Meadow Biodiversity in Today‘s Slovenian Biology and Geography Curricula for Primary School and Grammar School in the Context of the Long-term History of Meadows

Discovering the Power of Nature:
Participatory Environmental Education for Sustainability:
Opportunities, Challenges and Practices

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Ratio of fertilized to non-fertilized meadows at 53 possession units, each represented by a column, the Alps of southern Carinthia between Jezersko and Lobnig/Lobnik. The great majority of these possession units are isolated mountain farms, around 550–1200 m: approximate calculations based on data from 1567:

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%

120 100 80 60 40 20 0

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53

■ Approx. percentage of fertilized or irrigated meadows within the total meadow area per farm (left ordinate)

■ Approx. percentage of non-fertilized, non-irrigated meadows within the total meadow area per farm (left ordinate)

◆ Quantity of 1st & 2nd crop hay together, per holding (in small carts, right ordinate)

StLA, Innerösterrichische Hofkammer, Sachabteilung, box 69, volume 8: Des ambts Capl bereuttung und beschreibung, 1567.



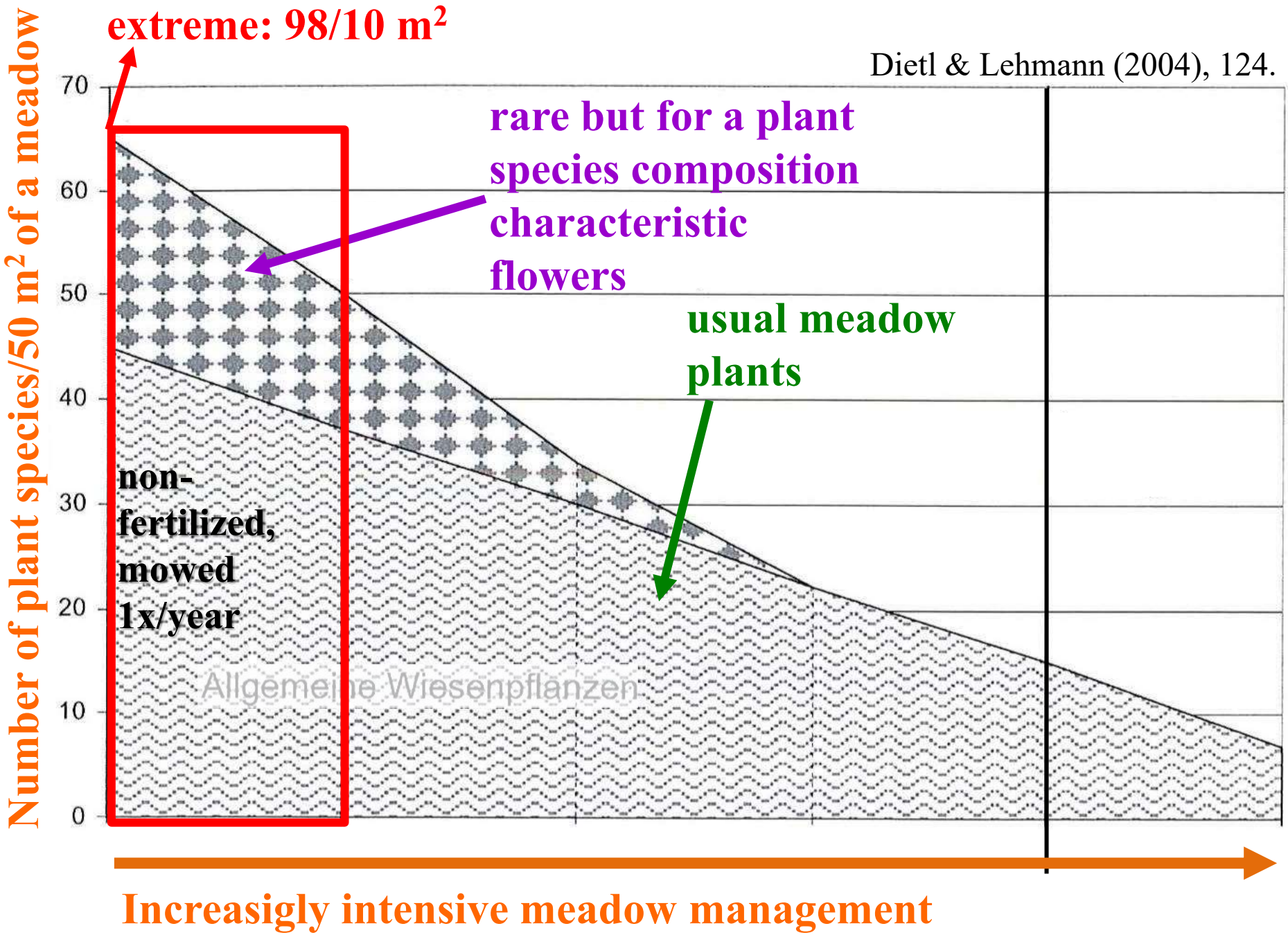
+ animal diversity:

Meadow complex Mussen, Lesachtal, Carinthia (1460–2040 m n.m.v.)
> 1000 animal species:

- **670 butterfly species – including 221 pure meadow species,**
- **> 100 spider species,**
- **22 cicada species,**
- **several ground beetles, bumblebees, grasshoppers, ants, birds and some other organisms**




Aeschimann et al. (2004) in Ž. Zwitter.


extreme: 98/10 m²
Dietl & Lehmann (2004), 124.
rare but for a plant species composition characteristic flowers
usual meadow plants
non-fertilized, mowed 1x/year
Allgemeine Wiesenpflanzen
Number of plant species/50 m² of a meadow
0
10
20
30
40
50
60
70
Increasigly intensive meadow management

Aeschimann et al. (2004) in Ž. Zwitter.

