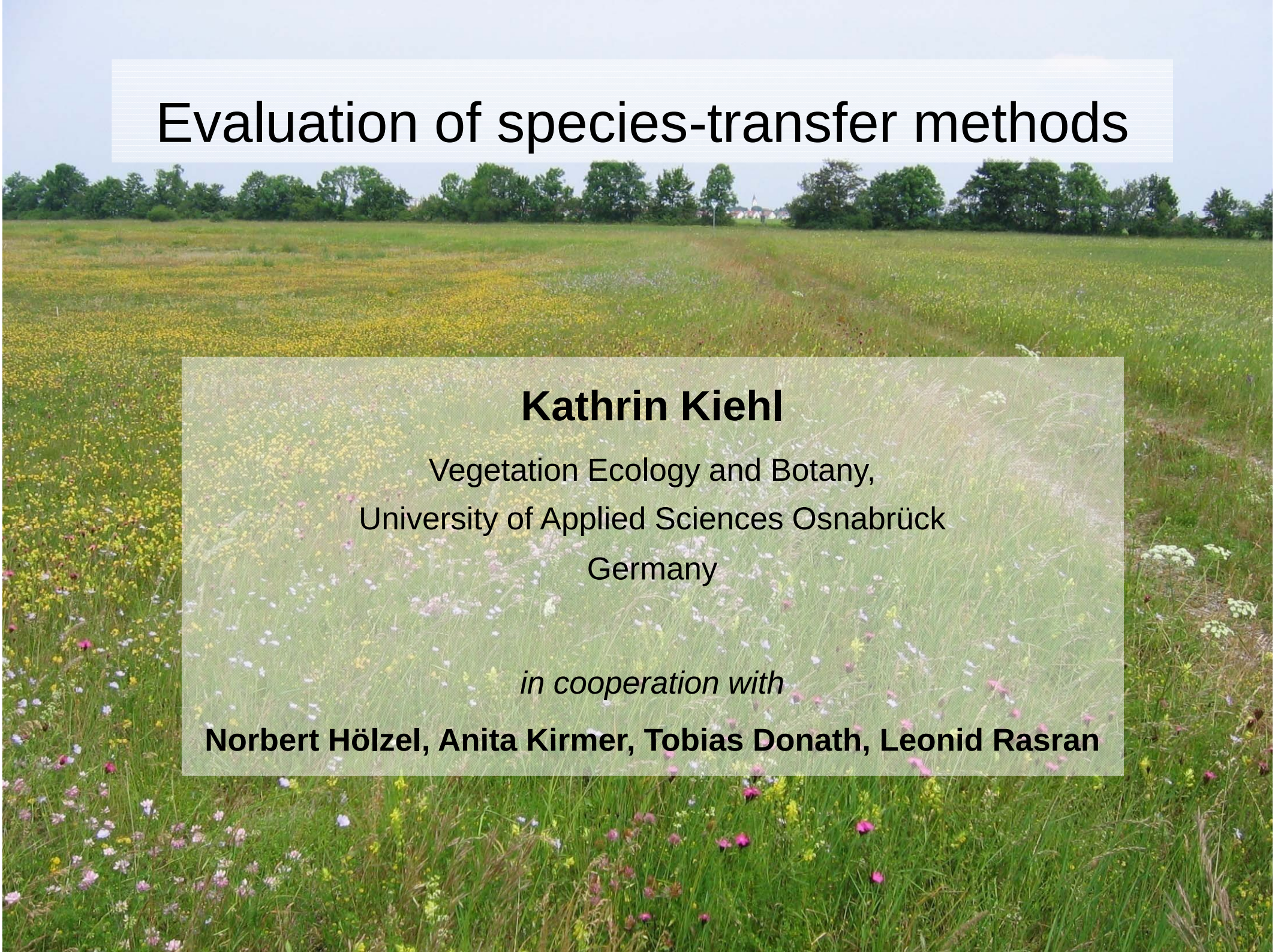

Evaluation of species-transfer methods

Kathrin Kiehl

Vegetation Ecology and Botany,

University of Applied Sciences Osnabrück

Germany

in cooperation with

Norbert Hölzel, Anita Kirmer, Tobias Donath, Leonid Rasran

Remnants of species-rich grasslands in fragmented landscapes

Remnants of species-rich grasslands in fragmented landscapes

Restoration projects started in 1970ies and 1980ies:

=> Restoration of land use regimes

Limiting factors for the restoration of species-rich grasslands

Abiotic constraints:

e.g. nutrient status, pH, hydrology (Bakker & Berendse 1999, *TREE*)

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Biotic constraints:

- Depleted seed bank of restoration sites
- Limited dispersal in fragmented landscapes

Restoration of species-rich grasslands on ex-arable land and other bare soils

Introduction of target species is necessary!

Pioneer work on grassland restoration by sowing in the UK in the 1970ies (Wells et al. 1989, Wells 1990)

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Reviews by Mortimer et al. 2002 *Appl. Veg. Sci.*, Walker et al. 2004 *Biol. Conserv.*, Kirmer & Tischew 2006, Kiehl et al. *submitted*

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Local provenance is important!

Van Andel 1998 *Persp. Plant Ecol. Evol. Syst.,* McKay et al. 2005 *Rest. Ecol.,* Bischoff et al. 2006 *Basic Appl. Ecol.*

Techniques for the establishment of species-rich grasslands

- Sowing of site-specific seed mixtures

photos: A. Kirmer, R. Schubert, DVL, U. Miller

Techniques for the establishment of species-rich grasslands

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Sowing of site-specific seed mixtures

- definition of seed zones for seed collection and propagation

Sowing of site-specific seed mixtures

- definition of seed zones for seed collection and propagation
- composition of specific mixtures for certain environmental conditions
- certification

Sowing of site-specific seed mixture in lignite mining area after one year

Foto: A. Kirmer, June 2001

Sowing of site-specific seed mixture in lignite mining area after four years

Foto: G. Jünger, June 2004

Sowing of site-specific seed mixture in mining area after seven years: 81 % of the sown species established

Foto: A. Kirmer, June 2007

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Introduction of seed-enriched chaff

- Very old method (used in Roman times and Middle Ages)
- Application of seed-containing plant material from hay-barn floors

Heublume
Foto: R. Schubert, DVL

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Heublume
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but: species-rich hay meadows have become rare!

