

Biodiversity of bog grassland

- the ecological and conservation point of view

Rainer Buchwald, Jana Packmor & Bente Oetken
AG Vegetationskunde und Naturschutz
Institut für Biologie und Umweltwissenschaften
(IBU)
C.v.O. Universität Oldenburg

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Erhalt von Moorgrünland durch angepasstes Management



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Characteristics of bog grassland

- **Origin:** natural bogs, characterised by wet and humid peat soils, very low pH-values and very low nutrient contents
- **Effects of agricultural (or other) utilisation:** deepening of the water level, transformation of the peat features (water-holding capacity etc.), peat mineralisation, decrease of the peat layer, emission of greenhouse gases, loss of nutrients into the ground/surface waters, strong transformation of fauna and flora; however: **degree of these effects dependent on the intensity of use**
- Requirements of a regular grassland utilisation: pH-values 5 to 7, high nutrient amounts, medium water levels (fresh, but not humid soils)
 - ⇒ distinct discrepancy between the original bogs and the regularly (intensively) used habitats
 - ⇒ **sustainable agricultural utilization of peat soils ,per se' not possible (contrary to mineral soils)!**
- (However:) Bog grassland is part of the Northwest-German **cultural landscape**, and **economic base** for many grassland farmers, particularly milk producers

Bog grassland in NW-Germany (mown, fertilised by PK)