Manuring 500 m a.s.l.	Number of mowings	Yield (tonnes of dry substance/ha)	Number of plant species/50 m^2
Non-manured	1	1.5–4 (–20 % = 1.2–3.2)	50–65, up to > 90

+ quality differences

Sainfoin (*Onobrychis viciifolia*)

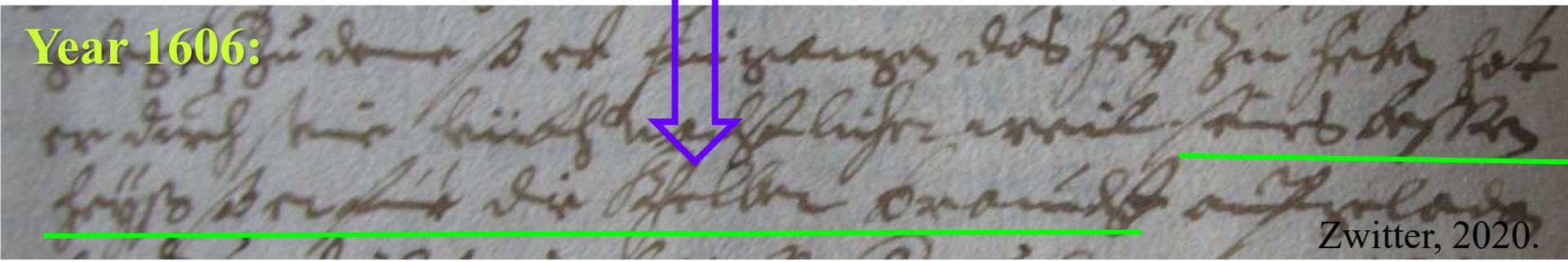
Matgrass sward (matgrass – *Nardus stricta*)

Foto: Ž. Zwitter.

Traditional ecological knowledge:

- knowledge & beliefs about the local environment

- experience; external knowledge impacts



Zwitter, 2020.

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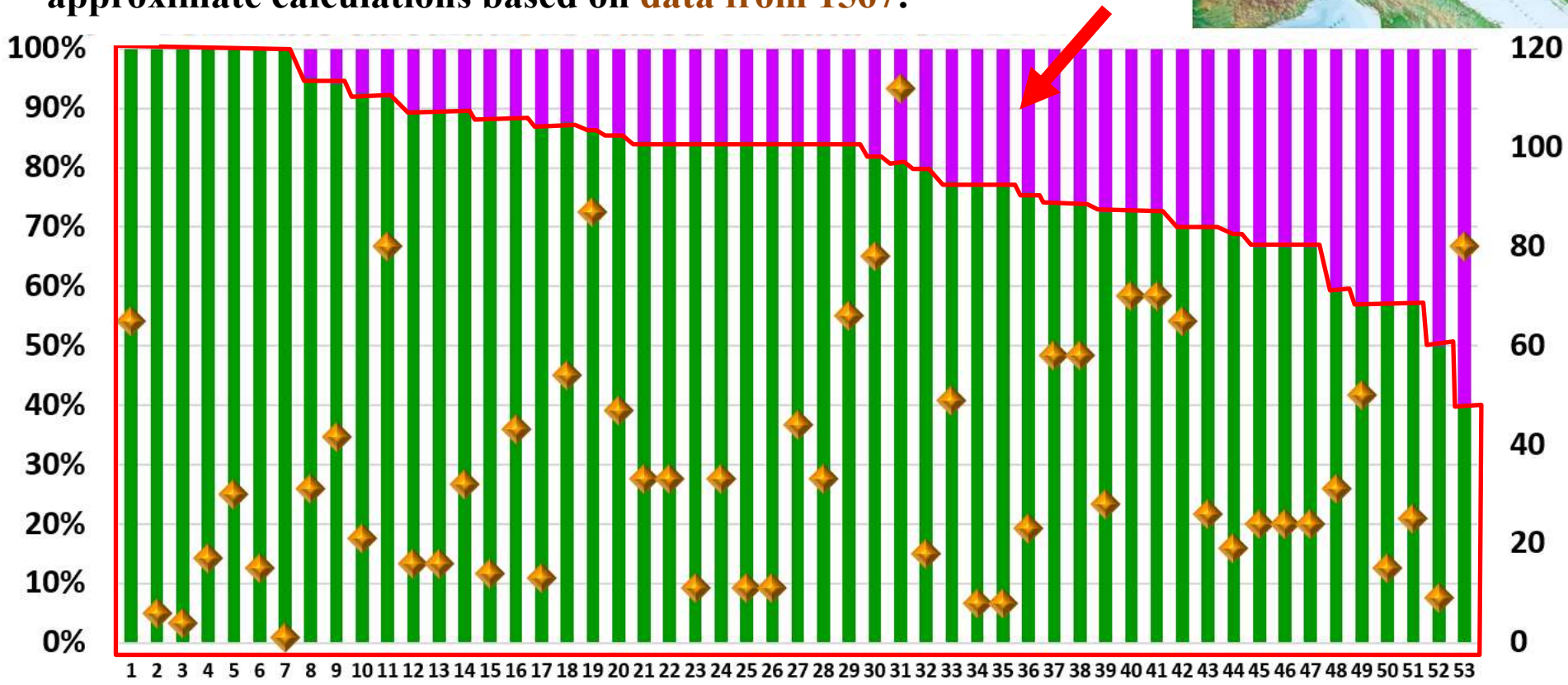