Heublume
Foto: R. Schubert, DVL


Threshing material from species rich meadows
Heudrusch®
Foto: J. Engelhardt
http://www.engelhardt-oekologie.de

Techniques for the establishment of species-rich grasslands

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photos: A. Kirmer, R. Schubert, DVL, U. Miller

Restoration of grasslands by transfer of freshly cut hay

Vegetation established by hay transfer on calcareous gravel after 3 years

Example 1: Restoration of calcareous grasslands on ex-arable fields north of Munich

Established vascular plant species 13 years after hay transfer

Species group	total number of transferred species	maximal number per field
Hay transfer species (from nature reserve)	103	60
Target species (Festuco-Brometea)	73	56
Red-list species	16	10

Data from Hummitzsch 2007, Kiehl 2009,

see also Kiehl & Pfadenhauer 2007 *Plant Ecol.*

Successfully transferred red-list species (2006)

Chamaecytisus ratisbonensis

Biscutella laevigata

Linum perenne

Veronica austriaca

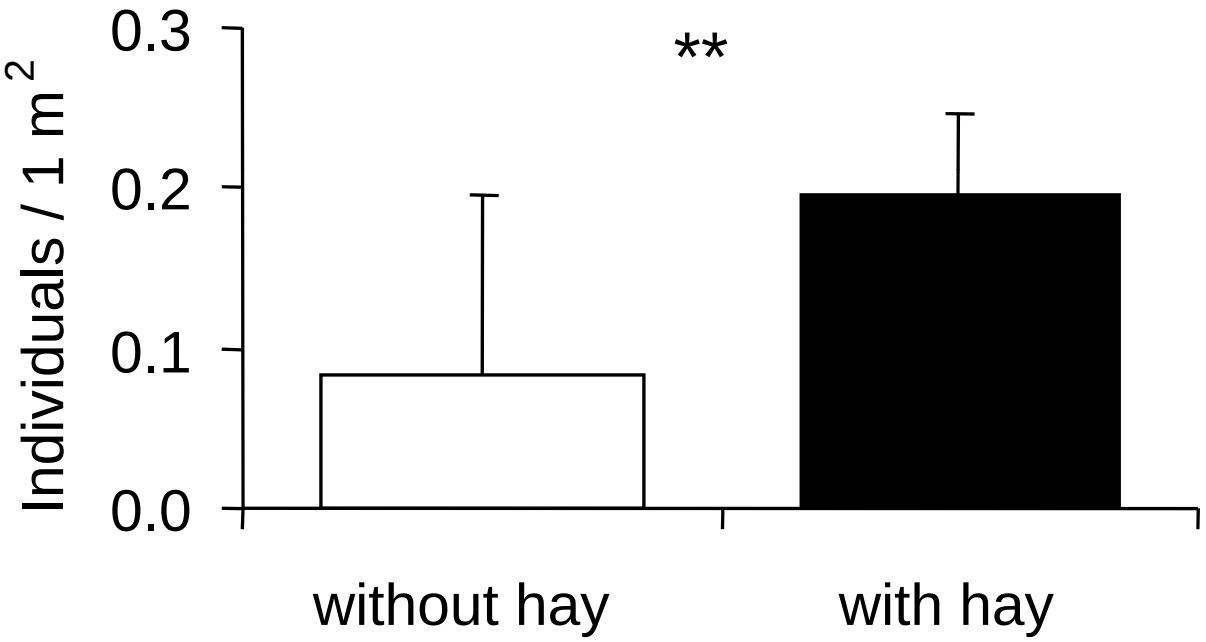
Dorycnium germanicum

Helianthemum nummularium

Hay transfer and grasshopper abundance (2002)

Metrioptera bicolor

(Photo: Willi Maile)



Wagner & Kiehl 2004, *Articulata*

Wagner 2004, *J. Insect Conserv.*

Example 2:

Restoration of dry sandy grasslands in lignite mining areas

Photos: A. Kirmer

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Restoration of dry sandy grasslands in lignite mining areas

