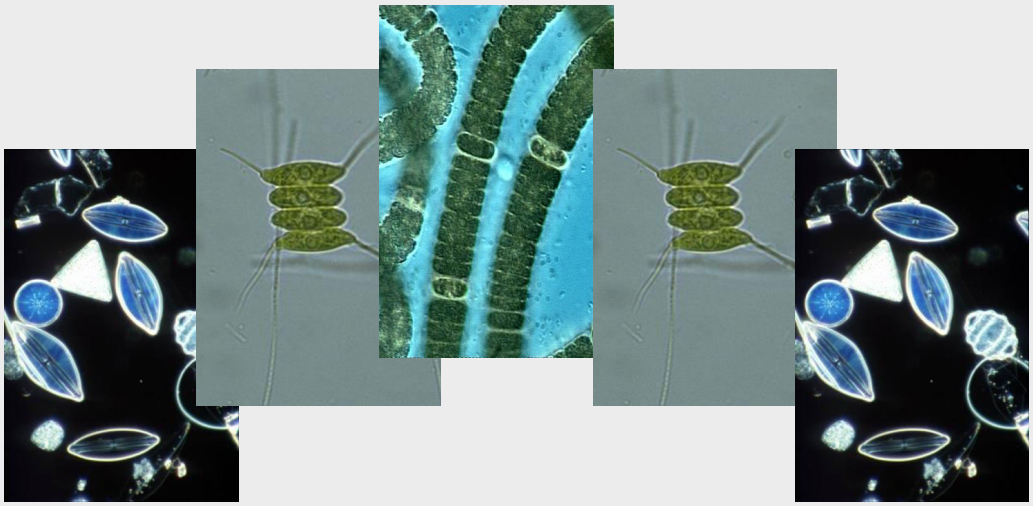
Abiotic variability in a microtidal lagoon

