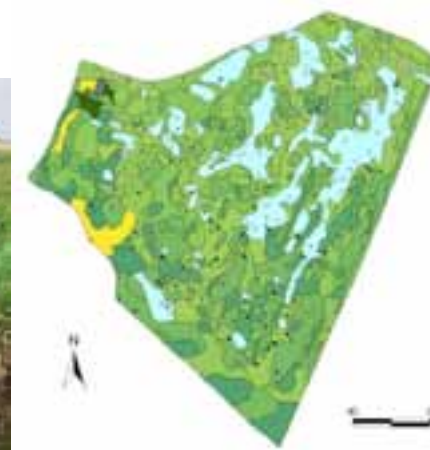


Vegetationsentwicklung in wiedervernässten Flusstalmooren Mecklenburg-Vorpommerns

04.10.2011, Salem

Tiemo Timmermann, Peggy Steffenhagen, Karsten Schulz,
Stefan Zerbe & Annett Frick



1 Einführung

Vegetation ist Indikator für Zustand und Leistungen von Ökosystemen („ecosystem services“, de Groot 2002).

- **Regulation:**
 - Senke C, Nährstoffe (>>Torfbildung, Torferhaltung)
 - Landschaftswasserhaushalt
- **Produktion:** Biomasse
- **„Information“:** Biodiversität, Natur, Landschaft

1 Einführung

Fragen

- Welche Entwicklungen zeigt die Vegetation?
- Wie sind sie zu erklären?
- Welche Entwicklungen sind zu erwarten?
- Wie sind sie zu bewerten (ecological services)?
- Wie lassen sich Vegetationsentwicklungen steuern?

2 Studien der Vegetationsentwicklung in MV

- **Monitoring:
Moorschutzkonzept,
LIFE, DEGES etc.**
- **Diplom- und
Doktorarbeiten
(Universität Greifswald
u.a.)**
- **Forschungsprojekte**

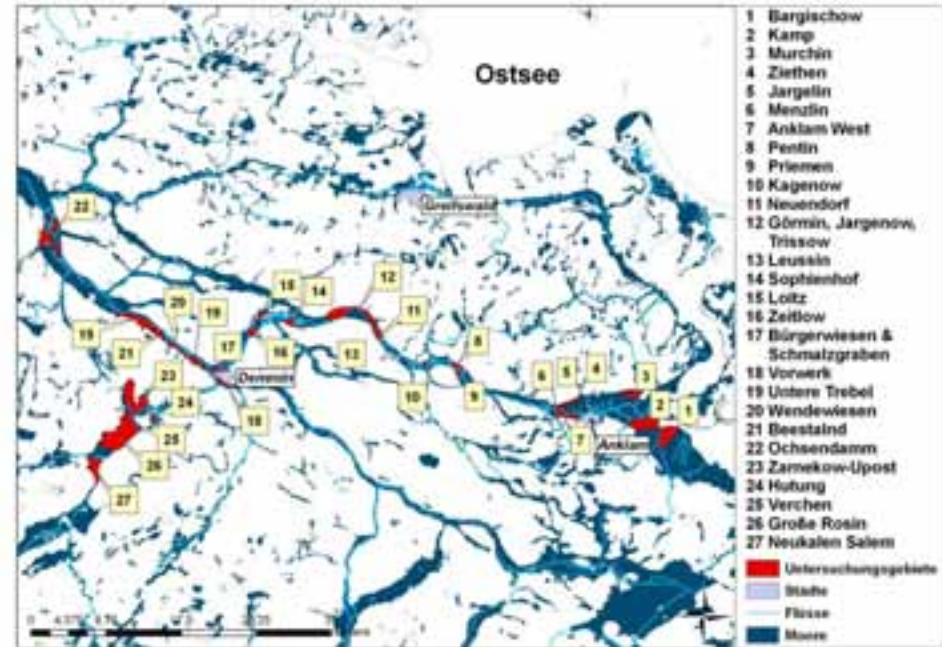


Abb.: Im Moorschutzprogramm MV vernässte Flächen in Peenetal & Trebeltal mit Satellitenbildkartierung, aus Steffenhagen & al. 2012

2 Studien der Vegetationsentwicklung in MV

Methoden

- **Dauerflächenuntersuchungen**
- **Kartierungen: Gelände, Satellitenbilder**
- **Biomasseanalysen** (standing crop TM, stoffliche Bilanzen)
- **Experimente zur Steuerung der Vegetation**
- **Kennzeichnung des Standorts**
 - Hydrologie
 - ehemalige Nutzungsintensität

2 Studien der Vegetationsentwicklung in MV

Konzept Vernässungsintensitäten

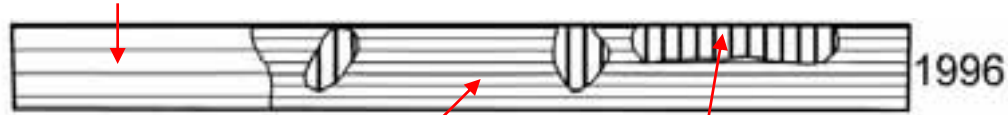
Vernässgs.- intensität	Jahresmedian (cm über Flur)		Wintermedian (cm über Flur)		Beschreibung	Wasserstufe
	Min	Max	Min	Max		
Extrem	50	140	60	150	permanent hoch überstaut	6 +
Sehr stark	20	50	30	60	permanent flach überstaut	6 +
Stark	0	20	0	30	langzeitig flach überstaut	5 +
Schwach	-20	0	-15	0	kurzzeitig flach überstaut	4 +

3 Ergebnisse: Vegetationskartierung Pentin (Peene)



Vernässung: 1998

Grünland, extensiv genutzt



Rohrglanzgras

Wasserschwaden



Offenes Wasser



Schilf

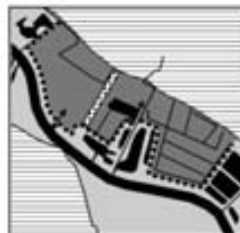
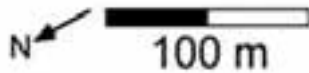


Seggen











schwach vern.




seit 1998



Vegetation

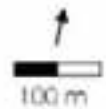
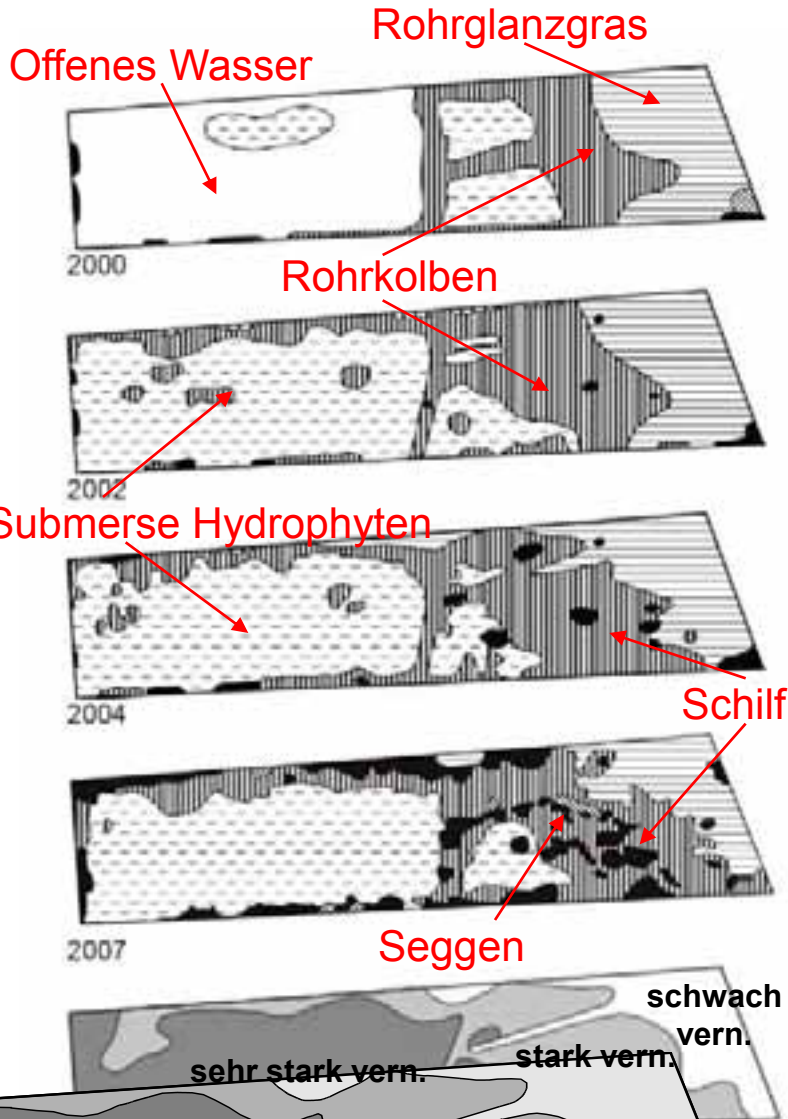
-  *Phalaris arundinacea*
-  *Glyceria maxima*
-  *Carex acutiformis*, *C. riparia*, *C. acuta*
-  *Phragmites australis*
-  *Typha latifolia*
-  Open water with hydrophytes
-  Open water without hydrophytes
-  Others (mainly grassland vegetation)

Wasserstände / Vernässungsintens.









-  Winter median +30 - +60 cm = **sehr stark**
-  Winter median 0 - +30 cm = **stark**
-  Winter median below soil surface **schwach**

aus: TIMMERMANN & al. 2011, Telma




3 Ergebnisse: Vegetationskartierung Ziethen (Peene)



Vegetation

-  *Phalaris arundinacea*
-  *Glyceria maxima*
-  *Carex acutiformis*, *C. riparia*, *C. acuta*
-  *Phragmites australis*
-  *Typha latifolia*
-  Open water with hydrophytes
-  Open water without hydrophytes
-  Others (mainly grassland vegetation)

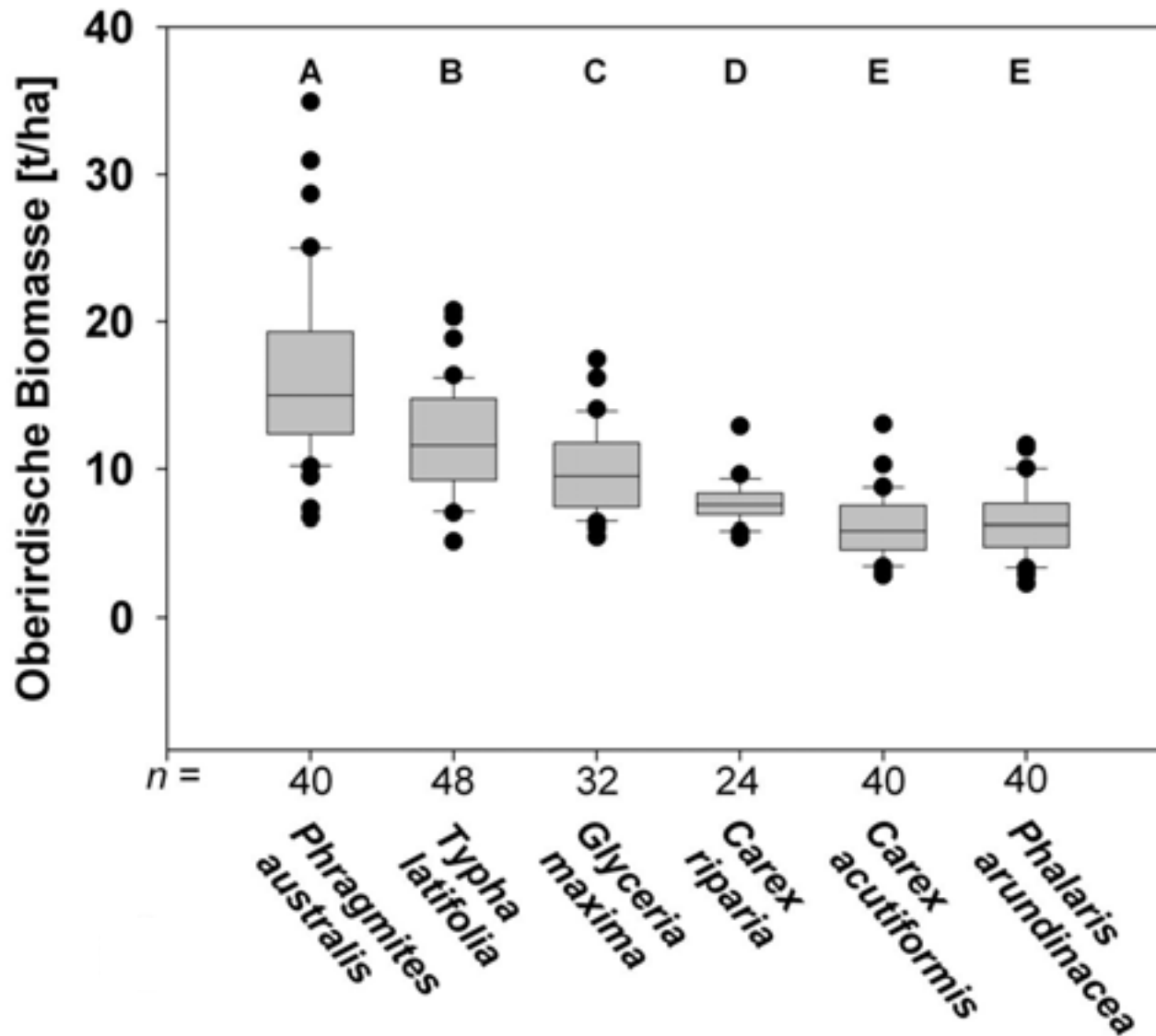
Wasserstände

-  Winter median +30 - +60 cm = **sehr stark vernässt**
-  Winter median 0 - +30 cm = **stark vernässt**
-  Winter median below soil surface = **schwach vernässt**