Species transfer by fresh hay

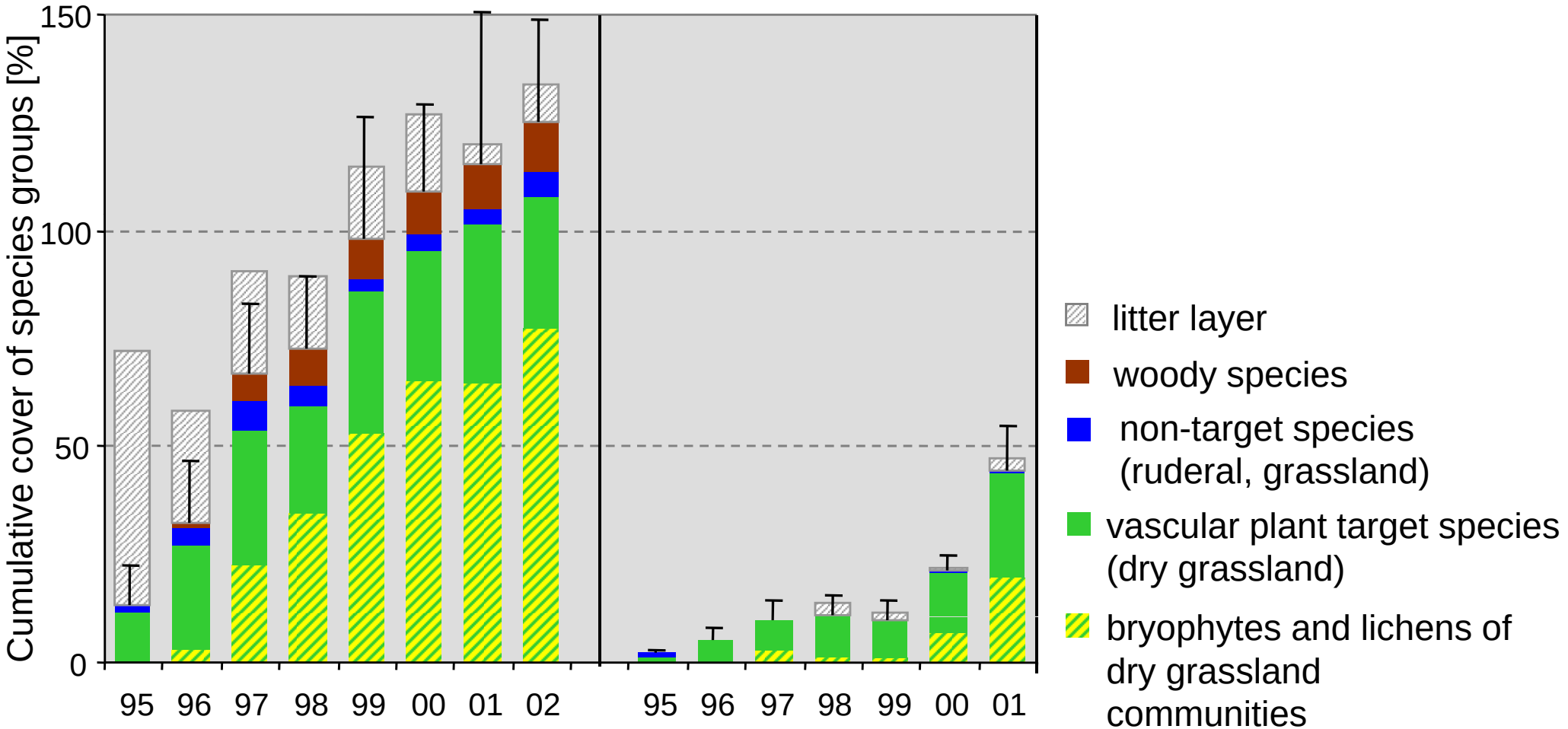
Photos: A. Kirmer

Species introduction by fresh hay in mining areas:

Restoration of dry sandy grasslands

application of fresh hay: 33 species

control plots: 13 species



(means n=8)

Modified after Kirmer 2004, *Dissertationes Botanicae*
see also Kirmer & Mahn 2001, *Appl. Veg. Sci.*

Succession after hay transfer in mining area

Target vegetation: dry sandy grassland

after 1 year

after 4 years

Helichrysum arenarium

after 8 years

Photos: A. Kirmer

Example 3: Floodplain meadows along the northern upper Rhine

Molinion

Cnidion

www.uni-giessen.de/stromtalwiesen

Photos: N. Hölzel

Restoration of floodplain meadows along the northern upper Rhine

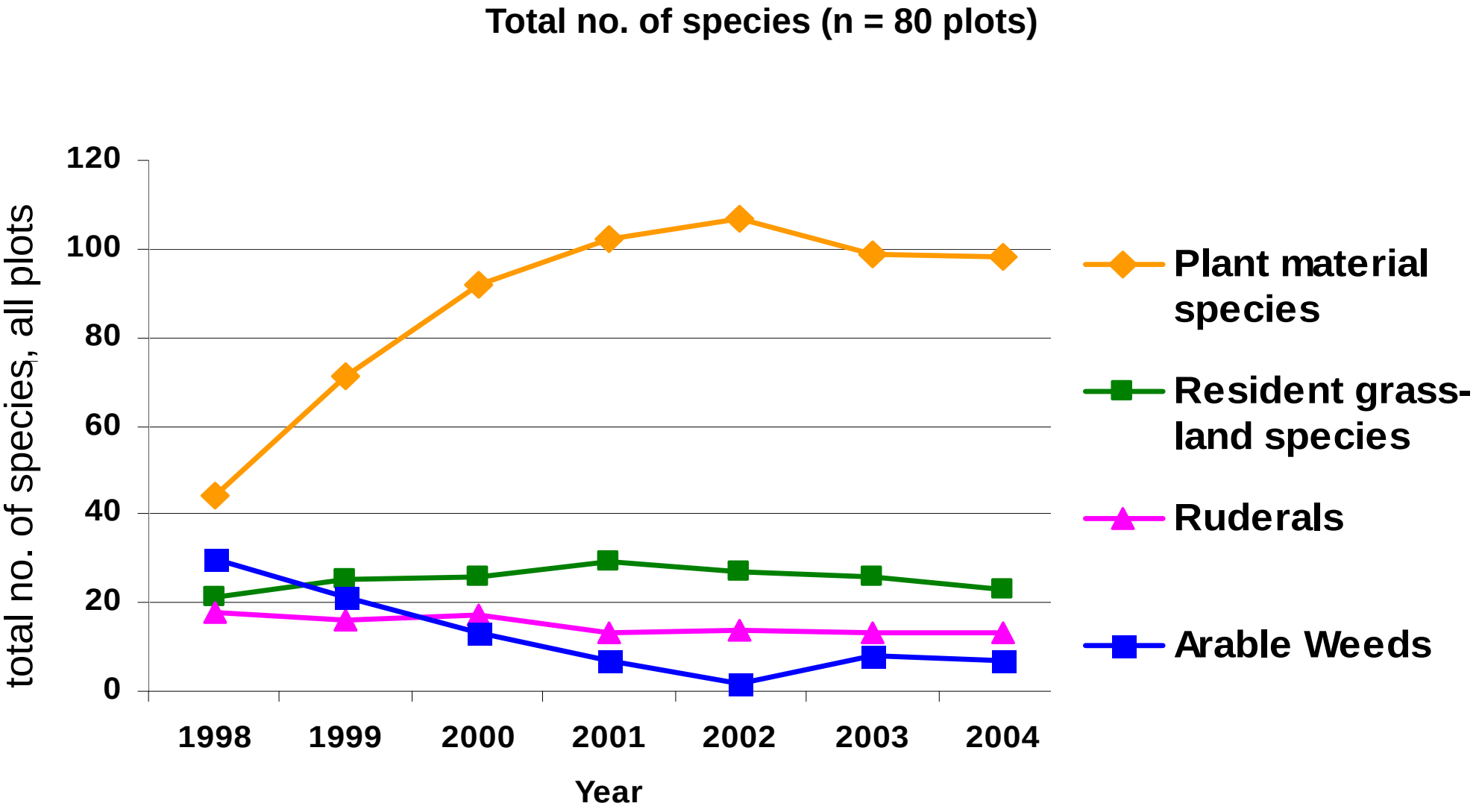
topsoil removal

harvesting of fresh hay

spreading of plant material

Photos: N. Hölzel, T. Donath

Development of different species groups 1998-2004



Hölzel & Otte 2003, *Appl. Veg. Sci.* (+ unpublished data from N. Hölzel)

