland areas and their quality in Latvia.

2.3 Provisioning Services (S. Rūsiņa, A. Auniņš)

Grasslands are an integral part of the livestock farming industry. Dairy farming is unimaginable without grasslands because grass and hay are the principal forage of livestock. The productivity of semi-natural grasslands is low (0.5–5 t ha^{-1} of hay) in comparison with sown grasslands. Floodplain grasslands are an exception: they are one of the most productive ecosystems in the world with green biomass reaching up to 10–30 t ha^{-1} or 2–4 t ha^{-1} of hay. Due to their vast area, floodplain grasslands are still a highly valuable economic asset in some regions of Latvia. Since they cannot be used as arable land due to agrotechnical conditions, only livestock farming is possible there. Semi-natural grasslands are an important resource in creating cultivated grass and legume varieties as well as ornamental plant selection.

The hay harvested in semi-natural grasslands is rich in vitamins, micronutrients and biologically active substances. Dairy products obtained from cows that graze and consume fresh grass, compared with cows kept only in the barn and eating mown grass and combined feed, are richer in vitamins and biologically active substances. The milk of a hay-fed cow has 1.1 mg of carotene per 1 kg, while that of a grass-fed cow has 4 mg (Tērauds 1955). Comparison of the benefits of sown grassland and semi-natural grassland hay for feeding dairy cattle has shown that hay rich in species is consumed well. The use of such hay in up to 40% of the total amount of feed

Fig. 2.5.1. The theme of the Nature Concert Hall (popular annual multimedia project including concerts) of 2015 was the meadow and the meadow vetchling (*Lathyrus pratensis*). Photo: A. Soms.

Fig. 2.5.2. Semi-natural grassland plant species *Ranunculus acris*, *Briza media*, *Primula veris*, *Helictotrichon pratense*, *Campanula rotundifolia* and *Geum rivale* in jewellery (jewellery by L. Gustiņa). Photo: L. Gustiņa.

did not reduce the milk yield and quality of even highly productive dairy cattle species (Bruinenberg et al. 2002). The beef and milk of cattle grazed in semi-natural grasslands is richer in antioxidants, Omega-3 unsaturated fatty acids and has a lower content of saturated fatty acids. Types of cheese produced from the milk of cows and sheep grazed in semi-natural pastures have a different aroma and taste and the biodiversity of the semi-natural grasslands is an important marketing aspect for these types of cheese (Moloney et al. 2008). The nutritional value of semi-natural grassland feed in comparison with sown grasslands is given in Table 2.1.2.

The grass is used in the production of bioenergy (biogas, biobutanol, grass pellets, pressed hay). Europe has successful examples of using grass of semi-natural grasslands in the production of bioenergy. The Estonian town of Lihula, for example, uses the semi-natural coastal grassland hay cut in Matsalu National Park for heating (Lausmaa 1999; Anon. 2006). 3,000 bales of hay (1,350–1,400 t of hay) are burnt during one heating season. The cost of heating for the residents is lower than before, when natural gas was used (Kask, Kask 2014). Estonian resources of semi-natural grasslands for bioenergy have been evaluated at approximately 18 kJ g^{-1} of grass energy value and an energy potential from 29 to 104 GJ ha^{-1} depending on the type of grassland (for energy crops it is usually around 100 GJ ha^{-1}) (Henisoo et al. 2010). In Latvia, the issue has only been addressed recently by the LIFE+ GRASSSERVICE project (implementation period 2013–2017). The aim of the project is to evaluate and map the available grasslands, including semi-natural grasslands, biomass resources, their economic value and alternative use options.