Approx. percentage of fertilized or irrigated meadows within the total meadow area per farm (left ordinate)

Approx. percentage of non-fertilized, non-irrigated meadows within the total meadow area per farm (left ordinate)

Quantity of 1st & 2nd crop hay together, per holding (in small carts, right ordinate)

StLA, Innerösterrichische Hofkammer, Sachabteilung, box 69, volume 8: Des ambts Capl bereuttung und beschreibung, 1567.

false oat-grass

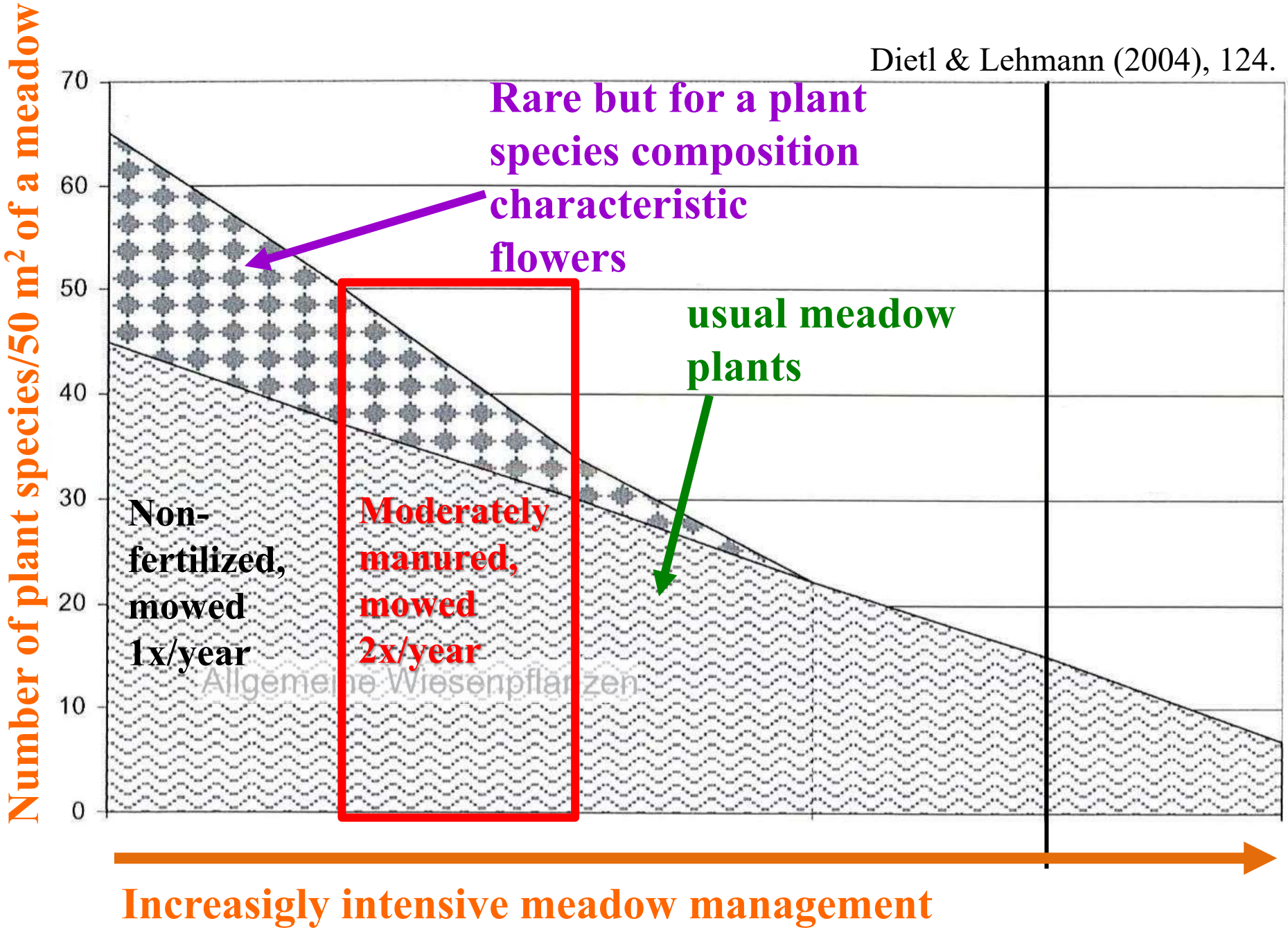
50–150 cm

30–80 cm

yellow oat-grass

sweet vernal-grass

Dietl & Lehmann (2004), 124.