Restored floodplain meadow after 7 years

Photo: N. Hölzel

www.uni-giessen.de/stromtalwiesen

Transferred Red-List species in newly restored floodplain meadows

Allium angulosum

Arabis nemorensis

Iris spuria

Viola pumila

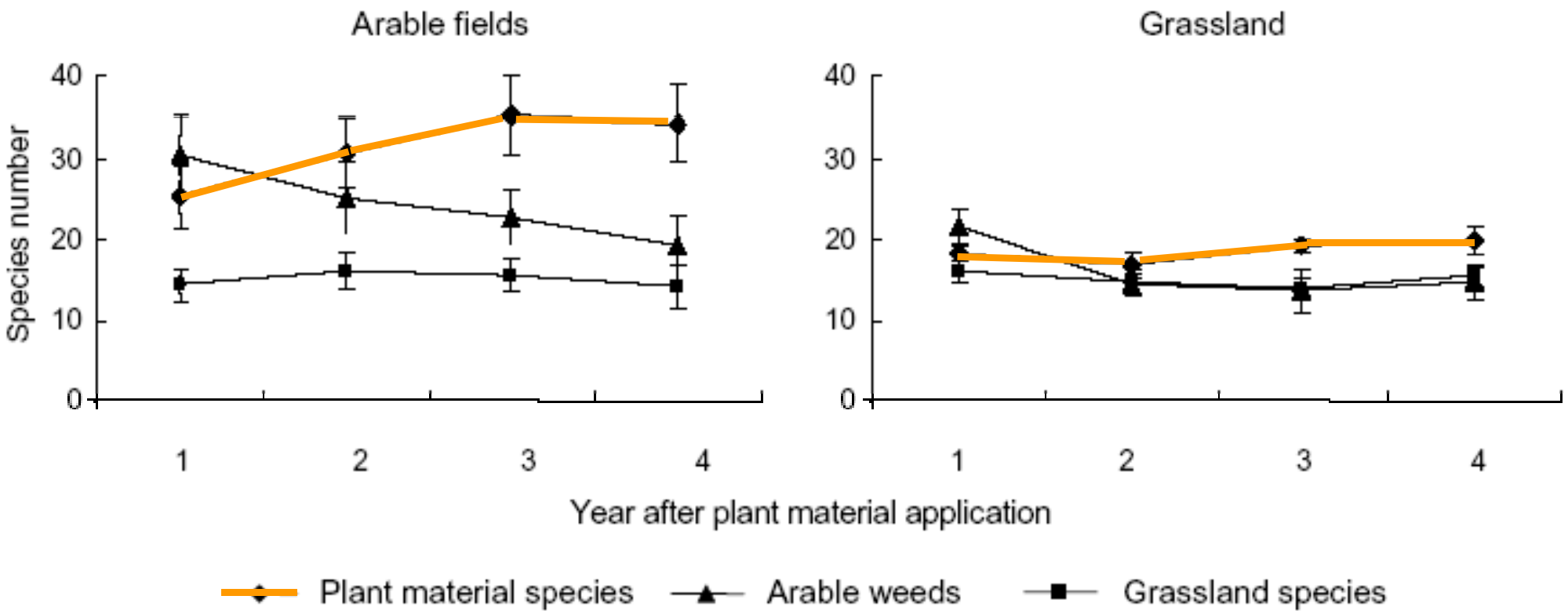
Viola elatior

Photos:

N. Hölzel

T. Donath

Effects of species introduction by fresh hay on species richness of ex-arable fields and grasslands