Vernässung: 1999

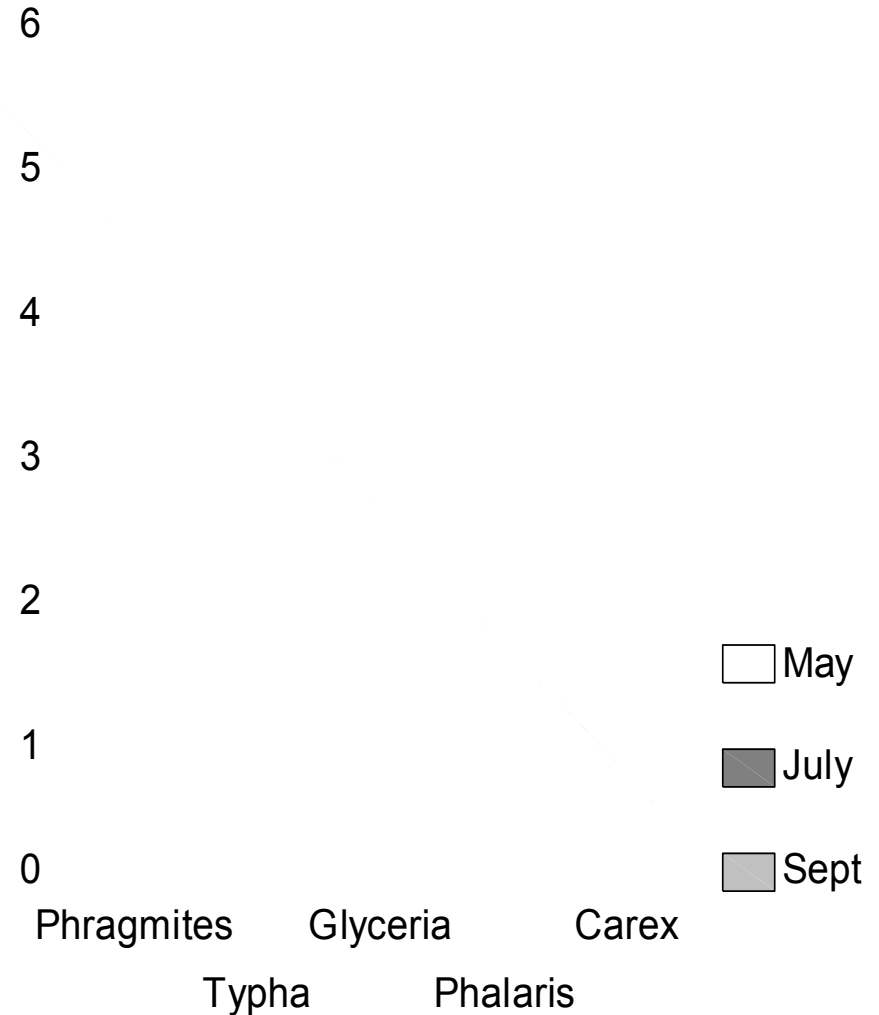
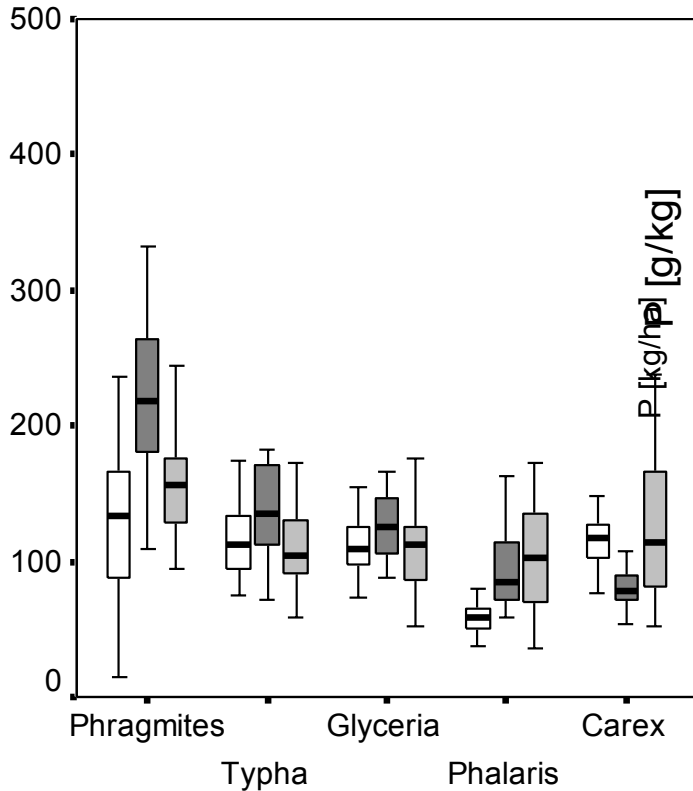


3 Ergebnisse: Oberirdische Biomasse (standing crop)



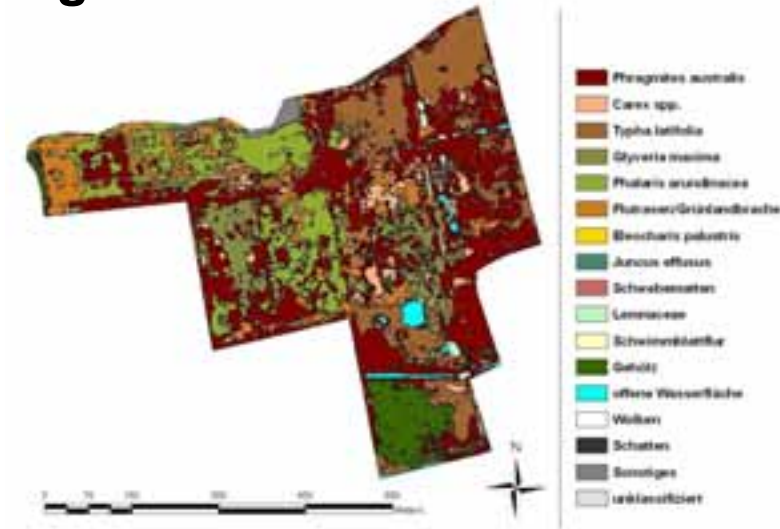
3 Ergebnisse:

Nährstoffgehalte (N, P) (crop) und ihre jahreszeitliche

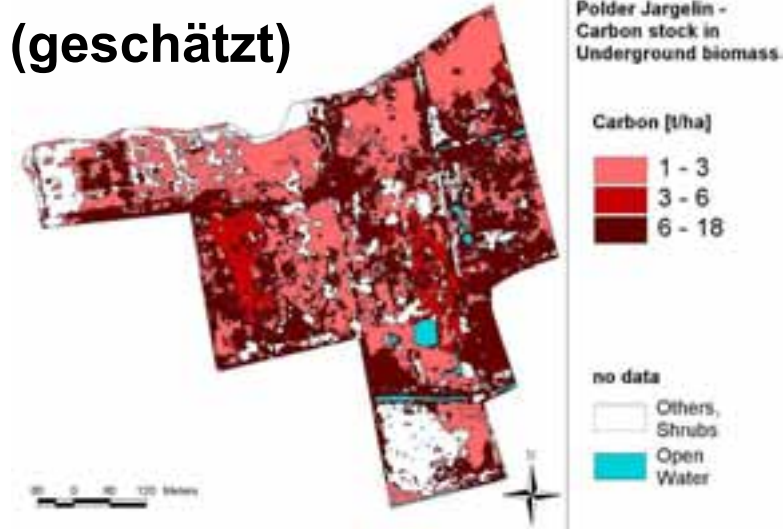


Bilanzierungen mit Satellitenbildern: Jargelin (Peene)

Vegetation



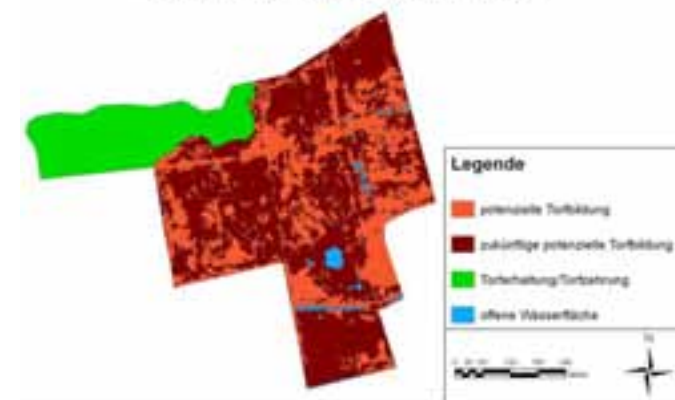
Kohlenstoff in unterirdischer Biomasse (geschätzt)



Mengenbilanzen: Biomasse (DM), C, P, N

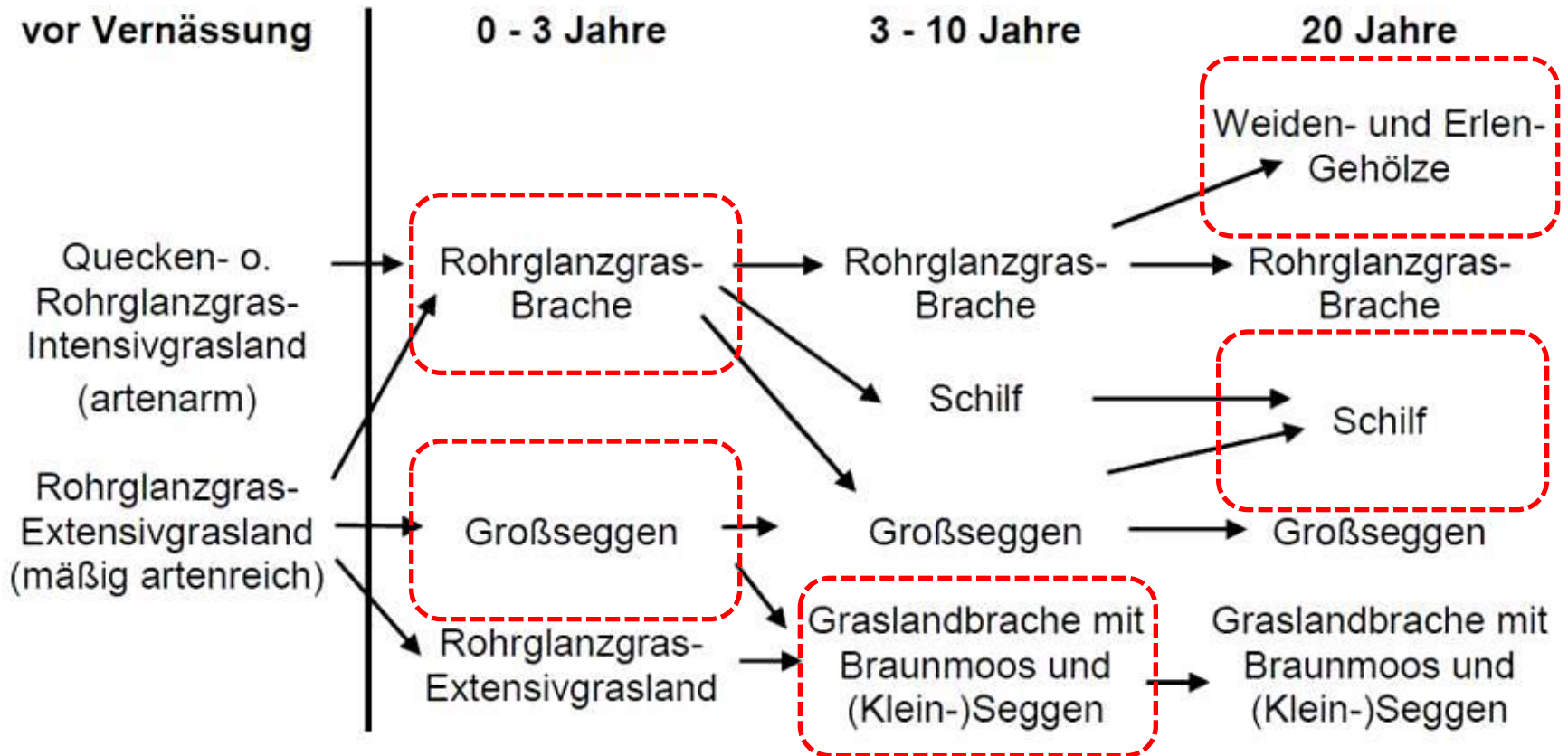
Vegetation types		area	DM	C	P	N
[ha]		[ha]	[t]	[t]	[t]	[t]
Potentially peat forming vegetation	<i>Phragmites australis</i>	11.1	184.5	85.4	0.21	2.12
	<i>Carex</i> spp.	1.6	11.0	5.1	0.02	0.15
	Sum	12.7	195.6	90.5	0.23	2.27
Not peat forming vegetation	<i>Typha latifolia</i>	5.6	68.1	31.5	0.16	1.05
	<i>Glyceria maxima</i>	2,1	21.0	9.4	0.06	0.26
	<i>Phalaris arundinacea</i>	5.1	32.9	15.1	0.06	0.34
	Sum	18.9	122.2	56.1	0.28	1.65
Total sum	32.5	317.8	146.6	0.51	3.92	