–irregular fluctuations result in stable succession trends? -



H. Schubert & A. Schoor, University of Rostock, Biosciences

Motivation

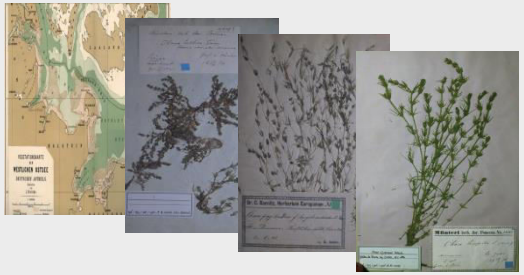
General motivation





Concepts & History

Conter

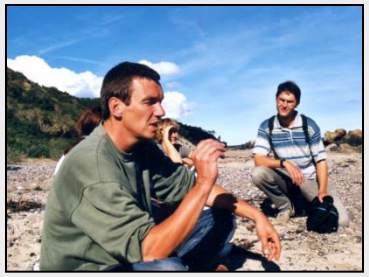



The field case & own results



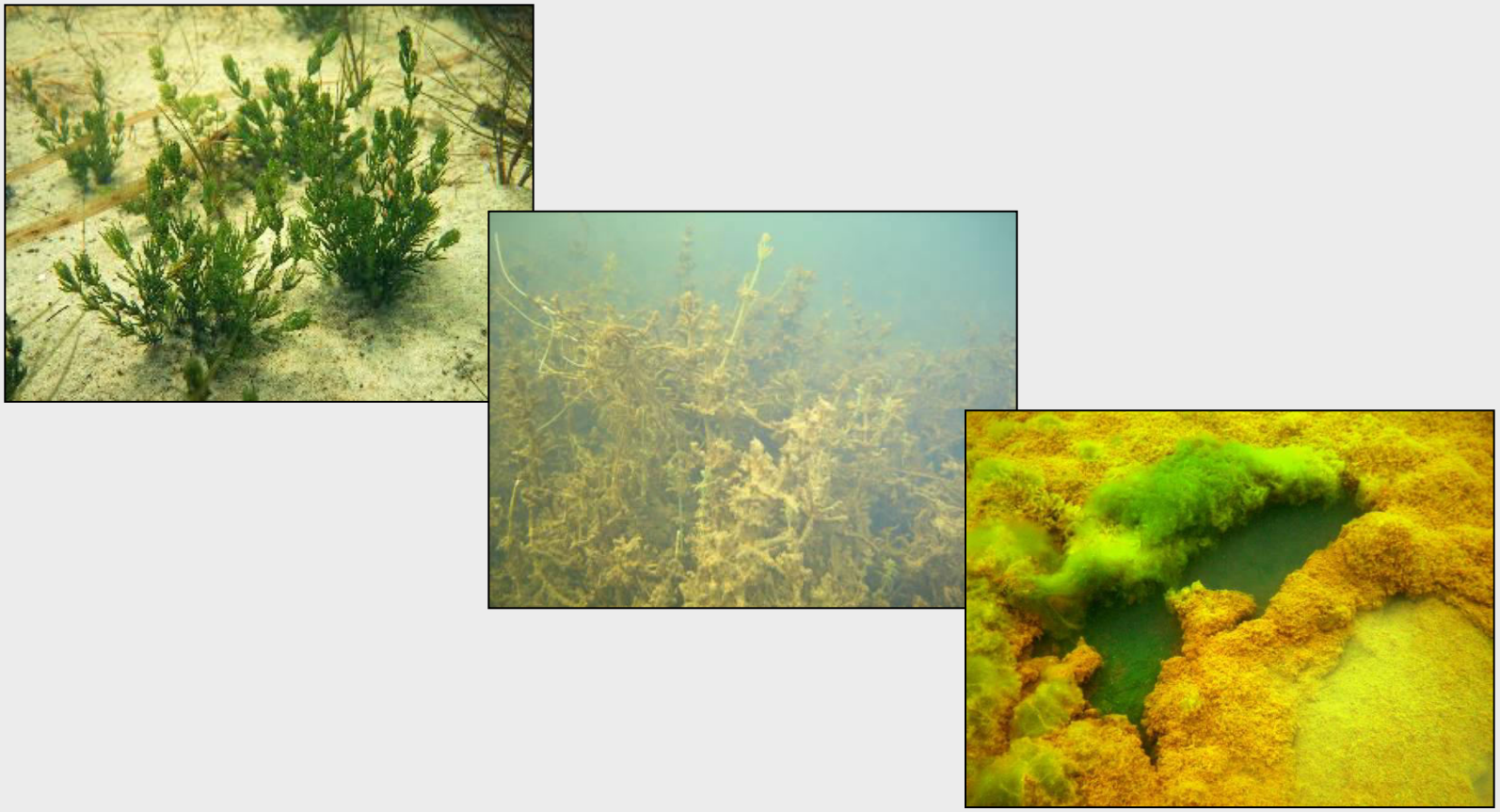


Synthesis and outlook




Motivation

Anthropogenic impacts as eutrophication have led to derogations of aquatic ecosystems worldwide



Motivation

This, together with the increased demand for water and water-related ressources has caused in major concerns about the future of aquatic ecosystems and consequently regulations have been released to protect them and to improve the „ecological status“ of already degraded ones





Motivation

All of these regulations ask for a „classification system“ which, by means of different kinds of indicators, allow a (quantitative) description of ecosystem‘s „health“