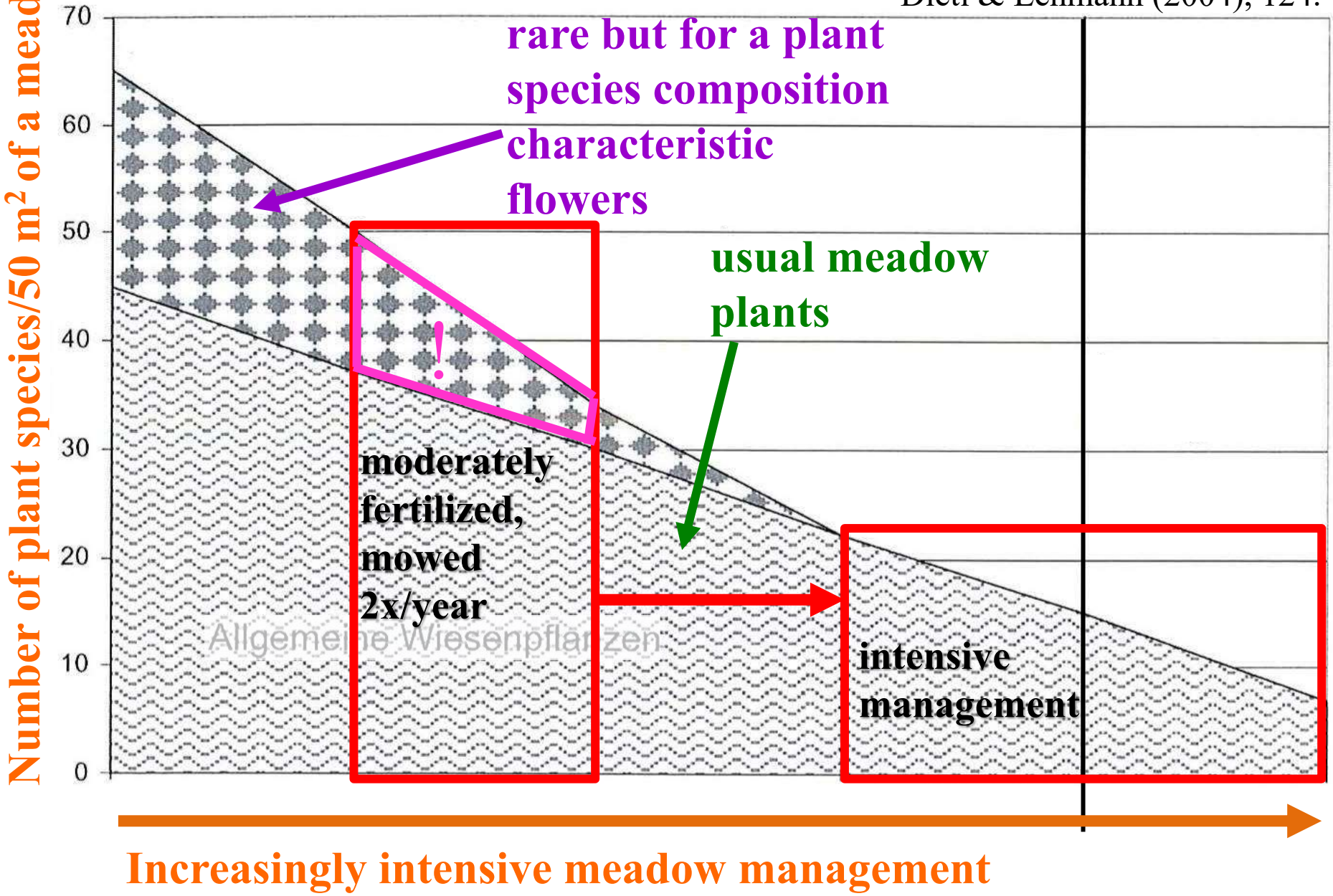
Manuring	Number of mowings	Yield (tonnes of dry substance/ha)	Number of plant species/50 m^2
Non-manured	**1**	**1,5–4 (–20 % = 1,2–3,2)**	**50–65, up to > 90**
Moderately manured, preferably with farmyard manure, or with a mild (usually highly diluted) slurry **500 m a.s.l.**	**2 to 3; productive grasses of these meadows depend on generative propagation > mowing no earlier than mid-June in low altitudes in the Alps**	**8 (6,4) (considering the moderate manuring grasses in these meadows are able to produce high yields)**	**30–50, including some rare species; nutritive value of hay medium; nutritive vale of second-crop hay high (present-day standards)**