Torfbildungspotenzial



4 Resumé: Vegetationsentwicklungsreihen

Schwache Vernässung / kurzzeitig flach überstaut / WS 4+



4 Resumé: Vegetationsentwicklungsreihen

Schwache Vernässung / kurzzeitig flach überstaut / WS 4+

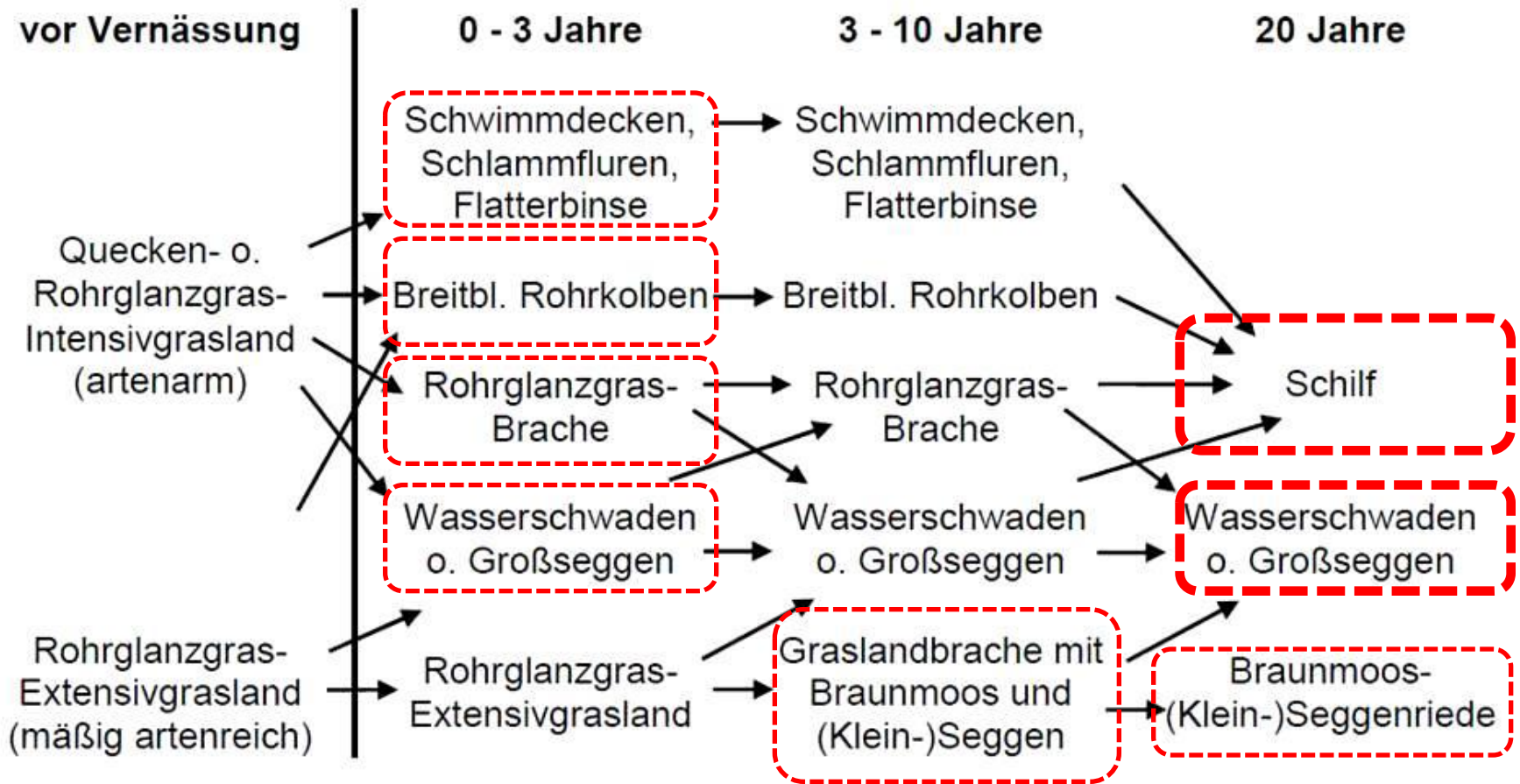


Friedländer Große
Wiese



4 Resumé: Vegetationsentwicklungsreihen

Starke Vernässung / langfristig flach überstaut / WS 5+



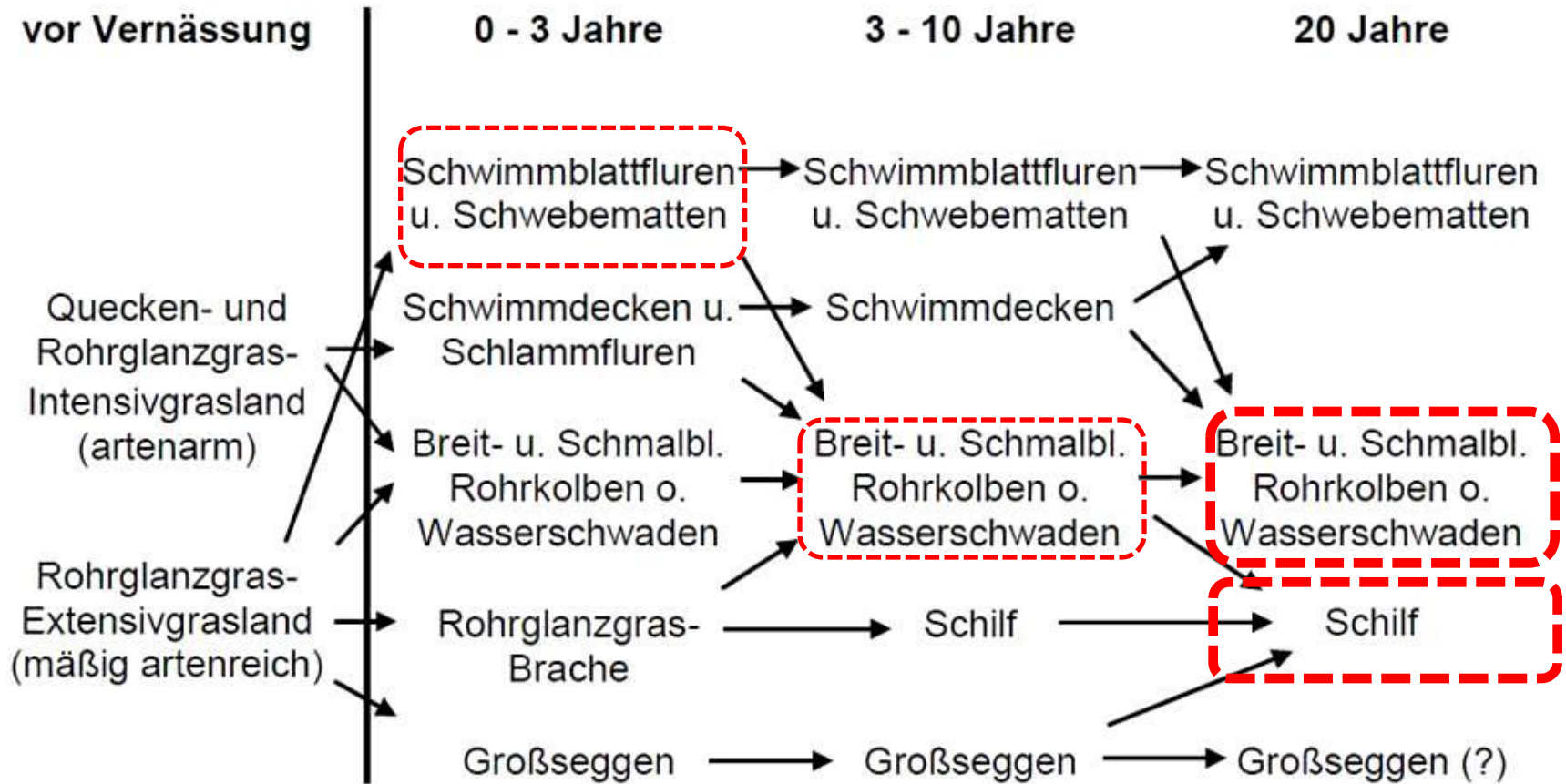
4 Resumé: Vegetationsentwicklungsreihen

Starke Vernässung / langfristig flach überstaut / WS 5+



4 Resumé: Vegetationsentwicklungsreihen

Sehr starke Vernässung / permanent flach überstaut / WS 6+



4 Resumé: Vegetationsentwicklungsreihen

Sehr starke Vernässung / permanent flach überstaut / WS 6+



Polder Ziethen (Peene)



Anklamer Stadtbruch (Peene)



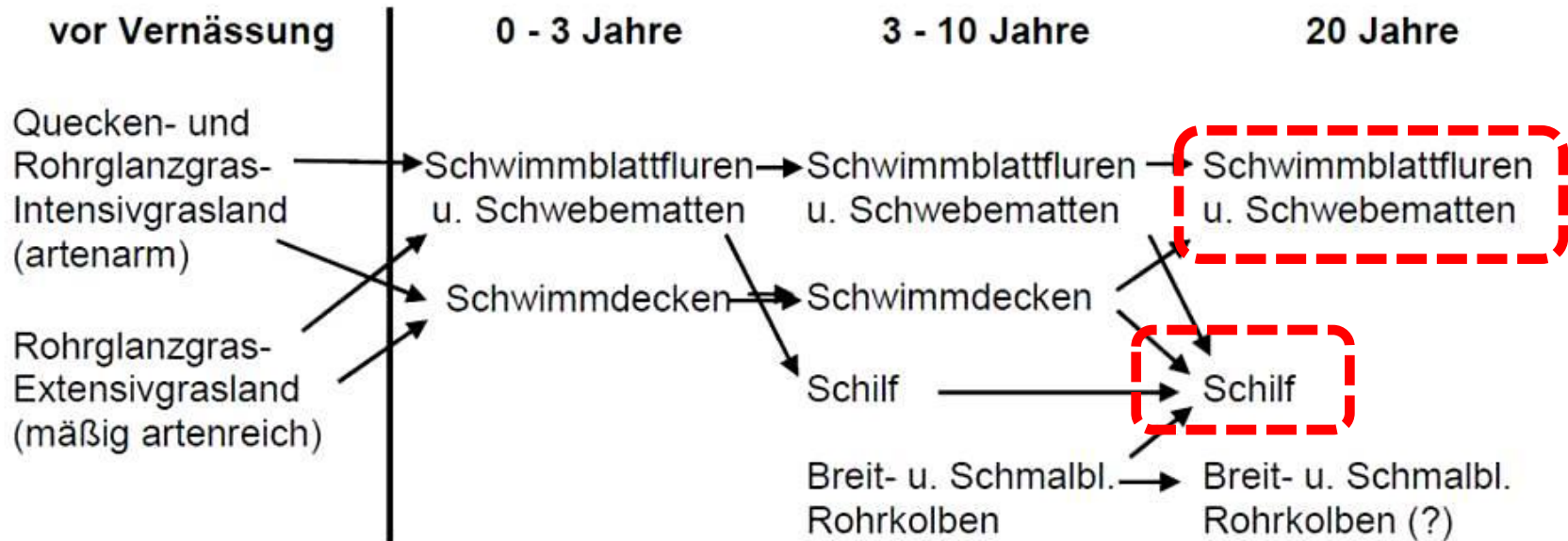
Anklamer Stadtbruch (Peene)



Anklamer Stadtbruch (Peene)