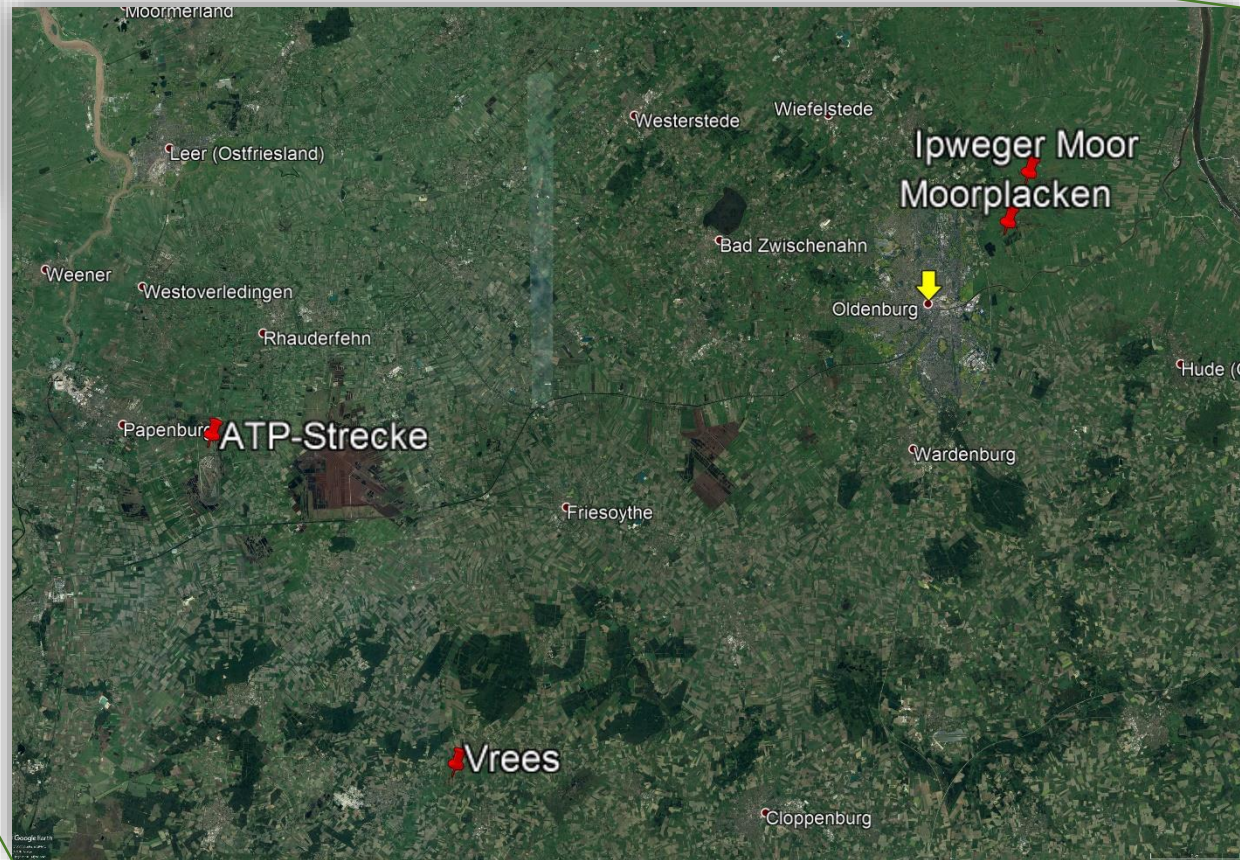




Bog grassland at Ipweger Moor (IM):
landscape, control variant and
variant after renovation of the sward.



Study regions in the northwestern part of Lower Saxony



Emsland: Vrees,
ATP-Strecke (Papenburg)

Quellen: www.niedersachsen.de & Google Earth

I. Phytodiversity of bog grassland (Lower Saxony)

- Data sampling by the frequency method: plots of 1 m², presence/absence of the vascular plants; assessment by frequencies (in %)
- Gradient of utilisation intensity, according to four classes (e, me, mi, i)
- Comparison of bog meadows and mineral soil meadows
- Further methods: relevés after Braun-Blanquet, species lists

Management (as grassland):

1-2 x mowing, since > 12 years no fertilisation (Moorplacken);

2 x mowing or grazing, with/without mulching, with/without fertilisation (Emsland);

4-5 x mowing, 4-6 x fertilisation (liquid manure, anorganic fertilizer) (Ipweger Moor)

Mean frequencies (%) of the dominant plant species in the areas Moorplacken (M), Emsland (E) and Ipweger Moor (IM)

| Area | M | E | IM | indicator value N (Ellenberg; 1-9) | indicator value F (Ellenberg; 1-9) |
|------------------------------------|------|-----------|------|---------------------------------------|---------------------------------------|
| No. of relevés (1 m ²) | 352 | 1850 | 324 | | |
| Intensity of use | e | (e-)me/mi | i | | |
| Mean number of species | 8,1 | 6,7 | 8,8 | | |
| <i>Holcus lanatus</i> | 81,5 | 75,5 | 11,1 | 5 | 6 |
| <i>Ranunculus repens</i> | 54 | 44,9 | 34,6 | 7 | 7~ |
| <i>Poa trivialis</i> | 15,9 | 56,4 | 2,2 | 7 | 7 |
| <i>Cardamine pratensis</i> | 21,6 | 17,6 | 33,6 | x | 6 |
| <i>Poa pratensis</i> (agg.) | 15,1 | 31,5 | 23,5 | 6 | 5 |
| <i>Holcus mollis</i> | 19,3 | 28,7 | 19,4 | 3 | 5 |
| <i>Glechoma hederacea</i> | 20,2 | 0,4 | 29,3 | 7 | 6 |
| <i>Rumex acetosa</i> | 73,6 | 55,5 | 0,3 | 6 | x |

Intensity of agricultural use: e = extensive; me = moderately extensive; mi = moderately intensive; i = intensive.