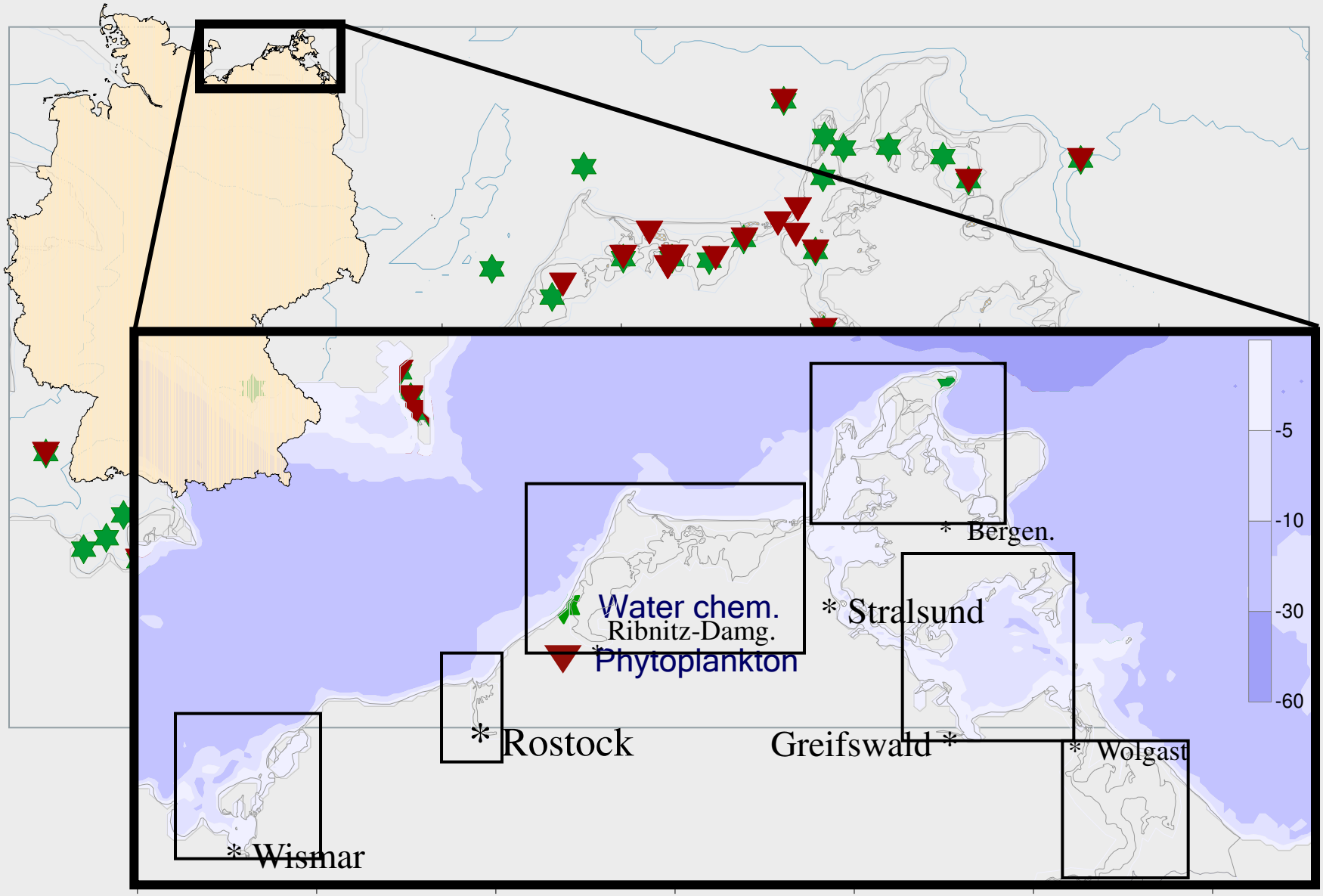
Phytoplankton – either as bulk parameter (Chl a) or in most cases at least resolved to rough taxonomic levels are part of most of these classifications – in the European Water Framework Directive Phytoplankton is one of the mandatory parameters for these classification systems.