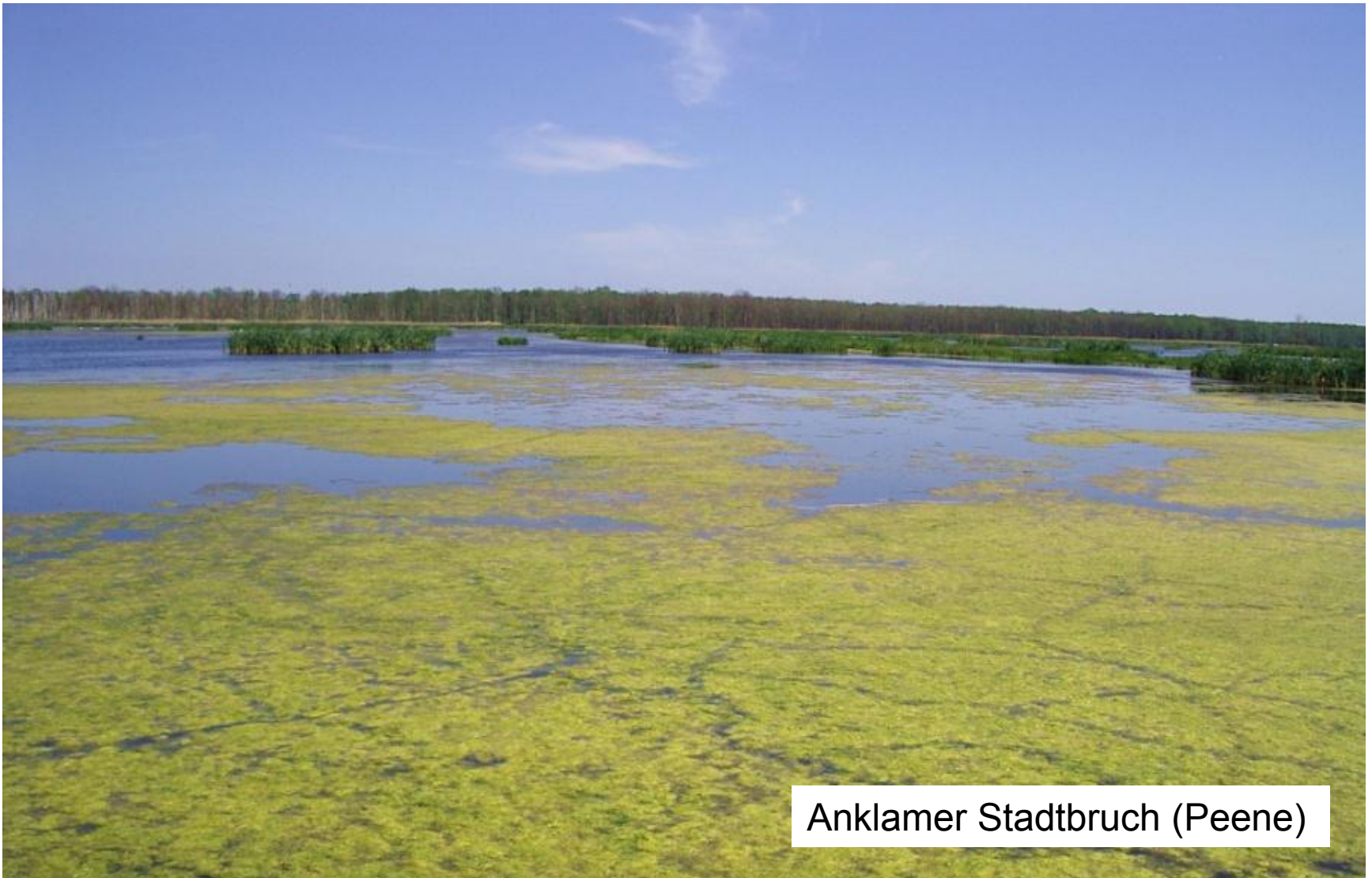
4 Resumé: Vegetationsentwicklungsreihen

Extreme Vernässung / permanent hoch überstaut / WS 6+



4 Resumé: Vegetationsentwicklungsreihen

Extreme Vernässung / permanent hoch überstaut / WS 6+

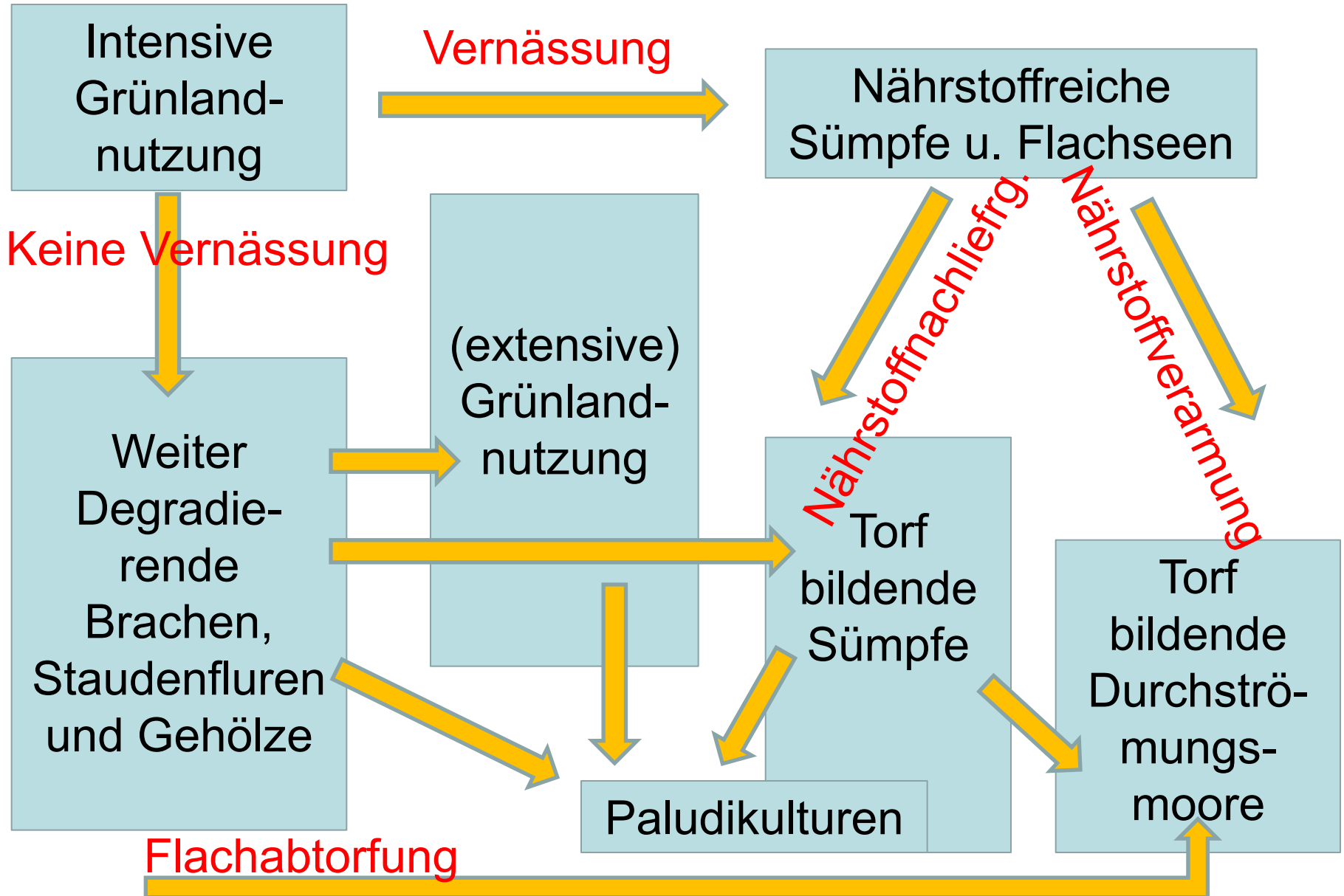


Anklamer Stadtbruch (Peene)

4 Resumé

- Die Vegetation der Flusstalmoore in MV ist geprägt durch artenarme Dominanzgesellschaften (Röhrichte, Riede, Staudenfluren, Schwimmblattgesellschaften)
- Hochauflösende Satellitenbilder ermöglichen großräumige Vegetationskartierungen und Stoffbilanzierungen
- Die Stoffbindung durch die Vegetation ist hoch, schwankt saisonal und ist stark art- und standortspezifisch
- Durch starke Zunahme von Schilf und Seggen besitzen große Flächen wieder das Potenzial zur Torfbildung
- Biomasse kann genutzt werden, wodurch gleichzeitig die Nährstoffflüsse in der Landschaft reduziert werden
- Lokal Regeneration artenreicher Braunmoos-Seggenriede

5 Ausblick: Hauptlinien der Vegetationsentwicklung



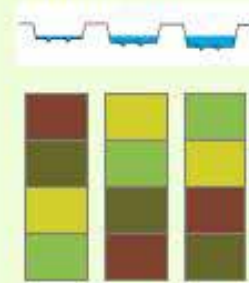
Flachtorfungsexperimente Renaturierung von Durchströmungsmooren im Kl. Landgraben (FöRiGeF)



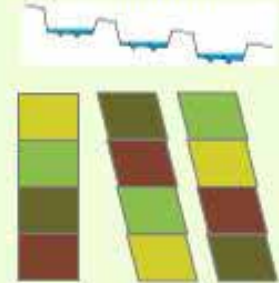
Top Soil Removal Experiments



Percolation Mire



Spring Mire



- Diaspores + 25 g Moss/m²
- Diaspores + 25 g Moss/m² + Hay
- Diaspores + 150 g Moss/m²
- Control

Diaspores (Seed Plants)	Bryophytes
<i>Carex flacca</i>	<i>Bryum pseudotriquetrum</i>
<i>Carex lasiocarpa</i>	<i>Calliergonella cespitosa</i>
<i>Carex lasiocarpa</i>	<i>Calliergon giganteum</i>
<i>Carex lasiocarpa</i>	<i>Calliergon abrotanetum</i>
<i>Carex nigra</i> *	<i>Campidium stellatum</i>
<i>Carex rostrata</i> *	<i>Dicranodictyon revolvens</i> *
<i>Dicranella</i> spp.	<i>Placidia adiantifolia</i>
<i>Pedicularis palustris</i>	<i>Plagiobryum alatum</i>

5 Ausblick

Nasse Bewirtschaftung (Paludikultur) in Flusstalmooren



Vegetationsentwicklung der Flusstalmoore MV positiv - ökologische Leistungen nehmen wieder zu:

- Schutz der Biodiversität
- Festlegung von Kohlenstoff und Nährstoffen
- Regulation des Wasserhaushalts
- Erzeugung von pflanzlichen Rohstoffen
- Landschaften für Erholung, Tourismus, Umweltbildung

5 Ausblick

Aktuelle Herausforderungen:

- Klärung der Klimabilanz von Standorttypen und ihrer Vegetation (GEST) > Bilanzierung mit Satellitendaten
- Praktikabilität von „Paludikulturen“ und Flachabtorfung
- Steuerung der Moor- und Vegetationsentwicklung in einer sich immer rascher wandelnden Welt

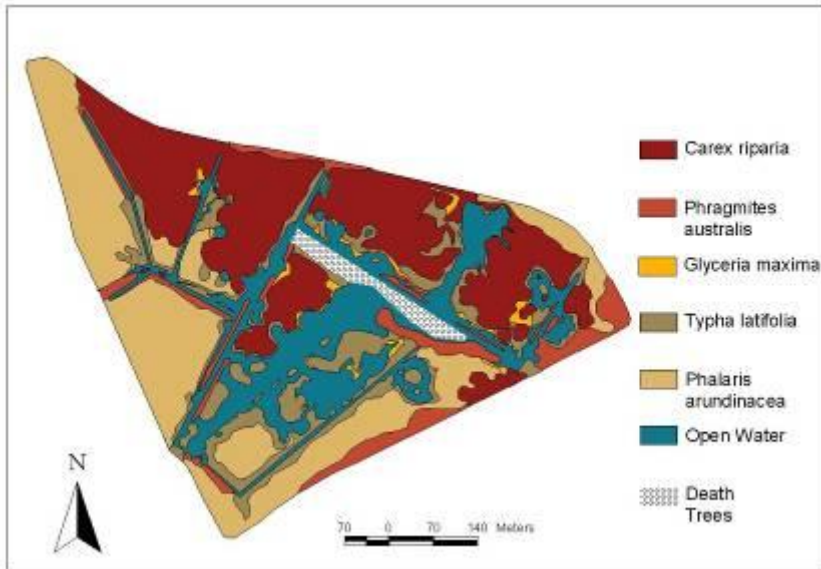
Vielen Dank!

... auch an Kollegen und Freunde: Prof. Dr. Michael Succow, Dr. Lebrecht Jeschke, Dr. Uwe Lenschow, Dr. Ulf Schievelbein, Kees Vegelin, Dr. Wendelin Wichtmann, Dr. Ingo Koska, Anett Adler, Rene Domain, Thomas Heinicke, Hagen Kokschi, Arndt Müller, Anja Prager, Janine Rösler, Claudia Sütering, Romy Zimmermann, Nicole Priller, Eike Beutler, Baburam Bhattarai, Romy Plonus sowie der Deutschen Bundesstiftung Umwelt (DBU) und dem LUNG M-V



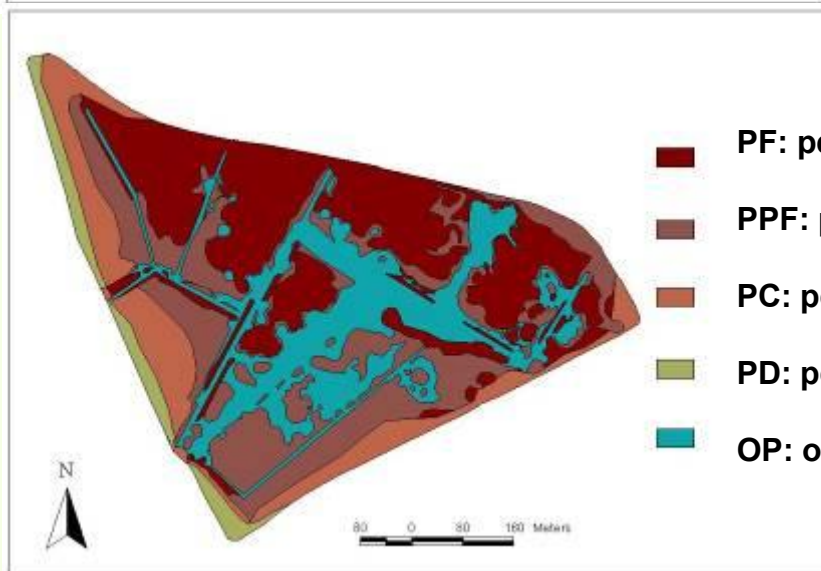
Anklamer Stadtbruch (2003), *Typha latifolia*, *Carex acutiformis* und *Glyceria maxima*, Foto: Karsten Schulz

Example II: Restoring Peat Growth and Bird Diversity by Flooding Fen Grasslands



Left: Mapping Peat growth potential by means of indicator plant species.

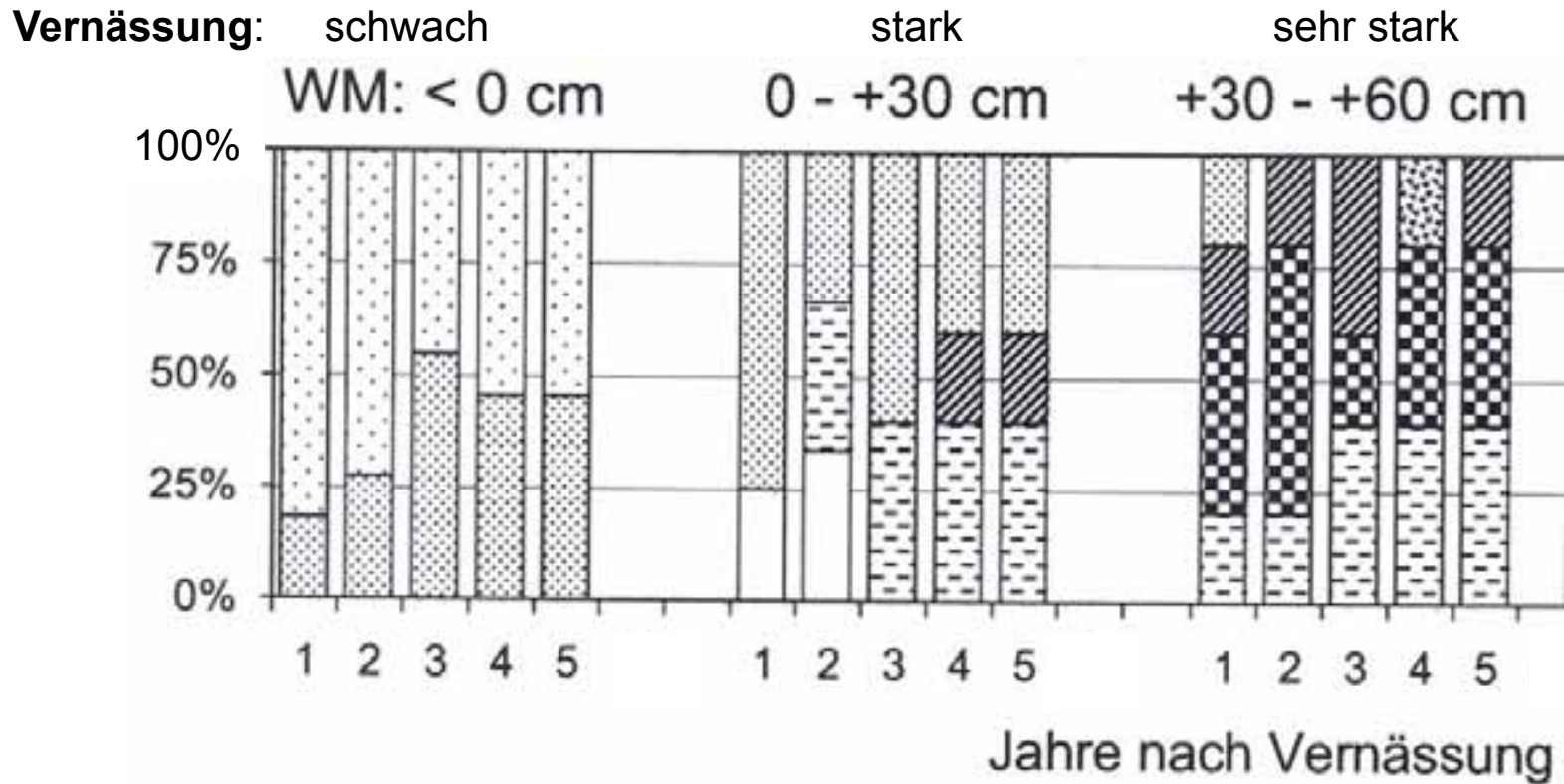
Right: Mosaics of reed plants in rewetted fen grasslands (Peene Valley, Germany) are very suitable bird habitats.