| Area | M | E | IM | indicator value N (Ellenberg; 1-9) | indicator value F (Ellenberg; 1-9) |
|---|------|-----------|------|--|--|
| No. of relevés (1 m ²) | 352 | 1850 | 324 | | |
| Intensity of use | e | (e-)me/mi | i | | |
| Mean number of species | 8,1 | 6,7 | 8,8 | | |
| <i>Juncus effusus</i> | 25,3 | 86,1 | 0 | 4 | 7 |
| <i>Agrostis capillaris</i> | 34,1 | 35,7 | 0 | 4 | x |
| <i>Anthoxanthum odoratum</i> | 31,8 | 30,8 | 0 | x | x |
| <i>Deschampsia cespitosa</i> | 58,5 | 1,4 | 0 | 3 | 7~ |
| <i>Cerastium holosteoides</i> | 24,4 | 34,1 | 0 | 5 | 5 |
| <i>Festuca rubra</i> | 30,1 | 19,6 | 0 | x | 6 |
| <i>Ranunculus acris</i> | 36,9 | 4,4 | 0 | x | 6 |
| <i>Epilobium</i> spp. | 27,3 | 8,4 | 0 | - | - |
| <i>Lolium multiflorum</i> et <i>perenne</i> | 1,7 | 4,1 | 96,9 | 8/7 | 4/5 |
| <i>Elymus repens</i> | 6,8 | 2,4 | 89,2 | 7 | x~ |
| <i>Taraxacum officinale</i> | 3,7 | 7,9 | 75,9 | 8 | 5 |
| <i>Phleum pratense</i> | 0 | 1,6 | 68,2 | 7 | 5 |
| <i>Stellaria media</i> | 1,4 | 1,3 | 57,7 | 8 | x |
| <i>Trifolium repens</i> | 4,8 | 11,9 | 43,5 | 6 | 5 |
| <i>Achillea millefolium</i> | 0,3 | 0,5 | 56,2 | 5 | 4 |
| <i>Capsella bursa-pastoris</i> | 0 | 0 | 34,3 | 6 | 5 |
| <i>Cardamine hirsuta</i> | 0 | 0 | 25,0 | 7 | 5 |

Species numbers in mesophilous valley grassland of the Alps (800-1750 m NN)

| Region | location of plots | fertilisation | number of releves (1 m ²) | number of species | | |
|-----------------------|---------------------|---------------|---------------------------------------|-------------------|------|------|
| | | | | min. | max. | mean |
| Oberes Vinschgau (IT) | centre | ++ | 729 | 6 | 32 | 15,3 |
| | margin | + | 441 | 6 | 35 | 20,8 |
| Val Müstair (CH) | centre | ++ | 407 | 3 | 27 | 14,4 |
| | margin or separated | - | 116 | 9 | 36 | 21,5 |

Type of agricultural use in seven variants of bog grassland (Emsland)

| Variant | grazing | mowing | mulching (autumn) | fertilisation (+ liming) |
|---------|------------------|--------|----------------------|-----------------------------|
| V1 | long, extensive | - | 1 x | P, K |
| V2 | long, extensive | - | - | P, K |
| V3 | short, intensive | 2 x | 1 x | P, K |
| V4 | - | 2 x | - | liquid manure |
| V5 | - | 2 x | 1 x | P, K |
| V6 | - | 2 x | - | P, K |
| V7 | - | - | 2 x | - |

Frequencies (in %) of the dominant species in the frequency relevés of seven variants (Emsland)