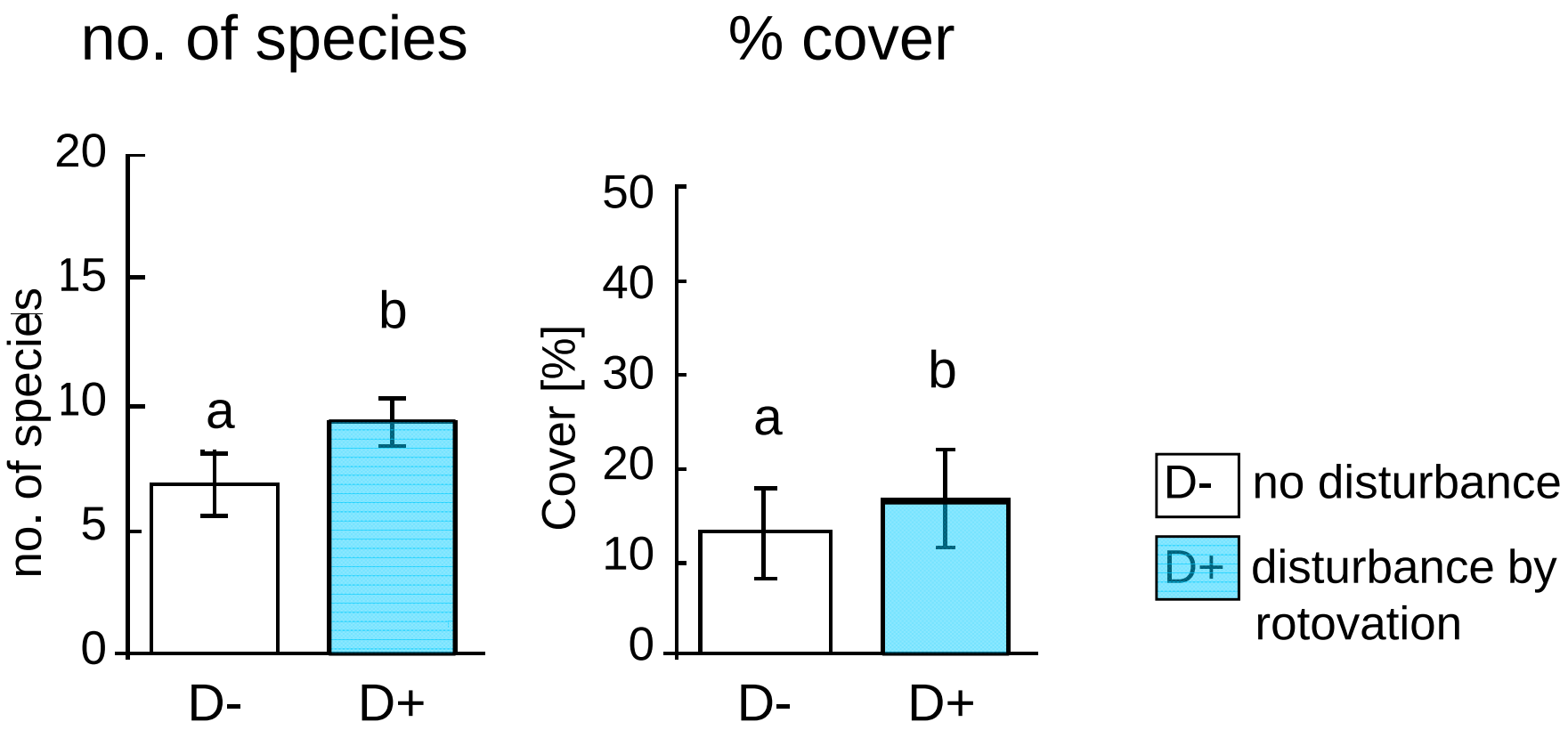


Donath et al. 2007, *Biol. Conserv.*

Soil disturbance enhances establishment of hay-transfer species in permanent grasslands

Fotos: S. Bissels

Disturbance favours establishment of hay-transfer species in grassland plots



modified after Donath et al. 2007, *Biol. Conserv.*

Environmental conditions on receptor sites determine the success of hay transfer

Habitat type	No. of transferred species per restoration field		Transfer rate	
	hay transfer		hay transfer	
Grassland without soil removal	16-30		31-44 %	
Ex-arable fields without soil removal	30-64		50-90 %	

Analysis of 33 publications, in Kiehl et al. submitted

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Environmental conditions on receptor sites determine the success of hay transfer

Comparison with sowing

Habitat type	No. of transferred species per restoration field		Transfer rate	
	hay transfer	**sowing**	hay transfer	**sowing**
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Ex-arable fields without soil removal	30-64	**9-31**	50-90 %	**47-100 %**
Top soil removal sites	24-71	**-**	50-96 %	**-**
Mining areas and quarries (raw soils)	24-80	**21-45**	48-86 %	**28-96 %**

Analysis of 33 publications,
in Kiehl et al. submitted

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photos: A. Kirmer, R. Schubert, DVL, U. Miller

Transfer of sods

Lignit mining area with raw soil, pH 3.3

target vegetation: dry sandy grassland

After 2 years(1997)

After 6 years (2001)

Fotos A. Kirmer

Transfer of sods

Lignit mining area with raw soil, pH 3.3

target vegetation: dry sandy grassland

After 2 years(1997)

After 6 years (2001)

after 10 years:
69 % of the plant species established

Fotos A. Kirmer

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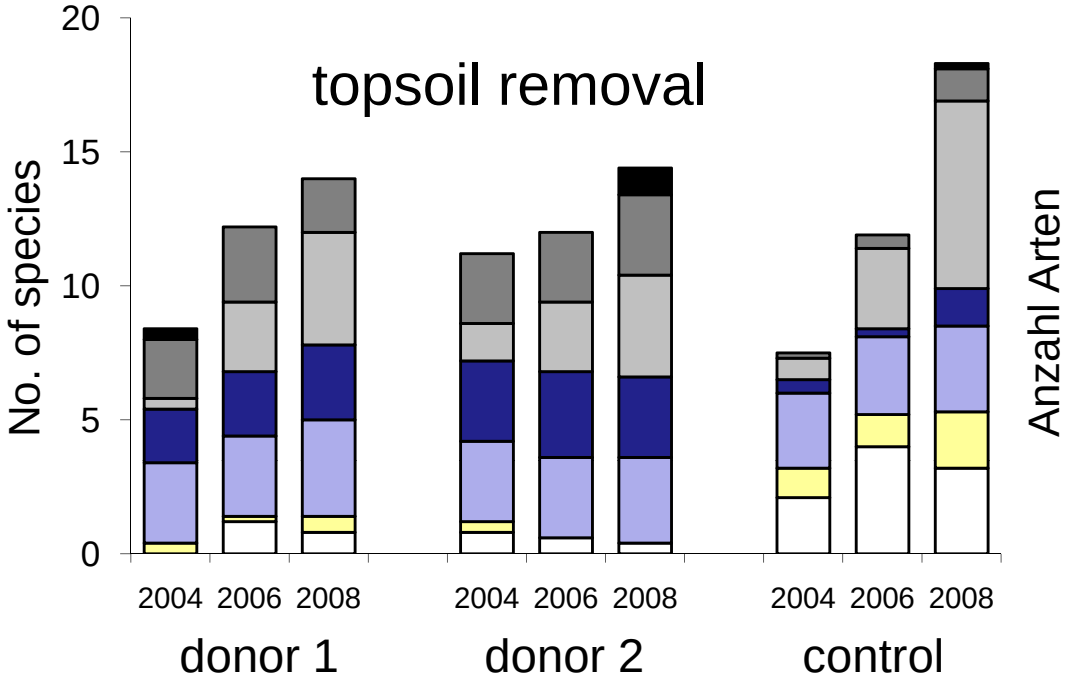
photos: A. Kirmer, R. Schubert, DVL, U. Miller

Transfer of bryophytes and lichens by raked material

No. of bryophyte and lichen species transferred by raked material in newly created calcareous grasslands



- epigaeic lichens
- fruticose lichens
- crustaceous lichens
- xerophytic akrokarpous bryophytes
- xerophytic pleurokarpous mosses
- mesophytic mosses
- ruderal mosses

means, n=5 (control: n=10)

Jeschke & Kiehl in prep.