- PF: peat forming
- PPF: potentially peat forming
- PC: peat conserving
- PD: peat degradation
- OP: open water

3 Ergebnisse: Beispiel Peenetal

Dauerflächen Polder Randow (n = 23 plots á 16m²)



- | | |
|----------------------|------------------|
| □ Grünland | ▣ Br. Rohrkolben |
| ▣ Rohrglanzgras | ▣ Großseggen |
| ▣ Gr. Wasserschwaden | ▣ Hydrophyten |
| | □ Offenes Wasser |

2 Theory



Expected succession after flooding

Course of succession



Submerge
hydrophytes

Reeds with *Typha*,
Phragmites and
Carex

Tall *Carex* reeds

Brown moss –
Carex reeds

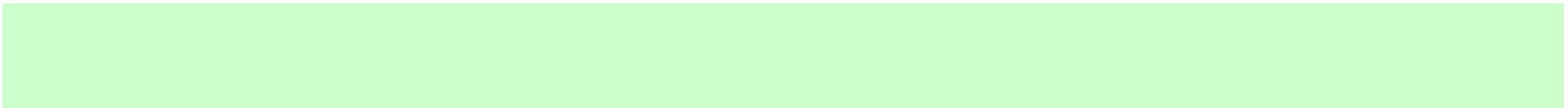
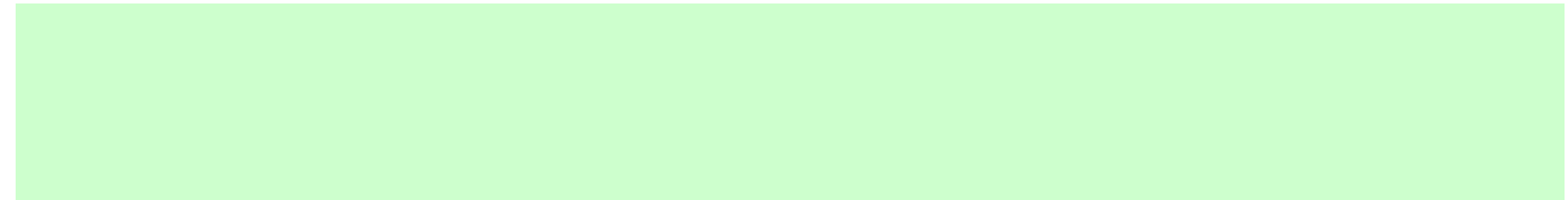
Shallow lakes

Paludification mires,
Transgression mires

Sloping mires
(surface flow)
Spring mires

Percolation mires

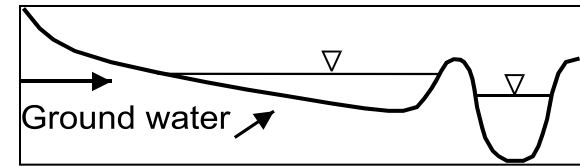
Peat formation
+ surface lifting





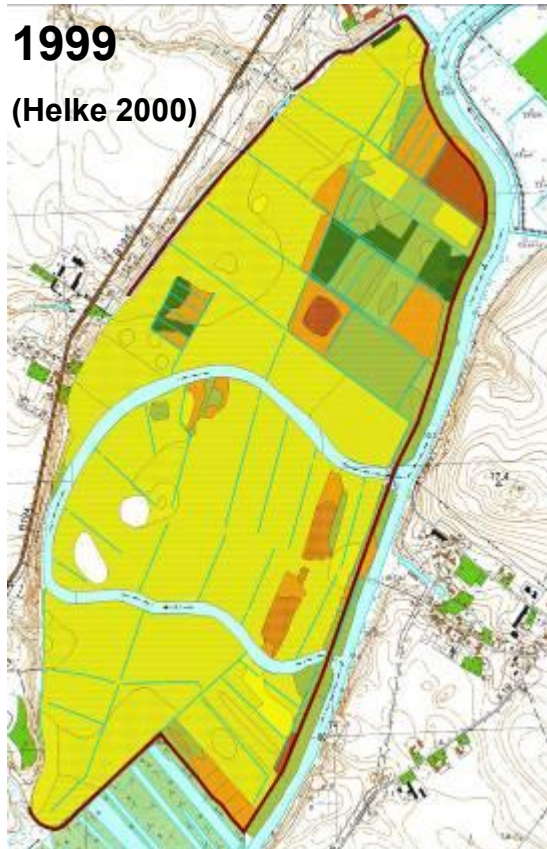
River Randow, NE-Germany, August 1986, Photo: M. Succow

Polder Randow (Peene) Rewetting: 2000



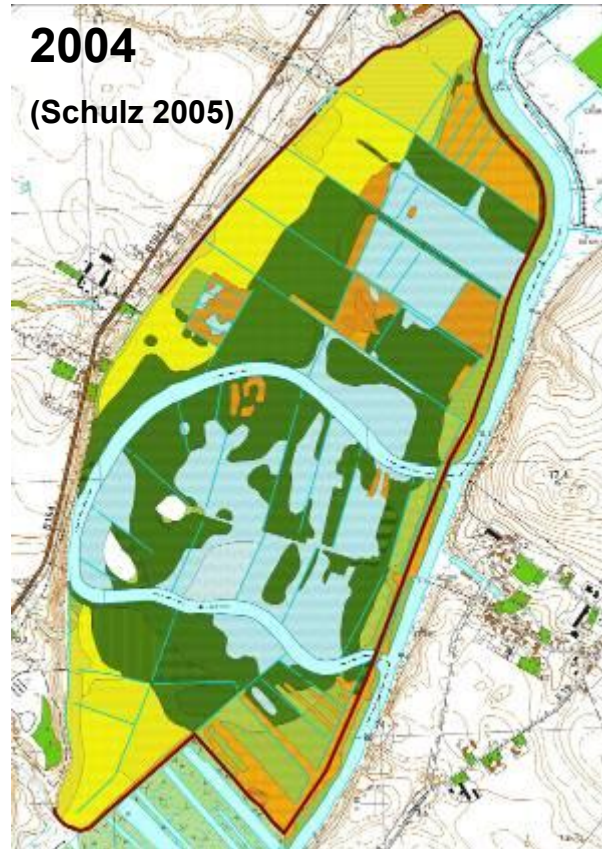
1999

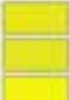
(Helke 2000)



2004

(Schulz 2005)



 **Species-poor Grasslands**
(*Cynosurion*, *Deschampsietalia*)

 **Tall herb vegetation**
(*Calystegio-Filipenduletalia*)

 **Woodlands:** *Salix cinerea*, *S. pentandra*, *Alnus glutinosa*

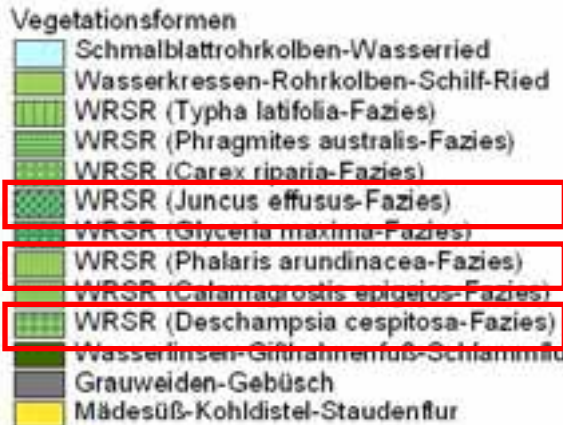
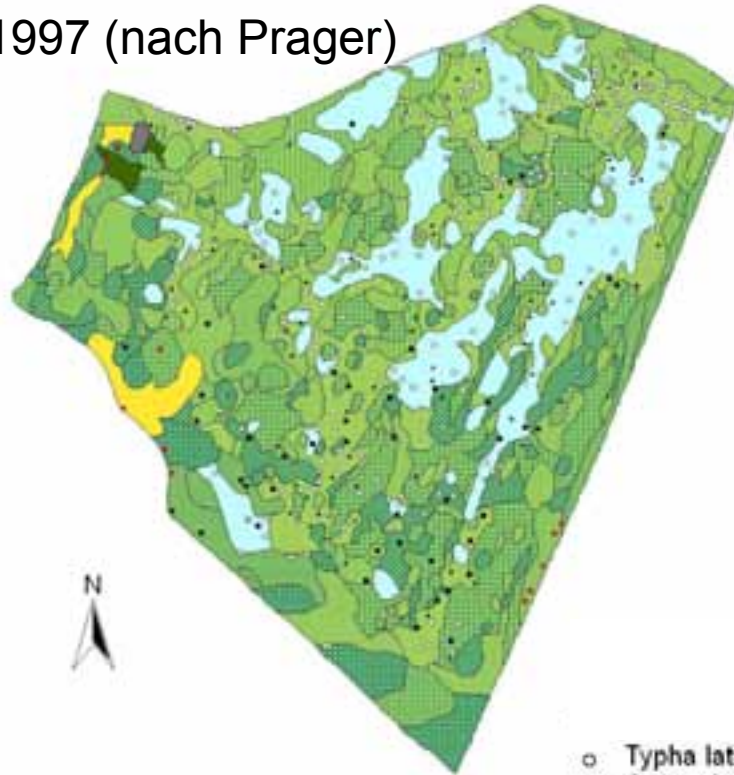
 **Open water**

 **Reeds:** *Typha latifolia*, *Glyceria maxima*,
Phalaris, *Carex* spp., *Phragmites*



Polder Zartenstrom (Peene) Rewetting: 1997

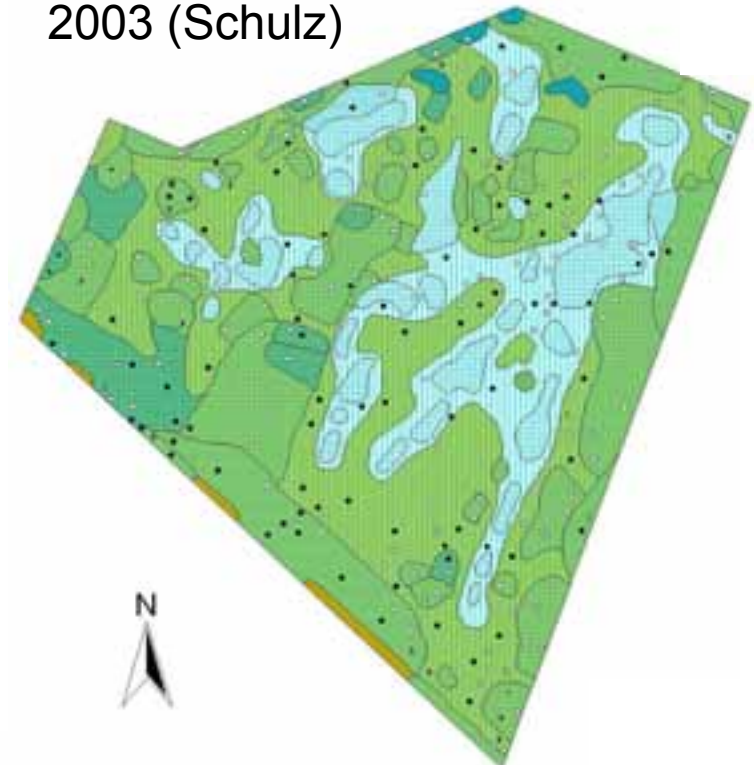
1997 (nach Prager)