| variant | V1 | V2 | V3 | V4 | V5 | V6 | V7 | total |
|-------------------------------|------|-------|------|------|------|------|------|-------|
| no. of relevés | 250 | 250 | 300 | 300 | 250 | 250 | 250 | 1850 |
| intensity of use | me | me | me | mi | mi | me | e | - |
| mean species number | 6,1 | 2,8 | 7,3 | 7,6 | 9,2 | 7,8 | 5,6 | 6,7 |
| species | | | | | | | | |
| <i>Juncus effusus</i> | 95,6 | 100,0 | 93,3 | 71,7 | 94,0 | 82,8 | 66,4 | 86,1 |
| <i>Holcus lanatus</i> | 88,0 | 28,8 | 80,3 | 82,7 | 78,8 | 98,0 | 69,2 | 75,5 |
| <i>Poa trivialis</i> | 60,4 | 8,0 | 55,7 | 66,7 | 73,6 | 75,2 | 53,6 | 56,4 |
| <i>Rumex acetosa</i> | 74,4 | 25,2 | 40,3 | 63,7 | 90,0 | 41,2 | 55,2 | 55,5 |
| <i>Ranunculus repens</i> | 34,0 | 1,2 | 32,7 | 69,7 | 89,6 | 52,0 | 32,8 | 44,9 |
| <i>Agrostis capillaris</i> | 1,2 | 11,6 | 22,7 | 40,7 | 79,2 | 61,6 | 34,4 | 35,7 |
| <i>Cerastium holosteoides</i> | 50,4 | 0,0 | 44,0 | 24,7 | 50,0 | 55,6 | 13,6 | 34,1 |
| <i>Anthoxanthum odoratum</i> | 23,2 | 12,8 | 23,3 | 62,7 | 64,8 | 18,4 | 5,6 | 30,8 |
| <i>Poa pratensis</i> agg. | 36,8 | 6,4 | 17,0 | 52,7 | 32,0 | 46,4 | 28,0 | 31,5 |
| <i>Holcus mollis</i> | 61,2 | 14,4 | 34,0 | 46,3 | 14,0 | 16,4 | 10,0 | 28,7 |
| <i>Festuca rubra</i> | 4,4 | 2,0 | 25,3 | 8,7 | 58,0 | 15,6 | 24,0 | 19,6 |
| <i>Cardamine pratensis</i> | 7,2 | 5,6 | 10,0 | 35,7 | 53,2 | 8,0 | 1,6 | 17,6 |
| <i>Cirsium palustre</i> | 26,4 | 14,8 | 35,7 | 9,3 | 4,8 | 9,2 | 15,6 | 16,9 |

Intensity of agricultural use: e = extensive; me = moderately extensive; mi = moderately intensive; i = intensive



II. Zoodiversity: the example grasshoppers (Orthoptera)

- methods: catching by brailer, taking calling surveys (the typical sounds of grasshoppers)
- inventory: every 1-2 weeks on permanent plots of 50-100 m²; from May to September (focus on July & August)



Ipweger Moor: Orthoptera

- In total 10 species of Orthoptera were recorded between 2017 and 2018
 - *Chorthippus albomarginatus* dominant at all sampling sites; second most abundant species *Chorthippus biguttulus*; the other species in low abundances or with only single specimens
- **Low number of individuals and species**, low diversity; due to intensive use (4-5 x mowing, 4-6 x application of liquid manure and anorganic fertiliser)

| | 2017 | 2018 |
|--|------|------|
| Number of 100 m ² -plots | 9 | 9 |
| Number of controls | 8 | 7 |
| Total number of individuals | 187 | 95 |
| Median individuals/100 m ² | 2 | 0 |
| Max. individuals/100 m ² | 14 | 10 |
| Number of species | 8 | 7 |
| Number of species probably reproducing | 5 | 3 |
| Median species/100 m ² | 1 | 0 |
| Max. species/100 m ² | 4 | 3 |



Orthoptera fauna on two parts of the Moorplacken bog grassland

(2015; 7 controls; 1-2 x mowing, without fertilisation)

| Area | Size (ha) | Number of species | | | Total number of individuals |
|-------|-----------|-------------------|----------------------|----------|-----------------------------|
| | | total | probably reproducing | Red List | |
| North | 0,7 | 5 | 3(-4) | 2 | 241 |
| South | 1,5 | 6 | 5 | 1 | 322 |

Large population of *Chortippus montanus* (Red List: Lower Saxony 3, Germany V)!