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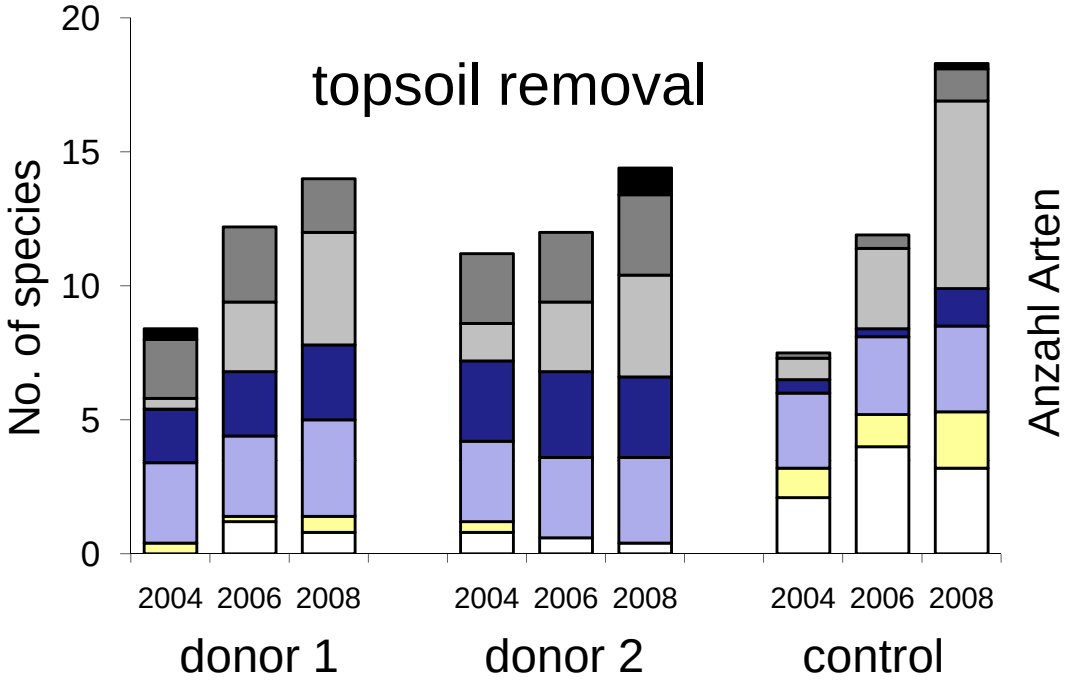

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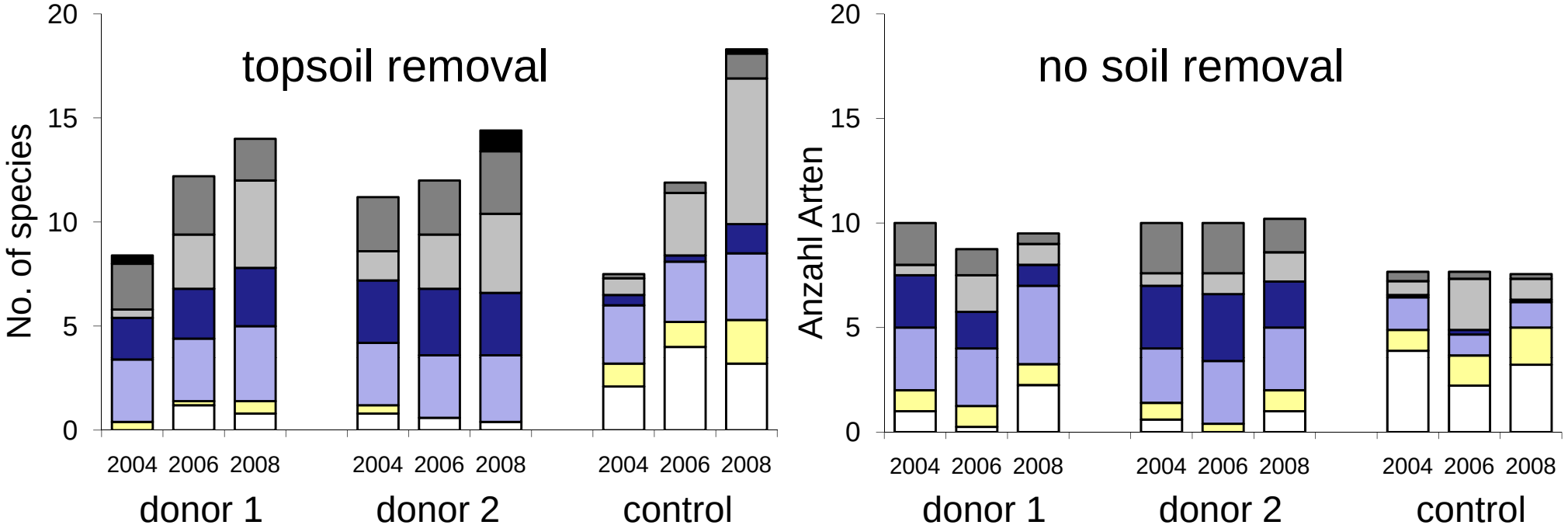