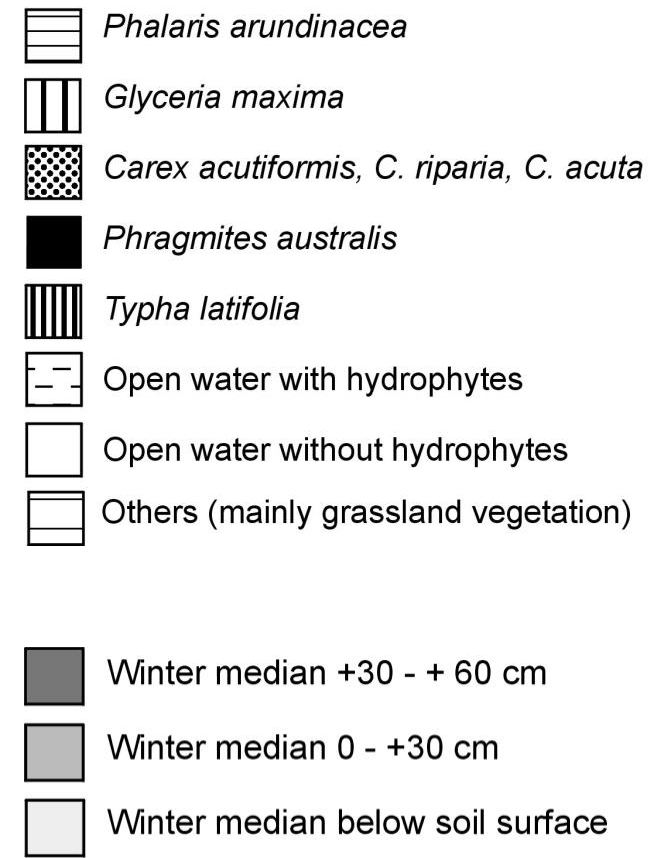
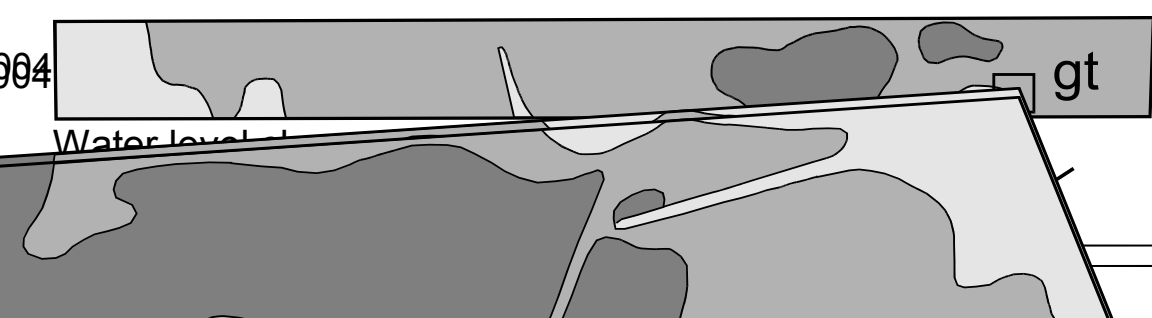
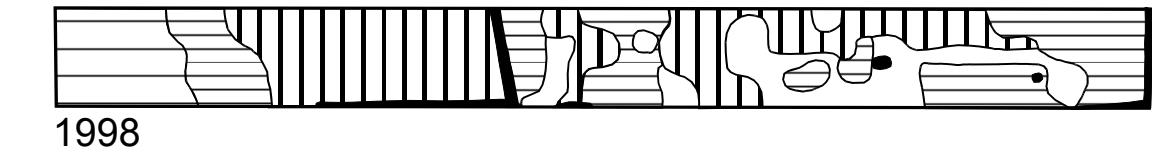
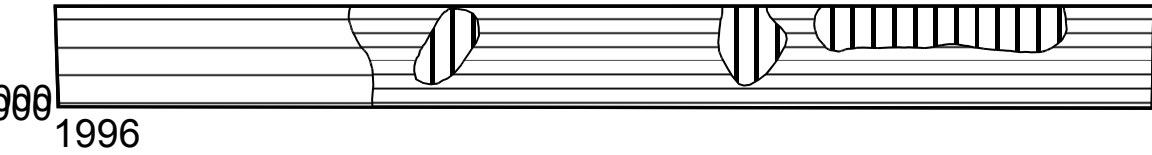
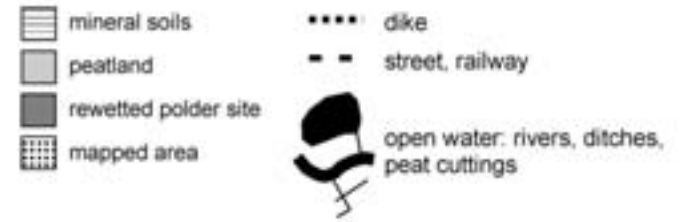
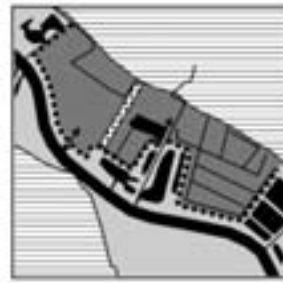
- Typha latifolia
- Carex riparia
- Phragmites australis
- Juncus effusus
- Glyceria maxima
- Phalaris arundinacea
- Schoenoplectus tabernaemontani
- Acorus calamus
- Eleocharis palustris
- Deschampsia cespitosa
- Calamagrostis epigejos
- Betula pendula
- Betula pendula, abgestorben
- Alnus glutinosa

WRSR = Wasserkressen-Rohrkolben-Schilf-Ried

2003 (Schulz)



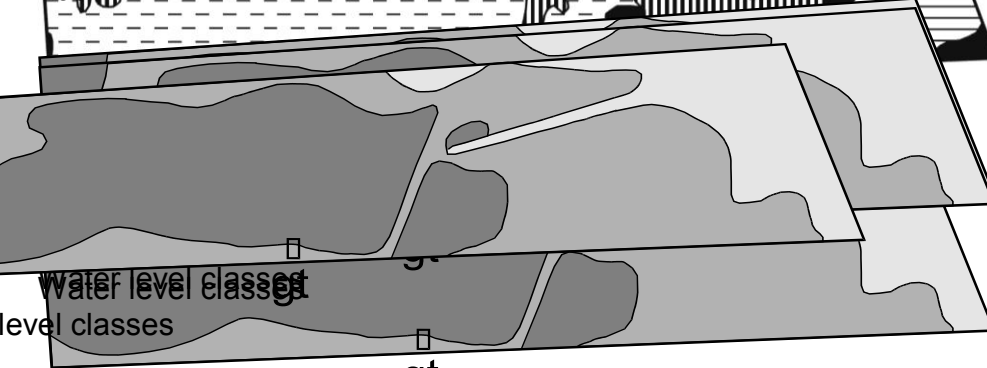
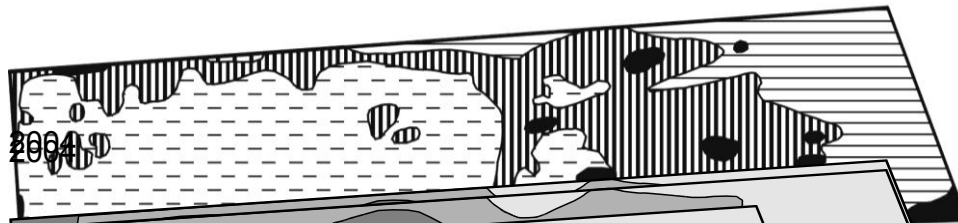
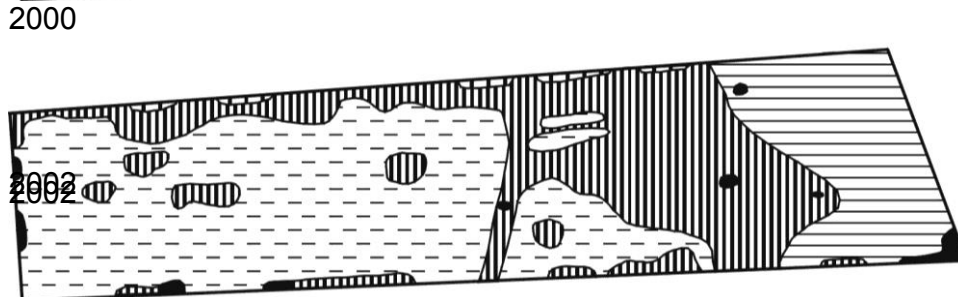
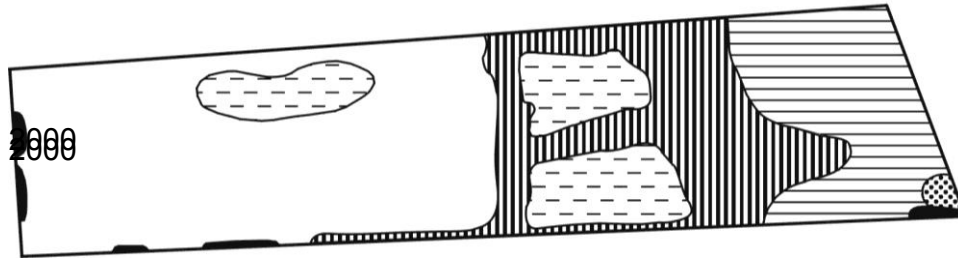
Transect – „strip“ Polder Pentin (Peene)



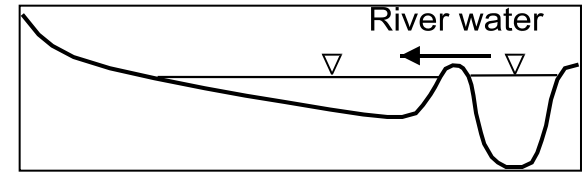
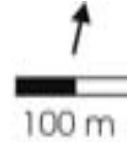
Timmermann
& al. 2006

Polder Ziethen 2 (Peene)









Rewetting: 1999






Water level classes



Timmermann & al. 2006

-  *Phalaris arundinacea*
-  *Glyceria maxima*
-  *Carex acutiformis*, *C. riparia*, *C. acuta*
-  *Phragmites australis*
-  *Typha latifolia*
-  Open water with hydrophytes
-  Open water without hydrophytes
-  Others (mainly grassland vegetation)

-  Winter median +30 - +60 cm
-  Winter median 0 - +30 cm
-  Winter median below soil surface

Photos:
K. Schulz



3 Ausgewählte Ergebnisse

Ökologische Moortypen mit Wiedervernässungen:

- Nährstoff- und basenreiche, Moore der Flusstäler
(v.a. Grassland, Wälder)

- Nährstoffarm- saure Moore
(Regenmoore, Kessel- und Verlandungsmoore)

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2 Important Ecological Services of Mires

1. Biodiversity: Habitats of rare species, rare ecosystem types
2. Regulation
 - Climate: C sink
 - Water: flood prevention, water purification (N, P, C etc)

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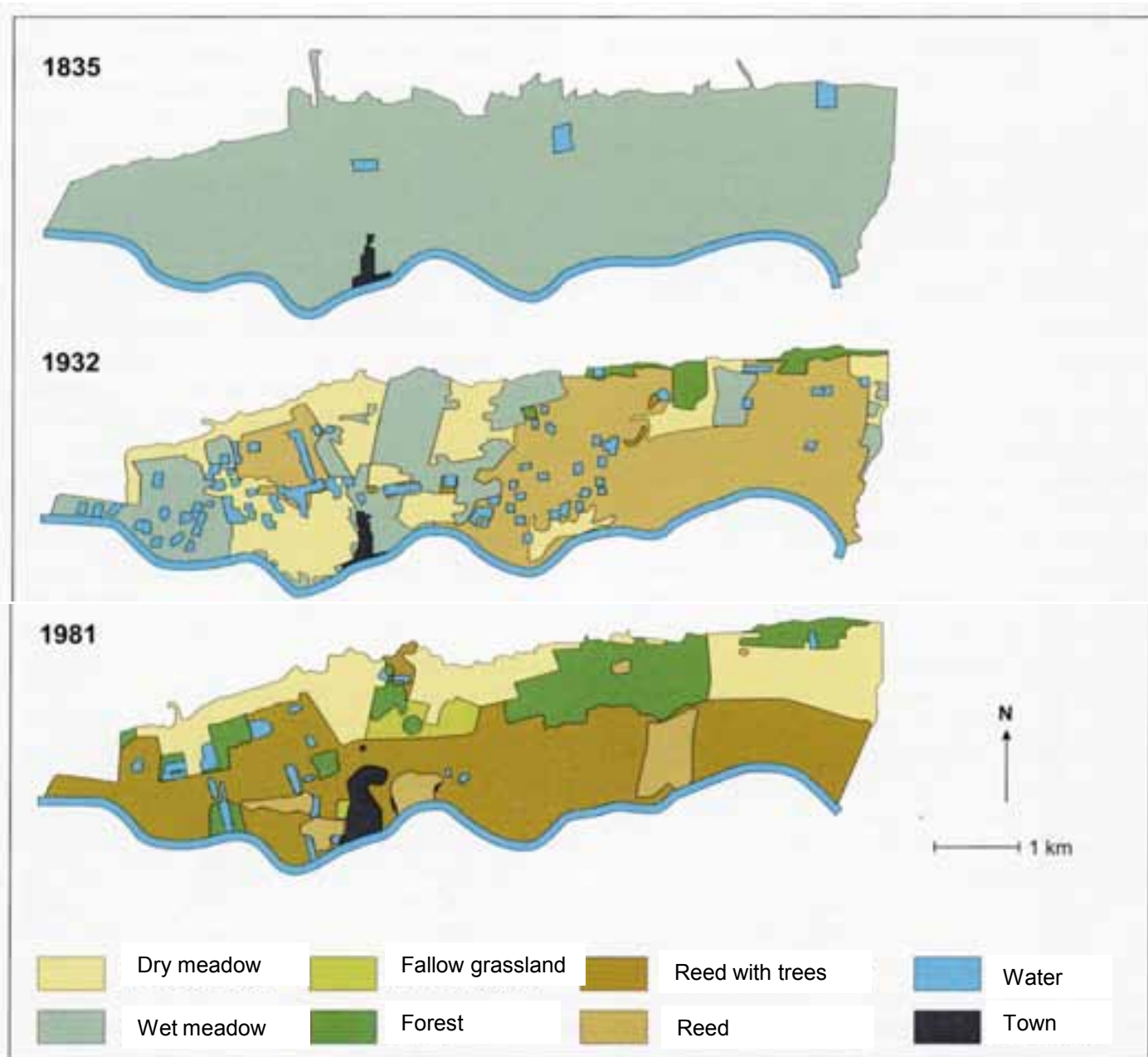
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History of Mires and Peatlands in Germany (M. Succow 2001)

I.	~ 12,000 – 5,000 yrs B.P.	Age of natural mire landscape
II.	~ 5.000 - 300 yrs B.P.	Age of anthropogenic support of mires
III.	~ 1700 – 1950/60	Age of peat cuttings and grasslands
IV.	~ 1950/60 - 1990	Age of industrial grassland use
V.	~ 1990 - 2000	Age of low-intensity grassland use
VI.	~ after 2000	Age of polytrophic swamps (restoration)
VII.	~ since 2010	Age of peat formation and sustainable use of peatlands („paludicultures“)