III. Summary and conclusions: biodiversity of bog grassland

- **Generally: bog grassland has a low biodiversity**, compared to fen grassland and to grassland on mineral soils; this applies in particular to bog grassland, that is intensively managed; in most cases no endangered species!
- **Specific factors affecting phytodiversity and floristic composition:** low pH-value, high N-input (atmospheric deposition, mineralisation, fertilisation), strong dependence on weather and therefore mineralisation rate, stagnant water by peat compaction (strong oscillations of the water level)
- **Vegetation:** strong dominance of sweet grasses and/or rushes (e.g. *Juncus effusus*); high proportion of plant species with low nutritional value (‘Problemarten’); low number of herb species; only few flowering stands of vascular plants; low structural diversity in the vegetation
- **Zoodiversity:** lack of flowering plant stands and/or structural and floristic diversity causes a low diversity of animal species, e.g. birds, grasshoppers and diurnal butterflies

How to reduce the discrepancy?

A. The integrative approach:

- moderately intensive grassland utilisation (mi): 2-3 x mowing (1st in June), or 2 x mowing with 1-2 x grazing; fertilisation with PK, rarely liming, no (or low) application of N
- advancement of the structural and floristic diversity (spatially and temporally)

B. The segregative approach: decision for any individual parcel of land, regarding ecological (biotic and abiotic), social and economic (agricultural) aspects; **main options:**

- intensively used grassland: 3-4 x mowing or grazing, 1-2 x fertilisation; medium water levels
- (moderately) extensively used grassland: 1-2 x mowing or 2 x grazing with mulching, with/without application of PK, rarely liming, no application of mineral fertiliser and liquid manure; soils humid, but drivable (June to September)
- succession to hairy birch forest (*Betula pubescens*)
- peat digging, followed by bog restoration
- top soil removal, followed by peat moss farming (cultivation of *Sphagnum* mosses)

How to enhance biodiversity in bog grassland?

- no exclusive grazing management (at least once mowing or mulching)
- first mowing or mulching not later than mid of June
- not more than three utilisations per year
- occasional fertilising (liming and/or application of PK and/or dung)
- pH-value (top soil) not under 4,5
- reduction of dominant species with low nutritional value (e.g. *Rumex* spp., *Deschampsia cespitosa*, *Juncus* spp. and others)
- permanence of grassland (no destruction of the sward, no regular sowing)
- establishment of marginal stripes (‘verges’) at ditches, forests, shrubberies (with occasionally mowing)

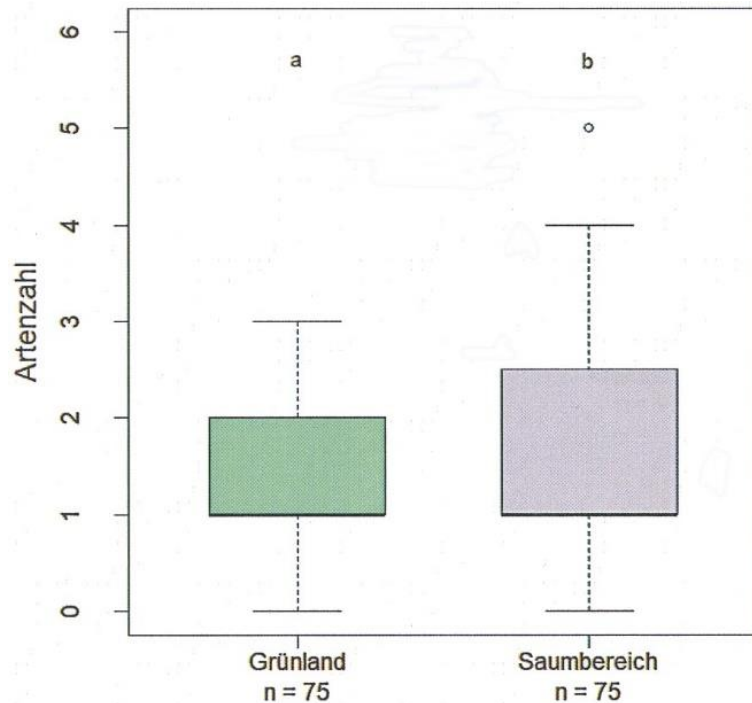
Thank you for your attention!