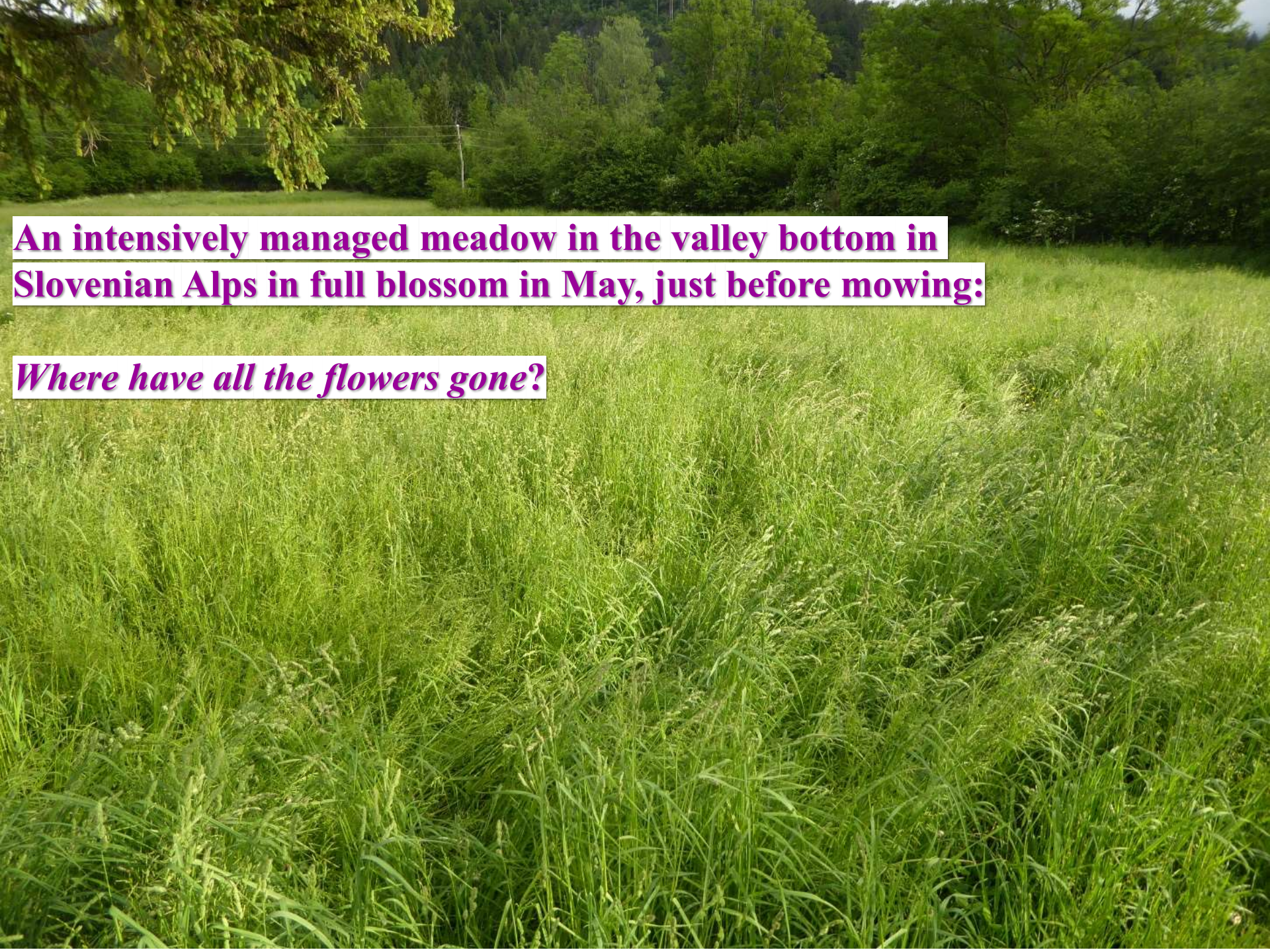
Dietl & Lehmann, 2004.

Second-crop hay

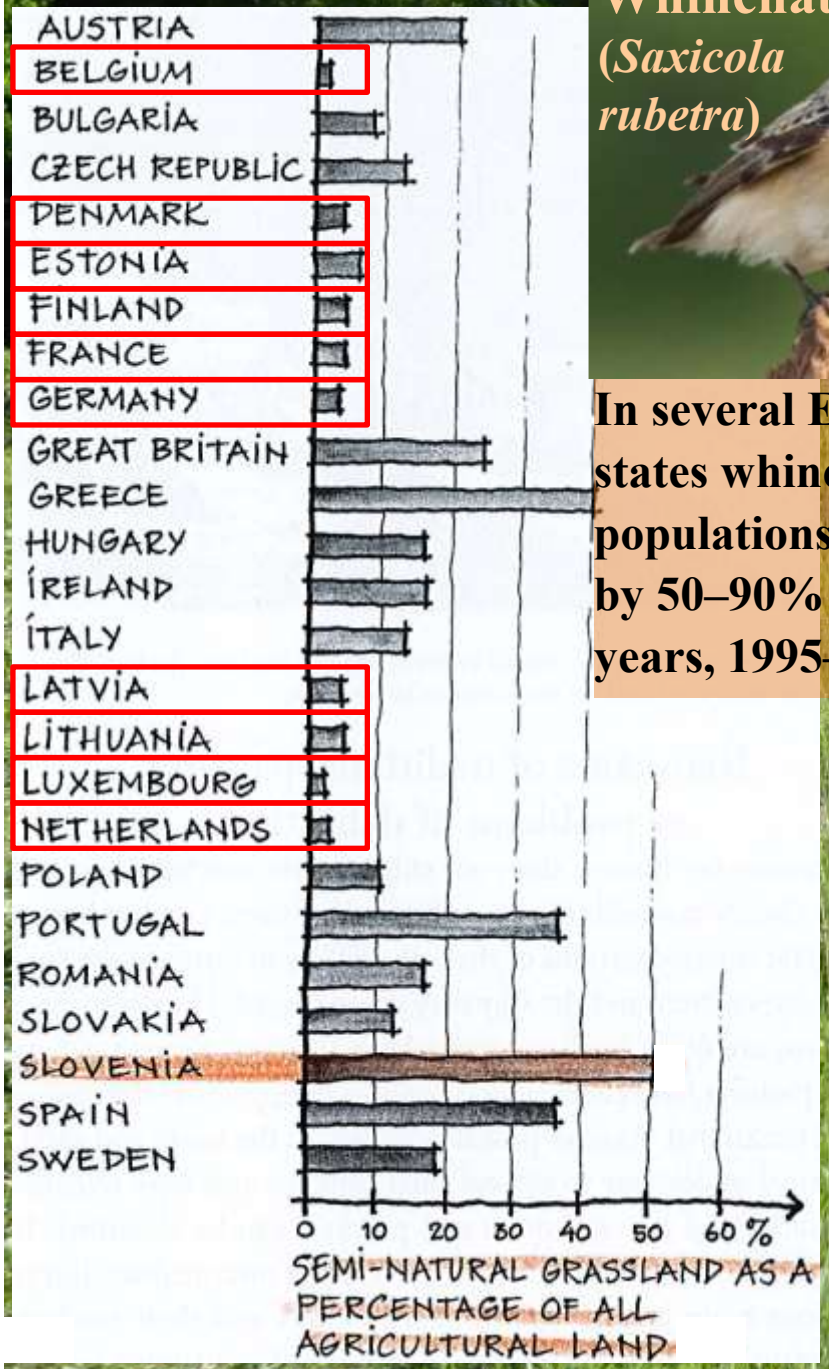
Photo: Ž. Zwitter.