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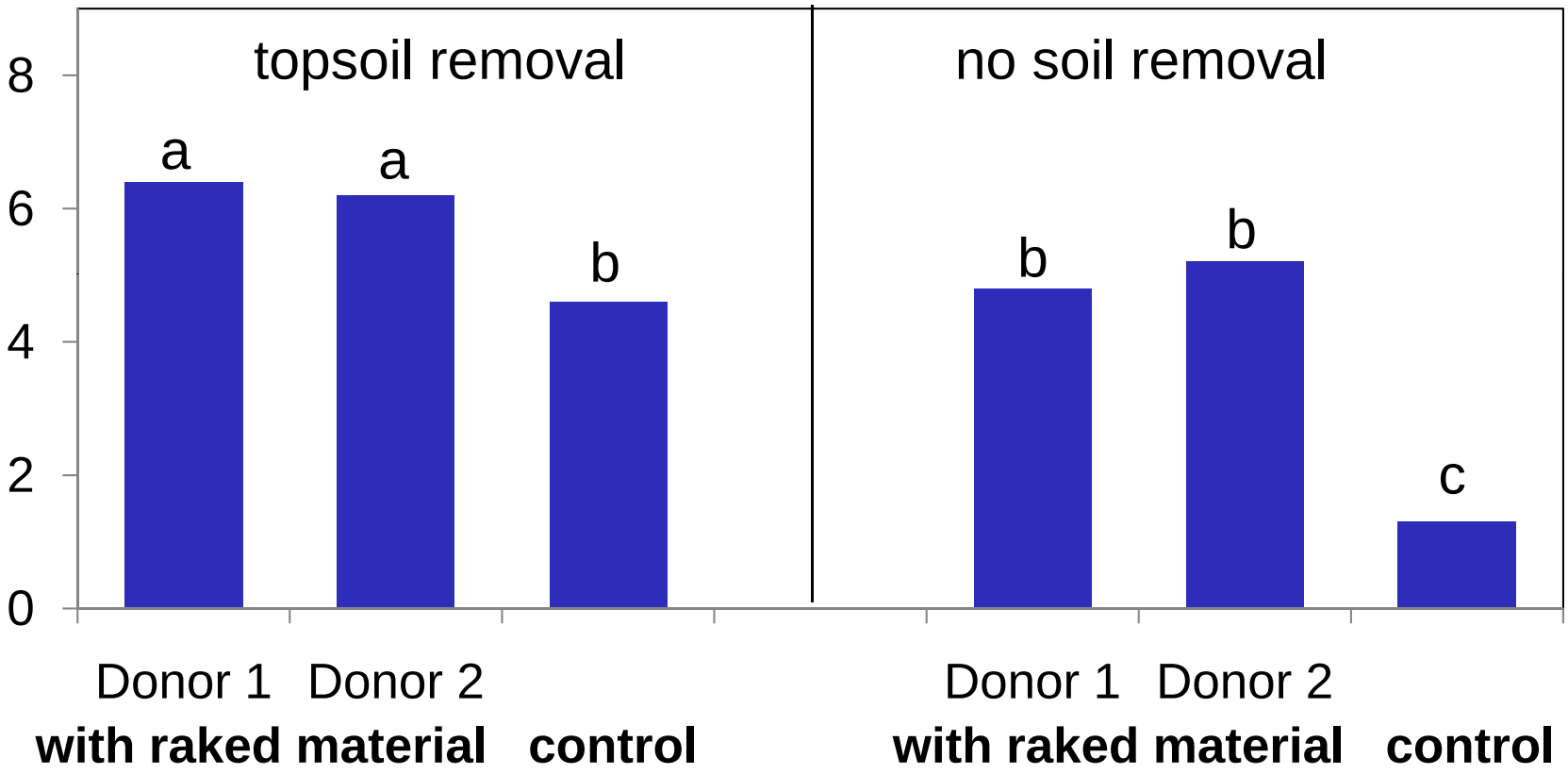
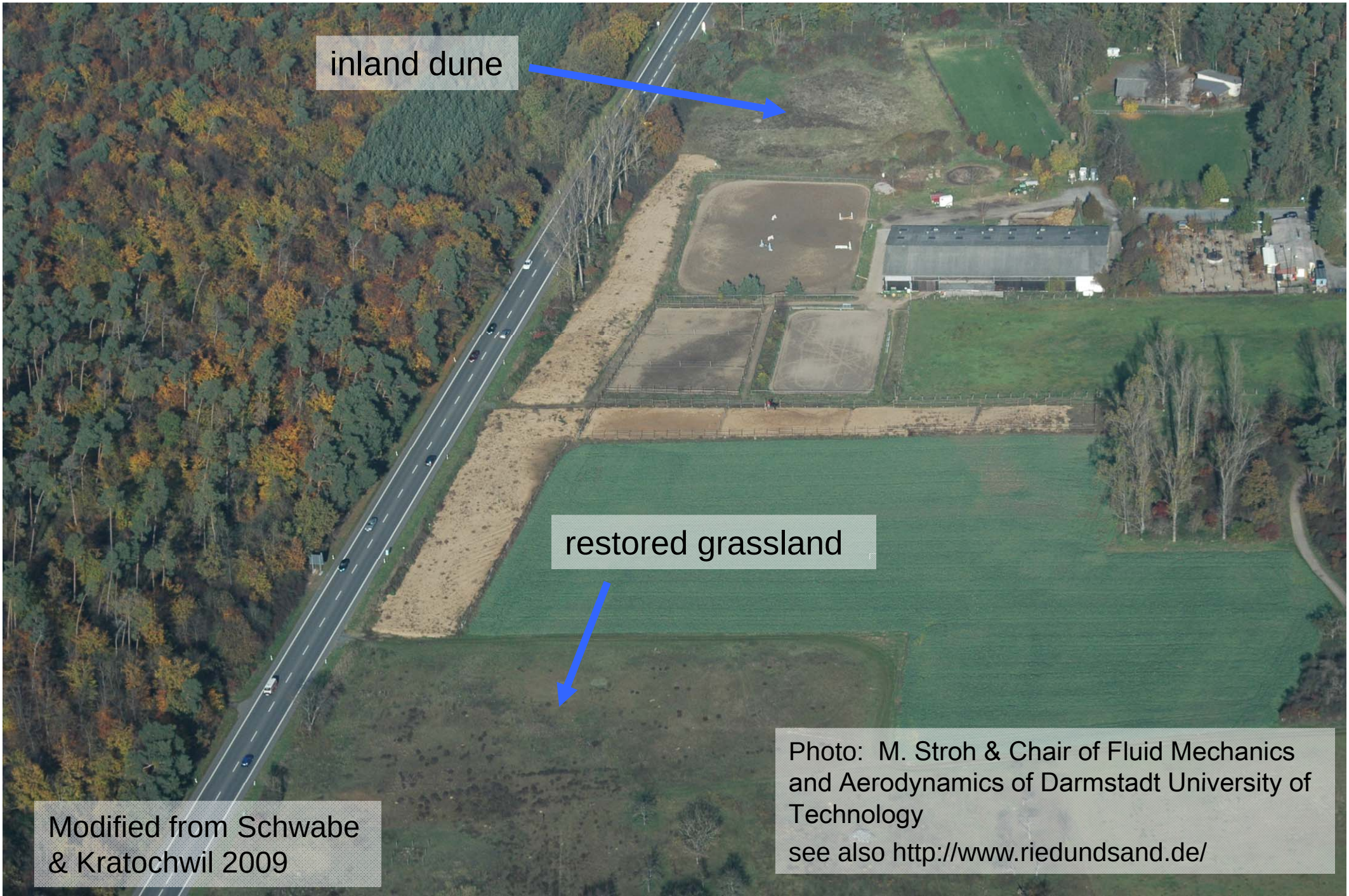
Raked material increases the number of xerophytic bryophytes (= target species) after 5 years