All classification approaches are basically comparing a „reference“ status, describing an ideal and undisturbed status of the ecosystem with the actual state of the ecosystem

The problem

Identification of long term trends in eutrophication in an shallow brackish ecosystem by means of (taxonomic) phytoplankton parameters

The tools – data set

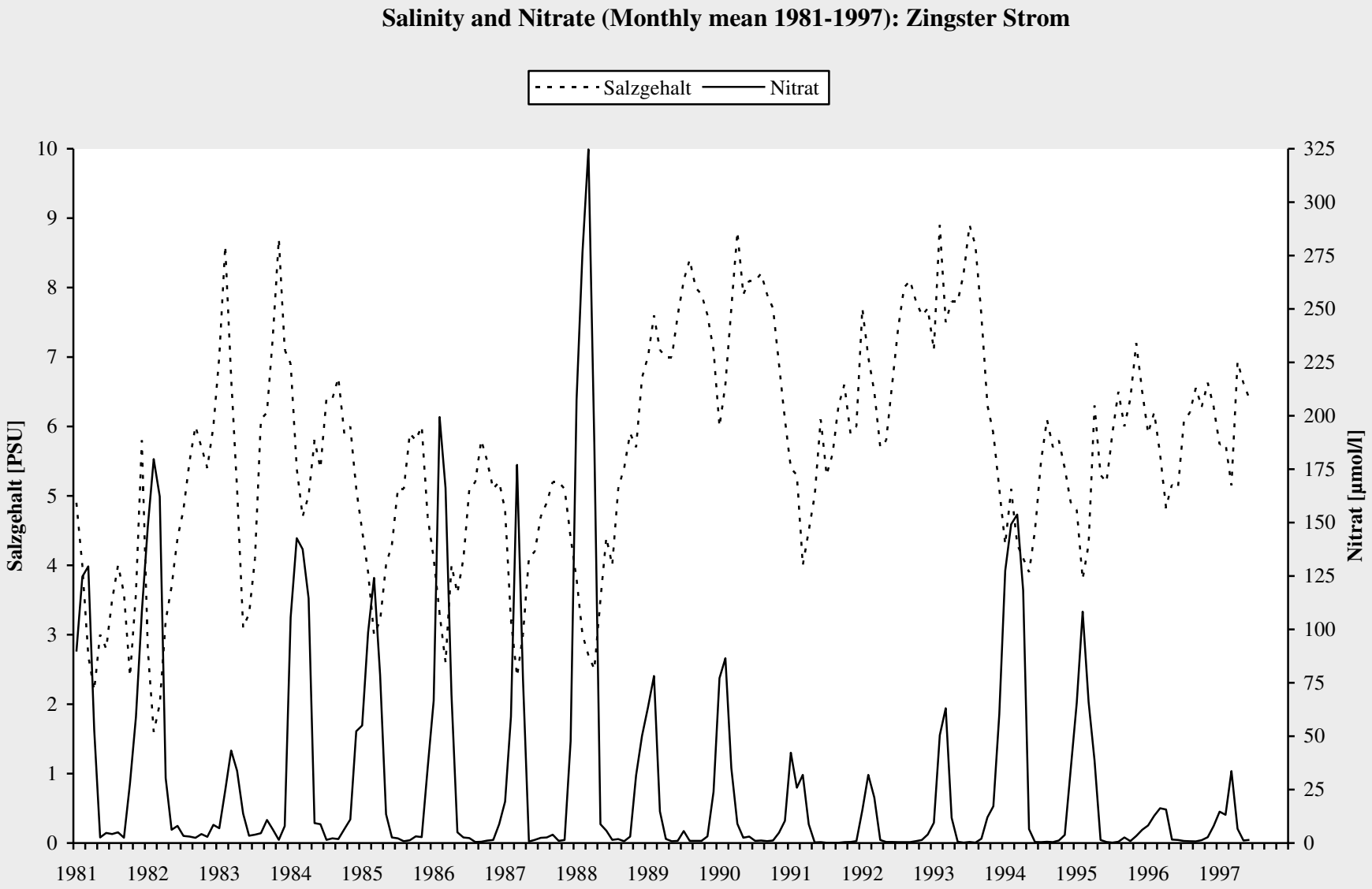


The tools – data set

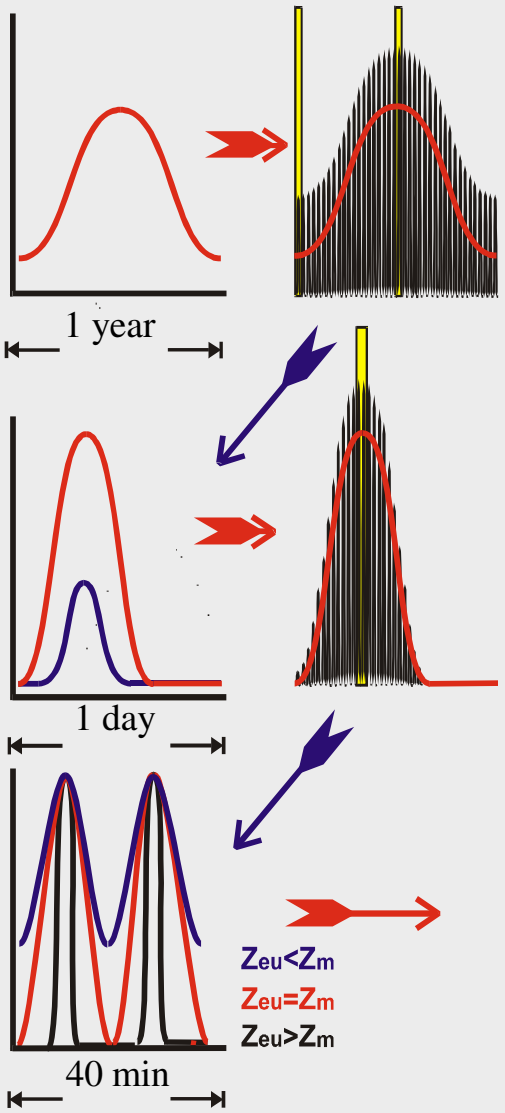
Datenquelle	Gewässer	Beprob.-Zeitraum	Stationen (n)	Datensätze (n)
IOW (Dr. N. Wasmund)	DZBK	1984 - 1991	19	1000
Uni. Rostock (A&S Botanik)	DZBK	1991 - 1997	11	653
LUNG MV	Unterwarnow	1988 - 1997	6	499
LUNG MV	Pommersche Bucht	1986 - 1999	4	412
LUNG MV	Ostsee	1986 - 1999	4	821
LUNG MV	Greifswalder Bodden	1988 - 1999	3	266
LUNG MV	Strelasund	1988 - 1999	2	289
LUNG MV	DZBK	1988 - 1996	1	69
LUNG MV	Wismarbucht	1988 - 1999	1	176
LUNG MV	Kubitzer Bodden	1988 - 1994	1	126
LUNG MV	Nordrügensche Bodden	1996 - 1997	1	15
LUNG MV	Stettiner Haff	1987 - 1999	1	251
LUNG MV	Peenestrom	1993 - 1997	1	61
LUNG MV Gesamt				2985

2985 Data sets (23 sites with > 5 years cont. monitoring)

There is a trend – at least a year-year variation



Example 1 – physical factor



Ranges

.....