Medical plants are an important resource. The majority of common medical plants in Latvia occur in semi-natural grasslands. Out of 110 wild species mentioned in the book by H. Rubine and V. Eniņa

"Ārstniecības augi" ("Medical Plants") (Rubine, Eniņa 2004), 38 species are semi-natural grassland species and a few more dozen are found in habitats related to grasslands – forest fringes, river banks and elsewhere. Up to 10-20 different medical plant species may be found together in one meadow, for instance, a mesic meadow may contain *Trifolium pratense, Trifolium repens, Agrimonia eupatoria, Hypericum perforatum, Ononis arvensis, Prunella vulgaris, Plantago lanceolata, Cichorium inthybus, Primula veris, Carum carvi* (Fig. 2.3.1).

Semi-natural grasslands are diverse bee pastures. Research carried out in the protected landscape area "Ziemeļgauja" revealed that there were 160 nectar plants within a 2 km radius around the beehives in semi-natural grasslands. One-year-long observation of the pollen composition of the honey revealed that bees, while gathering honey, visited the flowers of at least 50 different plant species, 65% of which were semi-natural grassland species (Bērziņa 2014).

The resources of semi-natural grasslands in the selection of grasses, legumes and ornamental plants are irreplaceable and they store great potential. For example, meadow fescue *Festuca pratensis* was collected in 38 different habitats in Switzerland and it was found that the wild forms have various advantages (wintering capacity, early emergence) (Madlaina et al. 2008).

Grasslands have been an important resource of game birds and other animals since ancient times. They provided a breeding habitat for many duck species, not only the meadow breeding ducks (*Anas querquedula, A. clypeata*, and *A. strepera*), but also the most important game species – *A. platyrhynchos*.

2.4 Regulating Services (S. Rūsiņa)

Ecological importance of grasslands is high. They protect the soil from erosion, ensure soil formation and the accumulation of organic matter in it. Floodplain grasslands regulate the flooding intensity, ensure nutrient circulation and purify the surface water. The herb vegetation efficiently absorbs the nitrogen that enters the floodplain from rivers and surface runoff. Meanwhile, mowing of grass and haymaking ensures nitrogen stripping from the ecosystem, protecting the rivers and the grassland itself from excessive enrichment with nitrogen and the decline in biodiversity.

Floodplains significantly reduce the risk of flooding. Conditions for denitrification in floodplains are highly favourable. Soil bacteria split the nitrates in anoxic conditions and release them into the atmosphere in a non-polluting form of gaseous nitrogen (Haycock et al. 1993). Although greenhouse gas emissions take place in wetlands, it has been proven that these emissions are lower in floodplains where moist conditions alternate with dry conditions in comparison with permanently moist areas, and the floods contribute to denitrification (Mitsch et al. 2008; Sha et al. 2011).

In semi-natural grasslands, the high plant diversity and the well-developed turf prevent the introduction of invasive species, limiting the spread of such species in the landscape.

2.5 Cultural Services (S. Rūsiņa)

Semi-natural meadows and pastures are a result of the synergy of humans and nature. The diversity in grasslands cannot exist without human participation. No other ecosystem is similar, as all others (mires, forests, aquatic ecosystems) are preserved best in natural conditions and can achieve the highest biodiversity if humans do not intervene and do not hinder the natural processes. In Latvia, many unique landscapes rich in semi-natural grasslands (e.g., sea coast at Mērsrags, river valleys near Kandava and Sabile (Abava), Kuldīga (Venta), Valka (Gauja)) have developed through close interaction between humans and nature. People lived in these landscapes, forming their tangible and intangible culture, sense of belonging and local identity, therefore the semi-natural grassland landscape is a heritage object in the same sense as a fisherman's village, manor estate or a collection of ethnographic tools. Meadows and pastures are a source of inspiration in music and art (Fig. 2.5.1, 2.5.2).

Both local residents and tourists in Europe appreciate semi-natural grasslands as an important element of the rural landscape. They ensure the beauty and identity of the landscape that tourists find worth seeing and enjoying (Stenseke 2006; Rūsiņa et al. 2013). Landscape elements of historical and cultural heritage value, such as ancient shallow ditch systems and hay barns in remote meadows are uniquely related to the semi-natural grasslands.