(letter indicate significant differences *P<0.05*)

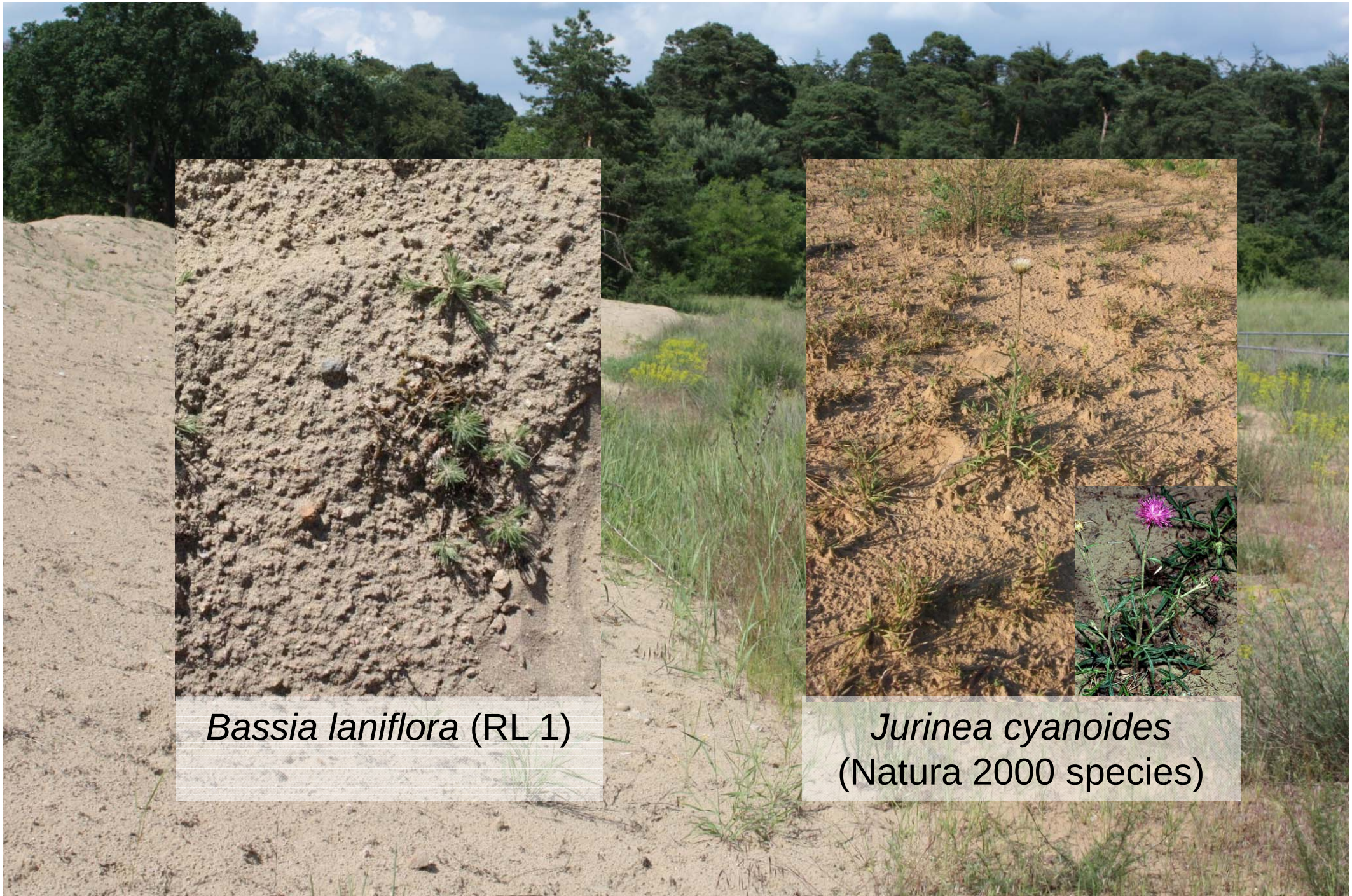
Connection of inland dunes and restored sandy grasslands by a sand corridor

Seeheim near Darmstadt



Application of nutrient-poor sand (from deep layers) and species transfer by raked material from inland dunes

Application of nutrient-poor sand (from deep layers) and species transfer by raked material from inland dunes



Bassia laniflora (RL 1)

Jurinea cyanoides
(Natura 2000 species)

Summary

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Important:

- Environmental conditions of receptor sites determine long-term restoration success

Thank you

for your attention!

Thanks for discussions, photos, data, information

Tobias Donath, Carsten Eichberg, Norbert Hölzel, Uta Hummitzsch, Michael Jeschke, Anita Kirmer, Annette Patzelt, Jörg Pfadenhauer, Angelika Schwabe-Kratochwil, Leonid Rasran, Meike Schächtele, Michael Stroh, Annuschka Thormann, Sabine Tischew, Christian Wagner