Dietl & Lehmann (2004), 124.




An intensively managed meadow in the valley bottom in Slovenian Alps in full blossom in May, just before mowing:
Where have all the flowers gone?

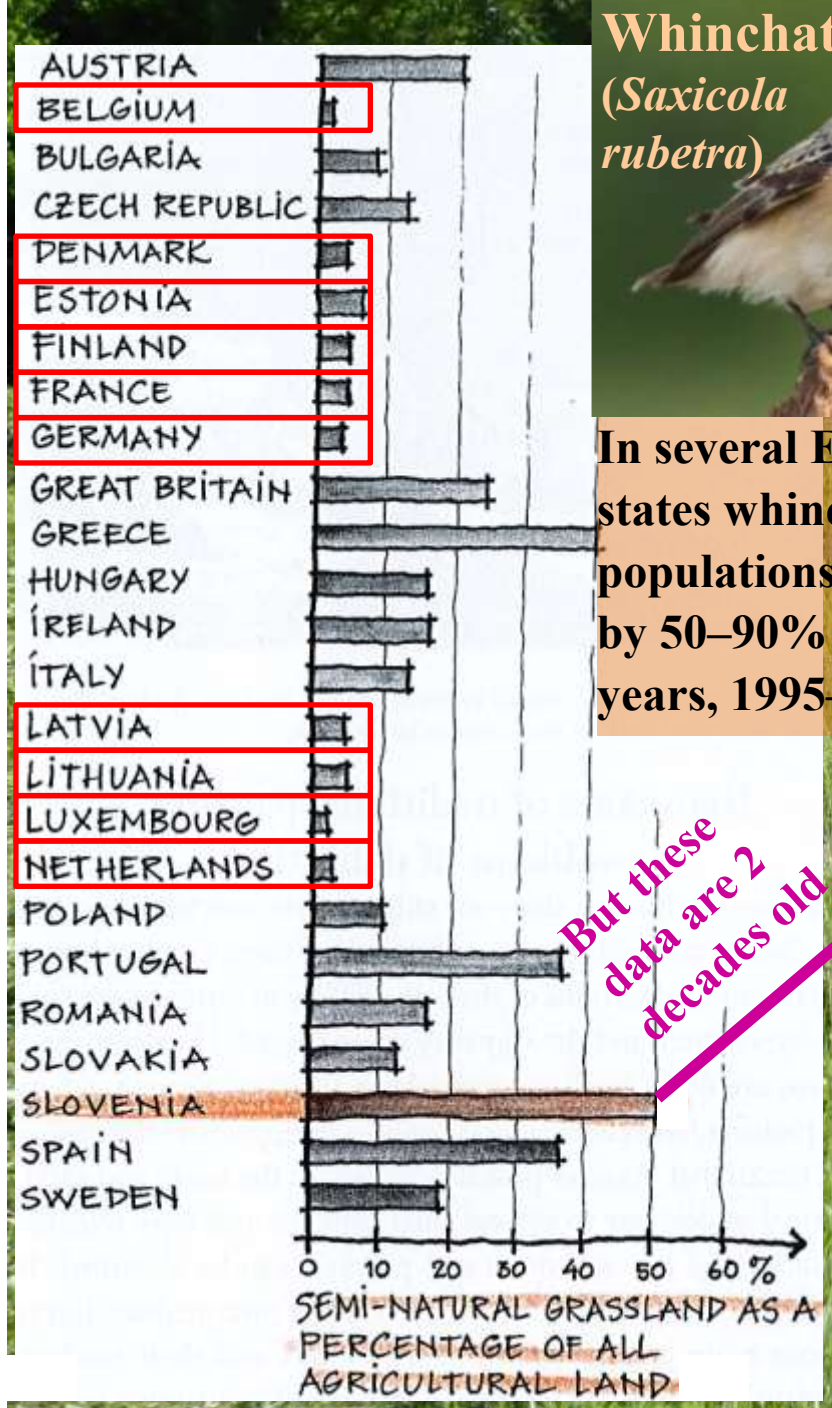
In Western and Northern Europe, “on all but the poorest land grass is normally managed as an intensive crop, regularly ploughed up and replanted with just a few specially bred [grass & clover] species” (Küster & Keenleyside, 2009, 12).



Whinchat (*Saxicola rubetra*)

In several European states whinchat populations decreased by 50–90% in 16 years, 1995–2011

Europen Farmland Bird Indicator: "populations of farmland bird species in Europe have undergone a widespread and rapid decline by as much as 57% since 1980."