(... hoping for a vivid discussion ...)

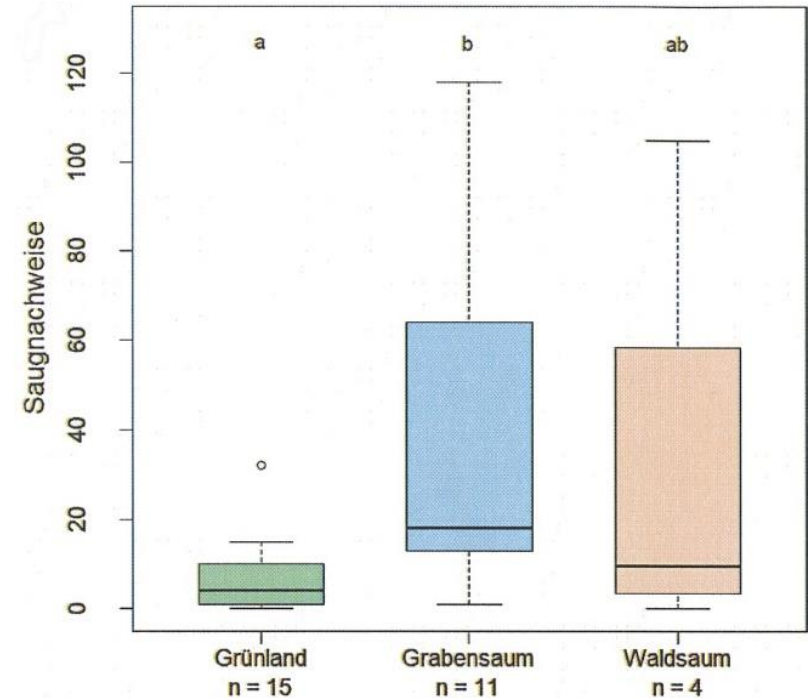




Diurnal butterflies (Lepidoptera) in the Moorplacken area (extensively used): species number 9 - 18, mean 13,2



Number of butterfly species in bog grassland (left) and its marginal parts (verges; right)



Number of sucking activities in bog grassland (left), ditch verges (central) and forest verges (right)

Orthoptera in mesophilous grassland (on mineral soils)

Species numbers of Orthoptera in mesophilous, fertilized grassland of NW-Germany (Projekt „Biotopverbund Grasland“); 7 plots, 6 controls.

- all populations: 3 - 6 species; mean 5,7 species
- stable populations: 2 - 5 species; mean 3,3 species

Species numbers of Orthoptera in mesophilous grassland of Val Müstair (1250-1750m NN, Engadin, CH); 28 plots, 3 controls.

| | mean size (m ²) | number of species | | number of species per plot (60 m ²) | | |
|--------------------------|--------------------------------|-------------------|----------|--|------|------|
| | | total | Red List | min. | max. | mean |
| fertilized (n=14) | 6500 | 7 | 0 | 1 | 5 | 2,7 |
| non-fertilized (n=14) | 250 | 17 | 4 | 0 | 8 | 4,2 |

SWAMPS: Orthoptera (2)

- Low number of individuals and species, as well as low diversity; due to intensive use (4-5 x mowing, 4-6 x application of liquid manure and anorganic fertiliser)

| | | Ipweger Moor | | |
|------------------------------------|------|-----------------------|----------------------|-----------------------|
| | | Control, not rewetted | Submerged irrigation | Damming up of ditches |
| Number of species | 2017 | 4-5 | 2-3 | 3-4 |
| | 2018 | 3 | 2 | 1-4 |
| Mean indiv. / 100 m ² | 2017 | 0,9-3,3 | 0,8-2,9 | 1,9-5,4 |
| | 2018 | 1,3-3,1 | 0,6-1,7 | 0,7-2,4 |
| Median indiv. / 100 m ² | 2017 | 1-3 | 0-4 | 2-5 |
| | 2018 | 1-2 | 0 | 0-2 |