Years

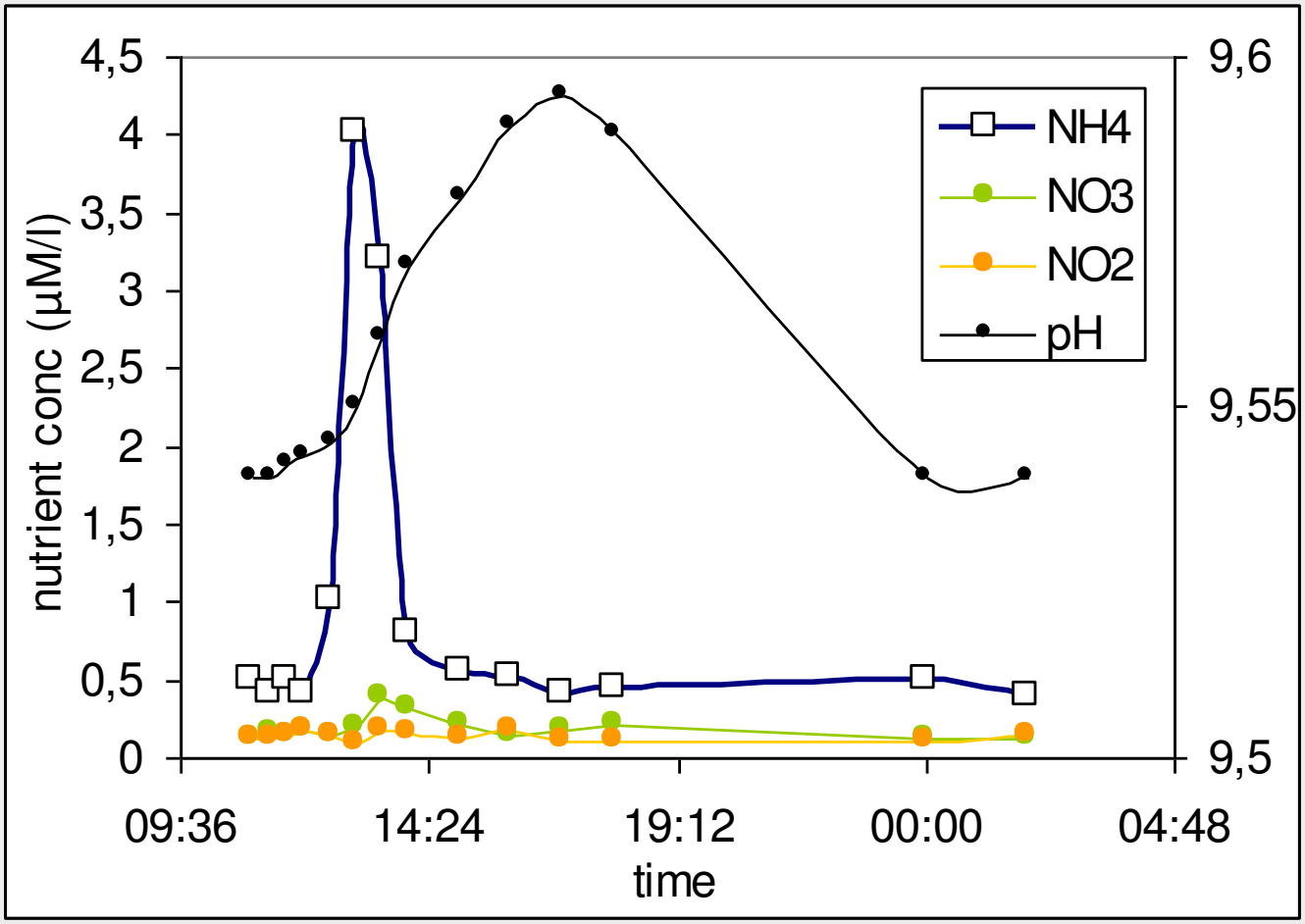
Biweekly (summer)

Days

~20 min

<0,1 sec

Example 2 – chemical factor



Data from: Schoor (1994)

Example 3 – biotic factor

Birds arrive



before



after

Approx. 1 Mio Geese and 20 000 Swans as potential Grazers were counted in the national parcs and nature protection areas with ~ 100000 ha water surface