But these data are 2 decades old

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In several European states whinchat populations decreased by 50–90% in 16 years, 1995–2011

Europen Farmland Bird Indicator: "populations of farmland bird species in Europe have undergone a widespread and rapid decline by as much as 57% since 1980."

the **quickly worsening situation in <u>Slovenian grasslands</u>:**

From 2008 to 2018, populations of bird species that are grassland specialists declined in Slovenia by 40.8% (Šumrada, Kmecl, & Erjavec, 2021).

Reconciliation between agricultural production and biodiversity conservation: considering biodiversity through its functional role in France:

Magda et al. 2015.

aromatic/healthy for livestock & legumes

much pollen/nectar: apiculture!

highly vulnerable to fertilization

abundant < a problem with vegetation renewal

A farmer from Mönichwald in the Alps of Styria, explained: "On my [result-based nature conservation plan] areas there are wart biters, field crickets and also the lesser-known long-horned grasshoppers. Once you get interested in these animals, you cannot let go. It is fascinating to observe which habitats they populate and how the populations develop. I deliberately mow some areas later or leave them untouched over the winter. Grasshoppers need the stalks in which their eggs can pass the winter. I also have old fruit trees on my land, which I leave standing as breeding trees for the hoopoe. And in the surrounding hedges I support the red-backed shrike, which now has several territories on my farm. I find it important for nature to be given sufficient space on my agricultural land."

Results-based nature conservation plan, [2019]

Biology, the current primary school syllabus (a selection of goals most relevant for this topic):

topics such as biodiversity loss, species extinction well represented – meadows an option, nowhere mandatory:

Pupils learn that the adaptive capacity of every species facing environmental change is limited and that a species gets extinct in case of a sudden and too serious environmental change (p. 17)

Pupils understand the reasons for the high levels of biodiversity in Slovenia (Slovenia as a biodiversity hotspot) and that in order to preserve the biodiversity various habitats have to be preserved (pp. 18, 34); the teacher decides which ecosystems will be dealt with (p. 34)

Pupils understand that … sustainable uses and sustainable development help preserve the biodiversity (p. 19)

Pupils understand the role of people in biotic systems and explore these impacts in their microregion (e.g., fragmentation of ecosystems, biodiversity loss) (pp. 19, 34)

Biology, the revised primary school syllabus, a selection of emphases concerning this topic:

Endemic species, biodiversity loss, endangered species, learning for sustainable future – meadows an option, nowhere mandatory:

Biodiversity in Slovenia: an emphasis should be placed on endemic and endangered/ protected (sub)species (pp. 11-12)

Pupils explain, why small populations (e.g., lynx in Slovenia) are more endangered than large ones and why they are more prone to extinction (p. 44).

Pupils … are aware of possible consequences of exceeded carrying capacity of ecosystems and planetary boundaries (p. 49).

Pupils learn why anthropogenic ecosystems cannot replace most ecological processes and functions of natural ecosystems. They explore how excessive expansion of anthropogenic ecosystems has been irreversibly destroying the biodiversity – and they look for sustainable solutions (p. 49).

Pupils apply their knowledge contributing to general awareness raising and to the mitigation of the biodiversity crisis locally and globally … (p. 49).

Pupils learn that only learning and awareness-raising in the society can solve the global crises, like the climate crisis, biodiversity crisis, health, and food crisis (p. 49).

Biology, the current grammar school syllabus (a selection of goals most relevant for this topic); the revised version brings no major novelties concerning this topic since it is already well covered in the current syllabus:

large-scale destruction of ecosystems through human activities, including a historical perspective; habitat fragmentation; endangered species (emphasis on Slovenia); species extinction; more sustainable future is an option; meadows an option, nowhere mandatory:

Students learn that the continuously increasing human use of resources has been impacting on natural processes ever more heavily … and that human sensitivity to climate change and changes in ecosystems have increased with the growth of human populations … (G4). Large-scale destruction of ecosystems is a threat for the future of the humankind (K25).

Students learn about the results of some international publications on global … changes in ecosystems, resources, and sustainable ecosystem management (G4).

Students learn that the humankind has a strong impact on other species and on entire ecosystems (e.g. habitat fragmentation and destruction, changes in the chemical composition of … soils) and that artificially synthesized substances impact on cycling of matter on Earth (e.g., … fertilizing …) (G4).

Students learn about species extinction, … that biodiversity preservation requires the preservation of populations large enough to include a sufficient number of mature specimens to succesfully reproduce and survive (G4).

Students understand the difference between natural species extinction and species extinction driven by humans (habitat destruction …), they get familiar with the term mass extinction and how it occurred from geological history until now (G4).

Students understand the term endangerment, they get to know a few examples of endangered species in Slovenia (G4).

Students learn that using recent knowledge and technologies, humankind could substantially decrease their impact on ecosystems (G23).

Slovenia as biodiversity hotspot: the selection of nationally important ecosystems dealt with belongs to every teacher‘s autonomy – an emphasis should be placed on endemic and endangered/ protected (sub)species (6.2.9)

Geography, the current grammar school syllabus (a selection of goals most relevant for this topic):

ecological footprint of farming, sustainability of farming, farming and maintenance of cultural landscapes – it depends on teacher's emphases whether students will understand seminatural hay meadows of the temperate zone:

general geography: students identify and study an example of human transformation of natural vegetation and human contribution to the extinction of animal species (p. 19)

general geography: students acquire a positive attitude to farming as source of food and raw materials, and to its role in cultural landscape maintenance (p. 20)

general geography: students explore environmental challenges related to intensive farming … (p. 20)

geography of Europe: students learn basic facts about farming and the related recent challenges (p. 26)

geography of Europe: students know the relevance of the EU's Common Agricultural Policy (p. 26)

geography of Slovenia: students explore the characteristics, challenges, and oprotunities for the development of farming in Slovenia (evolution of farming over the last 50 years, …, currents trends of transformation of Slovenian countryside) (p. 33)

geography of Slovenia: students explore the contribution of farming to environmental transformation (p. 33)

geography of Slovenia: students list examples of human impact on selected plant and animal species in Slovenia (p. 32)

field work: students evaluate soils from the perspective of farming and soil preservation (they look for sources of pollution, deduce the likely consequences, and evaluate human interventions in nature) (p. 40)