**Percolation mire
in the Peene River
near Anklam
(NE-Germany)**

**Vegetation
Changes
1835 - 1981**



Global Warming Potential (GWP) and water level

$$\text{GWP} = \text{CO}_2 + \text{NO}_x + \text{CH}_4$$

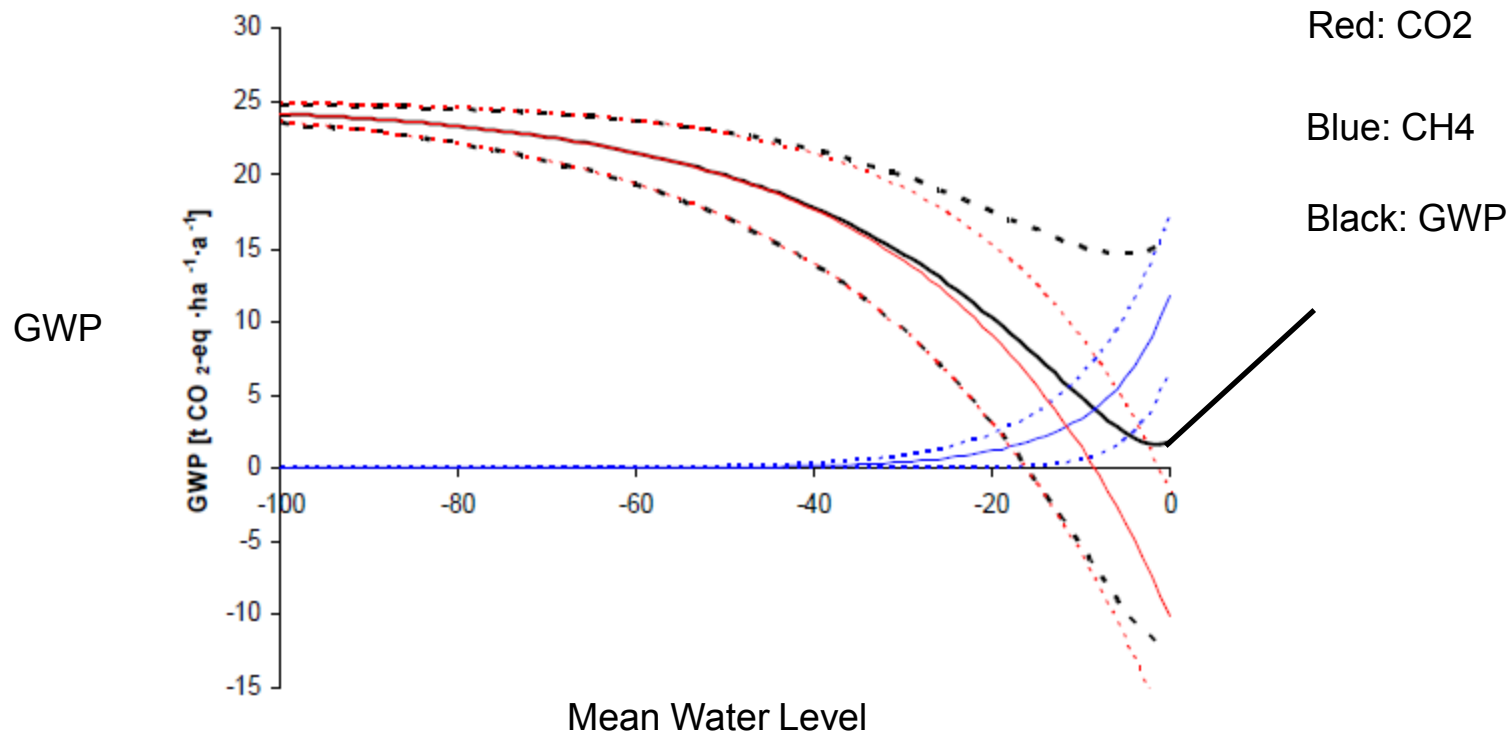


Abb. 15. Treibhauspotential (GWP) in Relation zum mittleren Wasserstand. Rote Linien bezeichnen Schätzwertbereiche für CO₂, blaue Linien für CH₄, schwarze Linien für GWP (gestrichelt: Minimum und Maximum; durchgezogen: Mittel des Bereichs). CH₄-Emissionen werden über Exponentialkurven angepasst.

Summary:

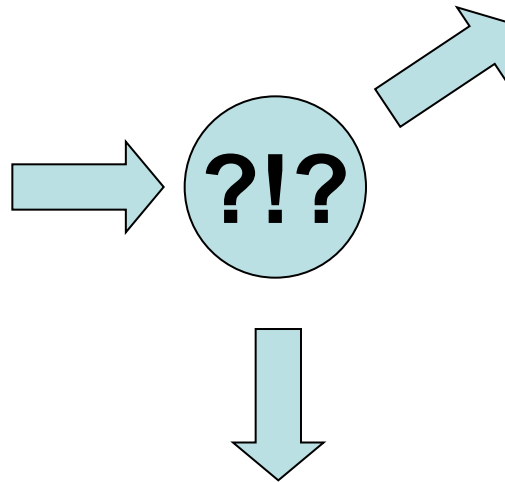
Ecosystem components changed by mire degradation

1. **Hydrology (Water):** lower mean water levels, higher amplitudes
2. **Peat:** decomposition, nutrient and C release
3. **Vegetation and Fauna:** increase of eutrophent species poor peatlands
4. **Surface Height and Relief:** peat loss due to mineralisation and peat cutting

4. Restoration Objectives, Principles and Tools



**Peatland: Stratigraphy-Investigation:
Calcarous gyttja, Germany 1992**

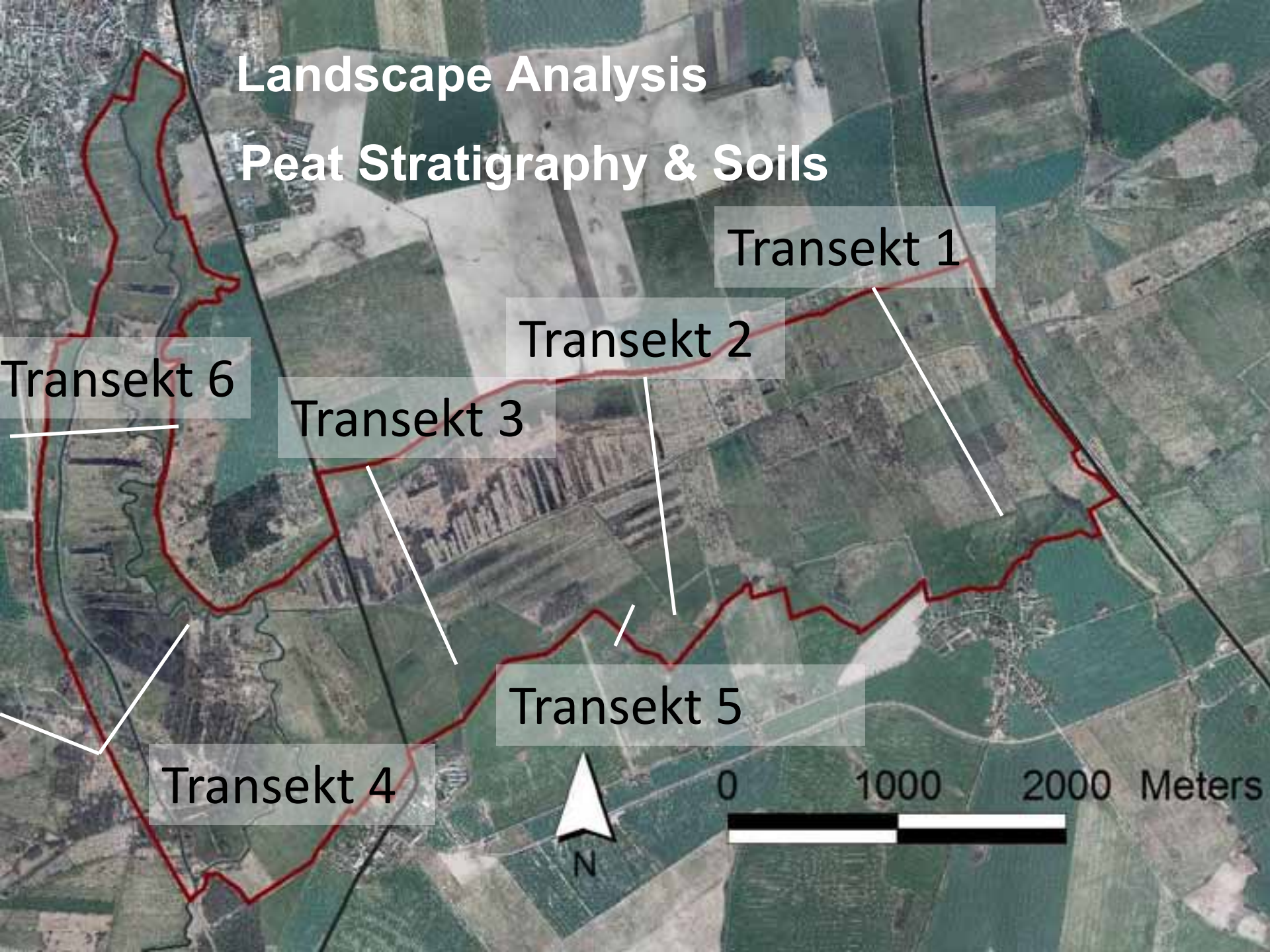


General Mire Restoration Objectives

- 1. Regulation:** e.g. climate (C- and N- fixation / accumulation)
and hydrology (nutrient fix., flood prevention)
- 2. Biodiversity:** e.g. species, habitats, ecosystems
- 3. Natural processes (= doing nothing)**
- 4. Information:** e.g. recreation, knowledge, experiences etc.
- 5. Production:** paludicultures, extensive used grasslands

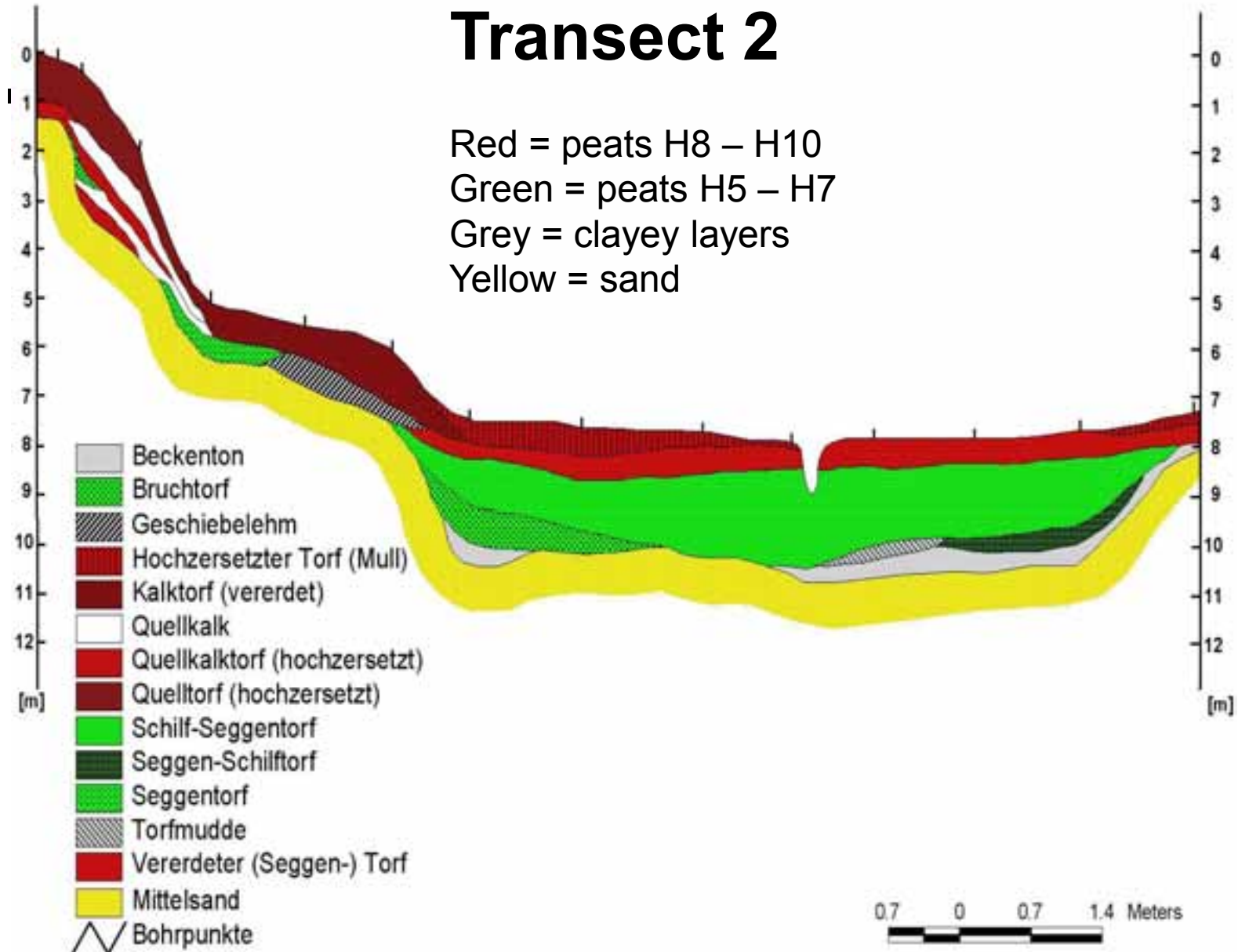
Landscape Analysis

Peat Stratigraphy & Soils

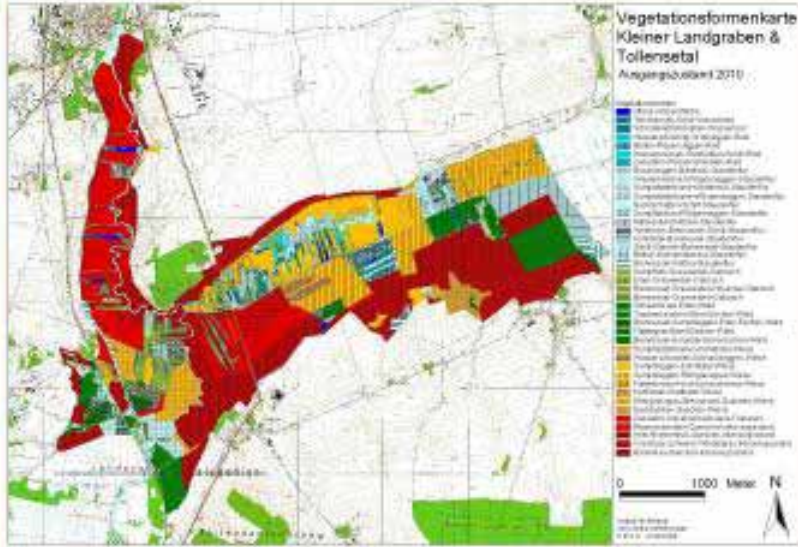


Transect 2

Red = peats H8 – H10
 Green = peats H5 – H7
 Grey = clayey layers
 Yellow = sand



Vegetation



Status description

Evaluation

Restoration Targets

Water level



Nutrient Supply



Soil Calcium Carbonate



Hydrogenetical Mire Type



Degradation



Conservation Priorities



Reference Ecosystem

Gützkower Wiesen



Mestrophic – base rich:

Brown Moos - *Carex* - Comm.