- Currently there is no discernable effect of the three water-management approaches on the Orthoptera fauna (Analyses of similarity (PERMANOVA, Bray-Curtis))

Highest phytodiversity of bog grassland (Rath 2012)

- high phytodiversity in four grassland areas of northwestern Lower Saxony
- species numbers: FM 33 (0,5 ha), MP 28 (0,5 ha), WM 23 (2,5 ha), TM 21 (3 ha)
- species of the Red List: *Thalictrum flavum* (3), *Succisa pratensis* (3), *Gentiana pneumonanthe* (2), *Luzula congesta* (3), *Carex panicea* (3), *Viola palustris* (V), *Carex vesicaria* (V) and others
- soil chemistry: pH 3,0 – 5,0; K < 3 mg / 100 ml (nutrient supply: A); P < 2 mg / 100 ml (nutrient supply A,B); C/N 15-26

Frequencies (in %) of phytosociological relevés in the areas Moorplacken (M), Emsland (E) and Ipweger Moor (IM)

| Area | M | E | IM |
|-----------------------------|----------------|----------------|--------------|
| Type of data | Braun-Blanquet | Braun-Blanquet | species list |
| Plot size (m ²) | 24 | 24 | 300 |
| Intensity of use | e | (e-)me/mi | i |
| Number of relevés | 123 | 658 | 18 |
| Mean number of species | 11,6 | 10,0 | 22,4 |
| <i>Holcus lanatus</i> | 84,6 | 82,1 | 83,3 |
| <i>Ranunculus repens</i> | 48,8 | 55,5 | 100,0 |
| <i>Rumex acetosa</i> | 78,9 | 70,2 | 27,8 |
| <i>Holcus mollis</i> | 26,0 | 37,8 | 94,4 |
| <i>Taraxacum officinale</i> | 25,2 | 25,5 | 100,0 |
| <i>Cardamine pratensis</i> | 17,1 | 37,5 | 88,9 |
| <i>Poa trivialis</i> | 29,3 | 63,2 | 50,0 |
| <i>Poa pratensis</i> (agg.) | 4,9 | 41,0 | 88,9 |
| <i>Trifolium repens</i> | 10,6 | 24,2 | 100,0 |

| Area | M | E | IM |
|--------------------------------------|----------------|----------------|--------------|
| Type of data | Braun-Blanquet | Braun-Blanquet | species list |
| Plot size (m ²) | 24 | 24 | 300 |
| Intensity of use | e | (e-)me/mi | i |
| Number of relevés | 123 | 658 | 18 |
| Mean number of species | 11,6 | 10,0 | 22,4 |
| <i>Juncus effusus</i> | 58,5 | 91,2 | 0 |
| <i>Anthoxanthum odoratum</i> | 50,4 | 45,6 | 0 |
| <i>Agrostis capillaris</i> | 35,8 | 53,5 | 5,6 |
| <i>Festuca rubra</i> | 63,4 | 28,9 | 0 |
| <i>Deschampsia cespitosa</i> | 85,4 | 3,5 | 0 |
| <i>Cirsium palustre</i> | 19,5 | 40,0 | 0 |
| <i>Ranunculus acris</i> | 40,7 | 7,6 | 0 |
| u.a. | - | - | - |
| <i>Elymus repens</i> | 13,0 | 6,2 | 100,0 |
| <i>Lolium multiflorum et perenne</i> | 10,6 | 7,0 | 100,0 |
| <i>Rumex crispus</i> | 1,6 | 10,2 | 100,0 |
| <i>Glechoma hederacea</i> | 26,0 | 0 | 83,3 |
| <i>Achillea millefolium</i> | 0,8 | 2,7 | 100,0 |
| <i>Phleum pratense</i> | 0 | 4,3 | 100,0 |
| u.a. | - | - | - |