Geography, the revised grammar school syllabus (that will enter into force in September 2026):

general geography: students explain the impact of abiotic environmental factors, people and other living beings on vegetation (p. 44)

general geography & geography of Slovenia: the topic of farming types: extensive farming, intensive farming, …, sustainable farming, organic farming (p. 55, 129)

general geography: students find out the reasons for and role of the current countryside transformation (p. 58)

general geography & geography of Slovenia: students evaluate the role of farming as source of food and raw materials, and in cultural landscape maintenance (pp. 72, 144)

general geography & geography of Slovenia: students explore (un)sustainable farming & present environmental challenges posed by intensive farming (p. 72, 144); participatory learning at (organic) farms is suggested (pp. 83, 130)

geography of Europe: students interpret the role of Dutch farming for the Netherlands, the EU, and the world, and evaluate it from the sustainability perspective (p. 113)

geography of Europe: students compare traditional and modern farming types in the Mediterranean (p. 116)

geography of Slovenia: students present CAP's positive and negative impacts on farming in Slovenia (p. 144)

Ecosystems explicitly (or almost explicitly) mentioned in the analysed curricula:

1. Biology, the current grammar school syllabus:

Didactic instruction concernig the topic of ecology: A teacher presents ecological concepts based on examples from real ecosystems; wherever possible, examples of organisms and ecosystems from Slovenia are used (e.g., a forest, meadow, sea, lake, river) (section G).

Not for all students:

Students estimate the species diversity in a selected ecosystem (e.g., … in a meadow) (K29)

Students understand the ecosystem services, e.g., pollination, natural pest suppression … (K24)

Students critically evaluate the environmental impacts of modern agriculture and livestock farming (e.g., pecticides, fertilizers, irrigation, methane as greenhouse gas) (K8)

Biology, the revised grammar school syllabus (a narrow selection of goals most relevant for this topic):

Elective goal: students learn the specifics in the growth of grasses and its relevance for the evolution of grasslands and herbivores (p. 50)

Geography, the revised grammar school syllabus (that will enter into force in September 2026):

general geography: the topic of vegetation (p. 25):
***natural vegetation, cultural vegetation, altitudinal zonation of vegetation, cultural landscape, forest clearing, forest burning, tropical rainforest, savannah, desert vegetation, Mediterranean vegetation, temperate-zone forests (conferous, deciduous, mixed), steppe, taiga, tundra* [what about seminatural meadows in the temperate zone?]**

geography of Latin America:
students explain the main features of the Amazon Rainforest (p. 92)

geography of Slovenia: students learn about the role of forests for people and landscapes, and explain the factors threatening the forests (p. 136)

geography of Slovenia: students present the specifics of the development of mountain farming, with an emphasis on alps (typically: summer mountain pastures) in the Alps, present the driving forces for changes in use of the alps (p. 156)

Geography, the current grammar school syllabus

geography of Slovenia: students evaluate the role of forests for people and their activities in various regions of Slovenia (including their home region) (p. 32)

geography of Slovenia: students list the factors most seriously threatening forests in various Slovenian regions (p. 32)

geography of Slovenia: students know the largest wetlands in Slovenia and their role for life (p. 32)

geography of Slovenia: students identify the key driving forces for the abandonment of alps (typically: summer mountain pastures) in the Alps (p. 36)

Elective additional topics from geography of Slovenia: the role of wetlands, rivers, lakes, and the sea in nature protection and economy (p. 43)

Geography, the revised primary school syllabus (that will enter into force in September 2026):

geography of Slovenia: pupils consider the role of wetlands (p. 65)

Conclusions

1. For millennia, until the second half of the 20th century, hay meadows were typically extensively managed > most meadow organisms evolutionarily adapted to seminatural meadows that are often biodiversity hotspots.
2. Due to the lack of balance between the economic, social, and environmental pillars of sustainability, the biodiversity of an average meadow in Slovenia has been rapidly declining in the 21st century.
3. Numerous learning objectives in the current and revised primary school and grammar school biology and geography syllabi in Slovenia allow for (participatory or other) learning about species-rich grasslands from the perspective of the environment and ecosystem services – but nowhere in these syllabi is it demanded that seminatural hay meadows in Central Europe or Slovenia serve as an example when dealing with topics such as sustainability in farming.
4. In order to preserve enough seminatural meadows in the landscape to prevent mass extinction, it is essential that learning about the very hot issue of species-rich grasslands be explicitly prescribed in biology and geography education in primary schools and grammar schools as soon as possible.
5. All citizens' (food consumers; food producers; food processors; businesspeople working in the marketing of food products that is frequently misleading from the perspective of biodiversity; members of the state administration; and politicians) knowledge about meadows plays a key role in the potential continued sustainable use of grasslands in Slovenia that would preserve biodiversity in a sufficient percentage of grasslands and enable an equitable situation for farmers.