First Developments January 2011



Top Soil Removal: Pros & Contras

▶ Pro

Removal of nutrients and (species poor) vegetation

Surface comes near the ground water level

Undegraded soils at the surface

- > Large soil pores enable percolation

- > diaspore input easy (hay)

- > establishment of target vegetation possible

▶ Contra

Expensive

Seedbank destruction (positive if no target species left)

How getting rid of peat?

Case study: Flooding of eutrophic fen grasslands in the Peene River



Peene river valley, Murchiner Wiesen (2003), 1 year after rewetting with high intensity, photo: Karsten Schulz

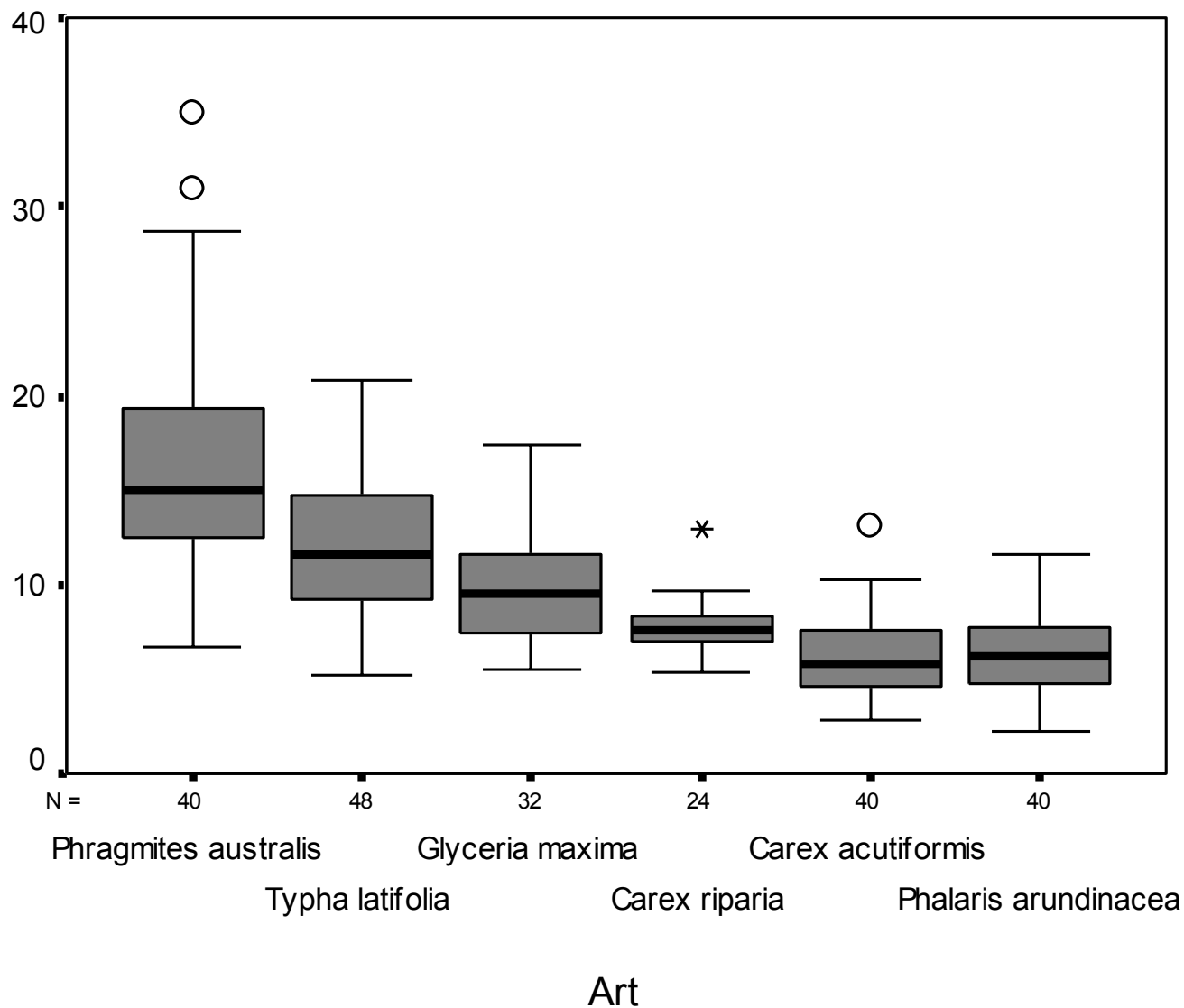


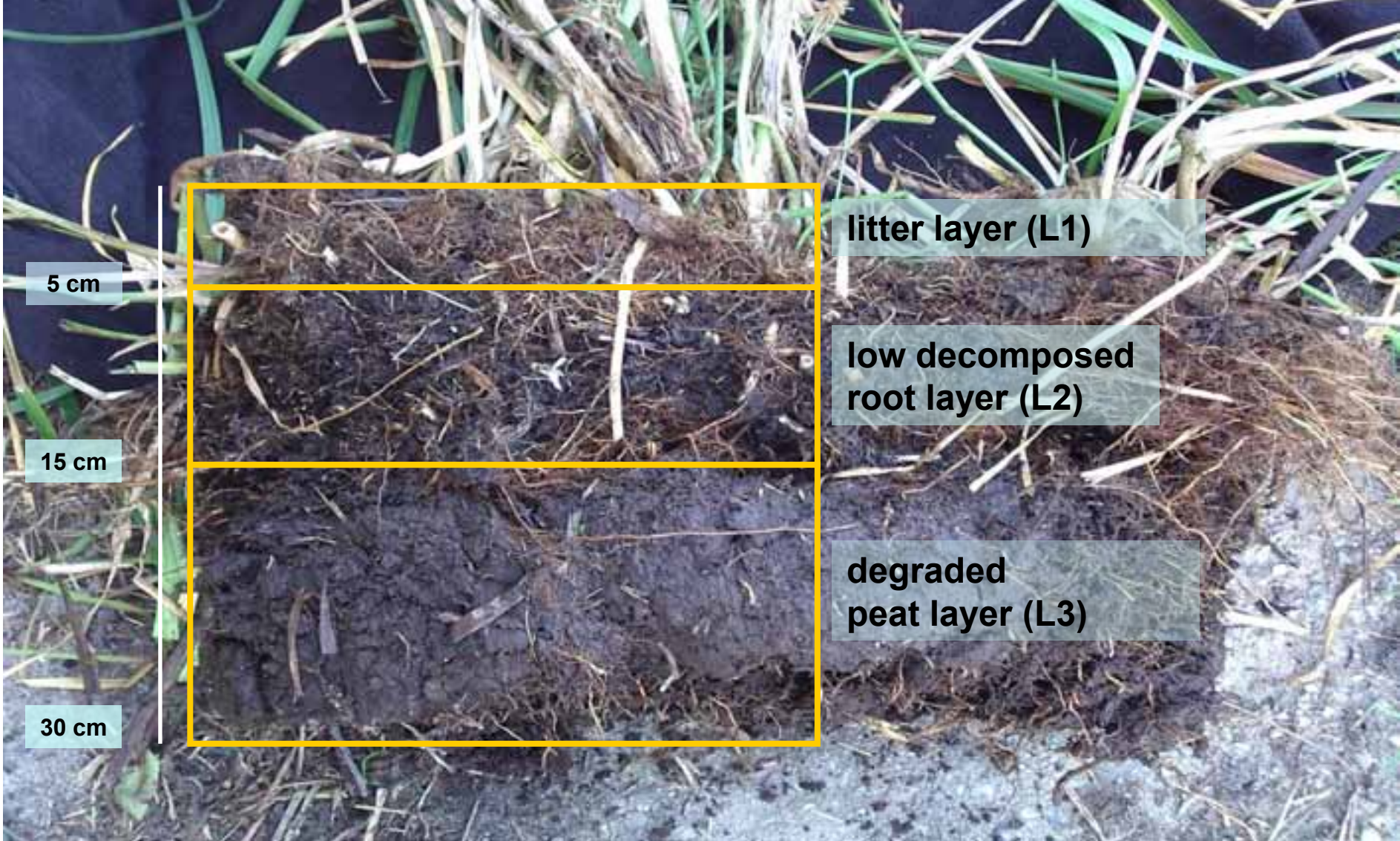
Peene river valley, Polder Bugewitz (2003), green algae and *Typha latifolia*,
photo: Karsten Schulz

Restoration measures raised mean water levels 50-100 cm



Biomass: Aboveground Standing crop (dm)





Soil profile of *Glyceria maxima*

L1: litter layer

L2: main rooting zone

L3: degraded peat, no rhizomes

Flooding of eutrophic grasslands: Pros & Contras

▶ Pro

Stop of peat mineralisation and Co₂ and NO_x emissions

Natural near reed vegetation

Initial Peat formation

Bird habitat

Cheap method

▶ Contra

Nutrient rich sites with species poor vegetation

Initially high CH₄ emissions (negative climate effect)

Risk of P mobility and export (eutrophication)

Global Warming Potential (GWP) and water level

$$\text{GWP} = \text{CO}_2 + \text{NO}_x + \text{CH}_4$$

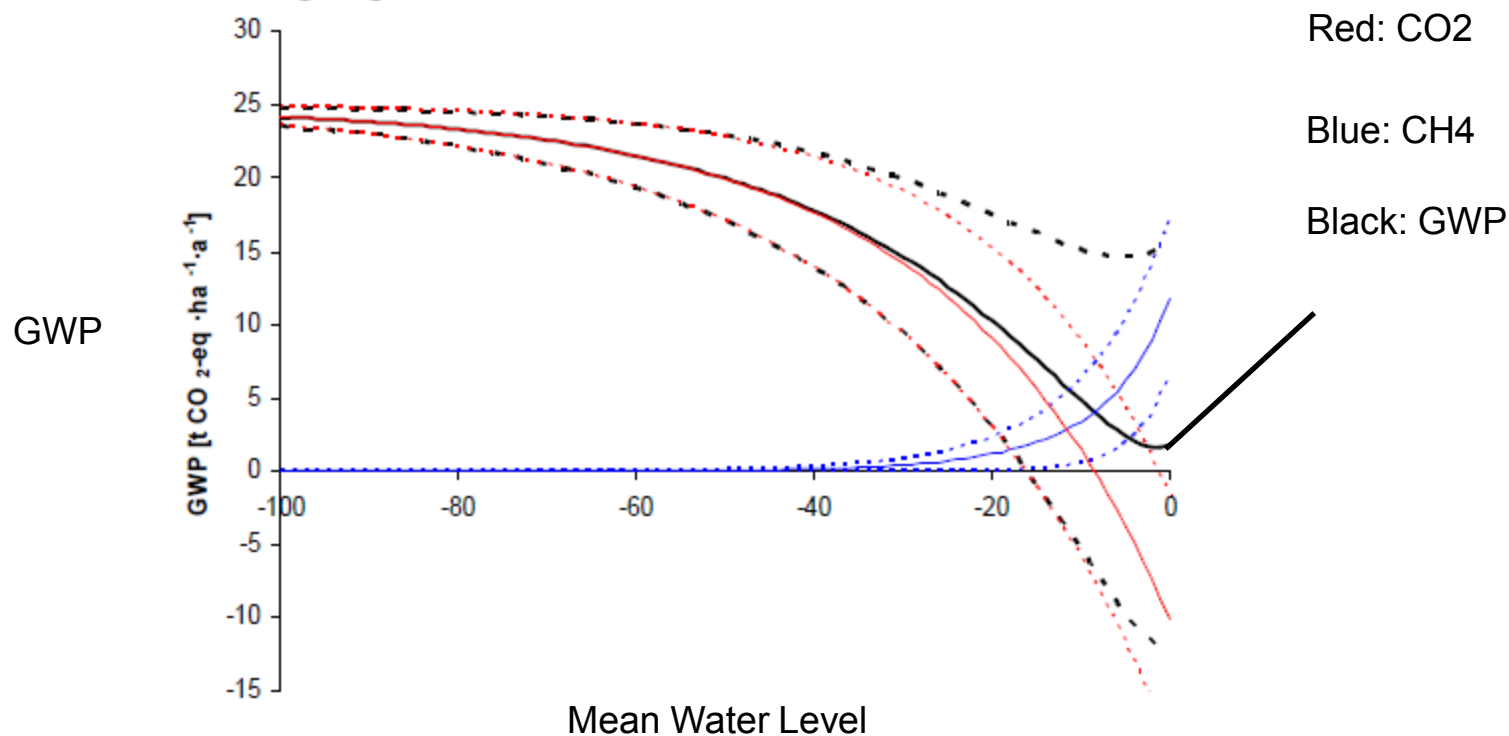


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6. “Paludicultures”

Sustainable production of biomass in rewetted peatlands

- ▶ Common reed, cattail, sedges



- ▶ Alder (*Alnus glutinosa*)



- ▶ Peat Moss (*Sphagnum* spp.)