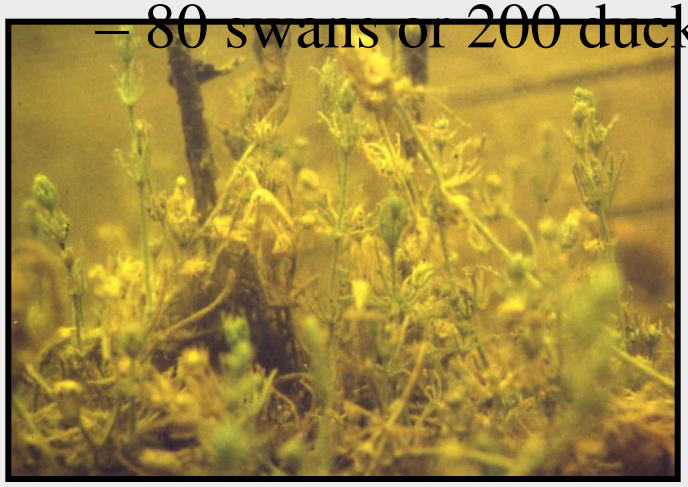
Characeen development starts at 12-15°C

No grazing effect

– 20% of the water surface are covered by macrophytes

– 80 swans or 200 ducks per ha

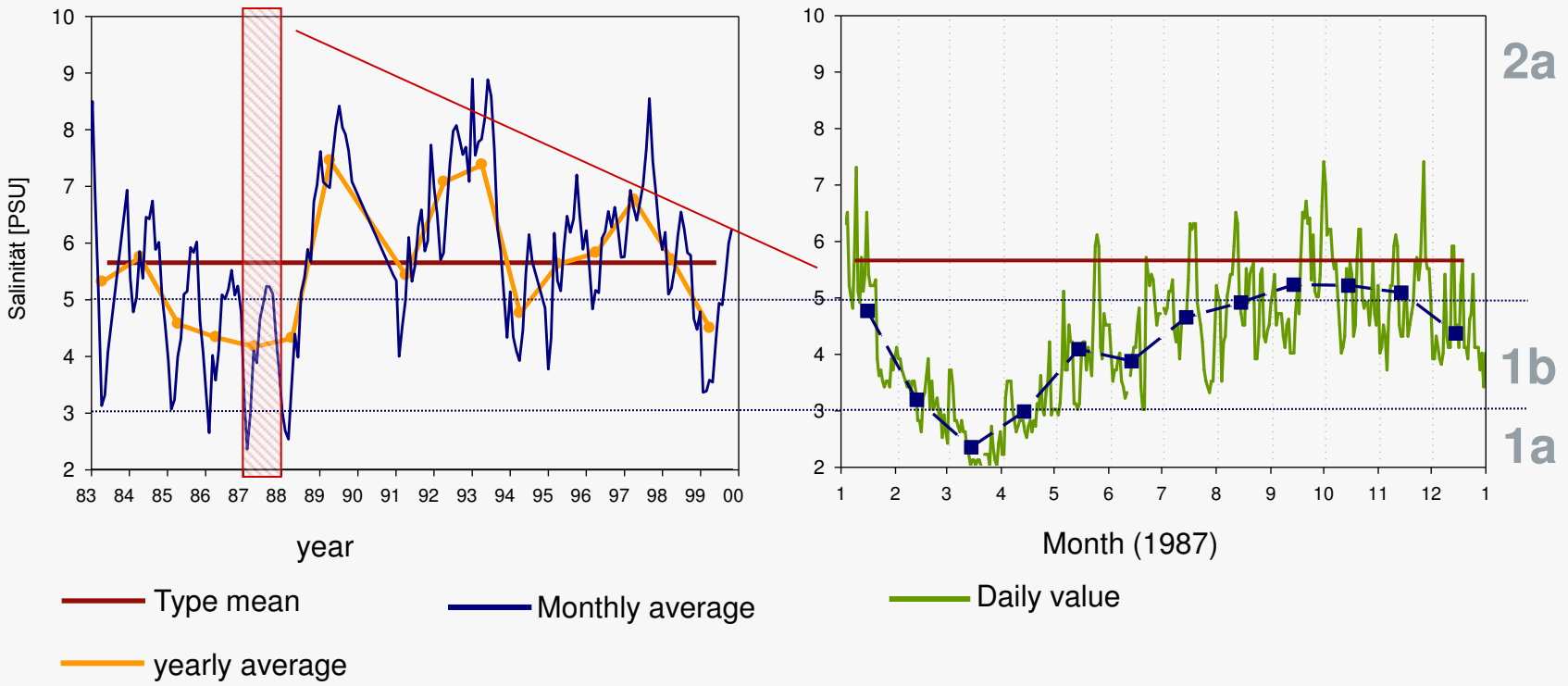
Phytoplankton dominance?





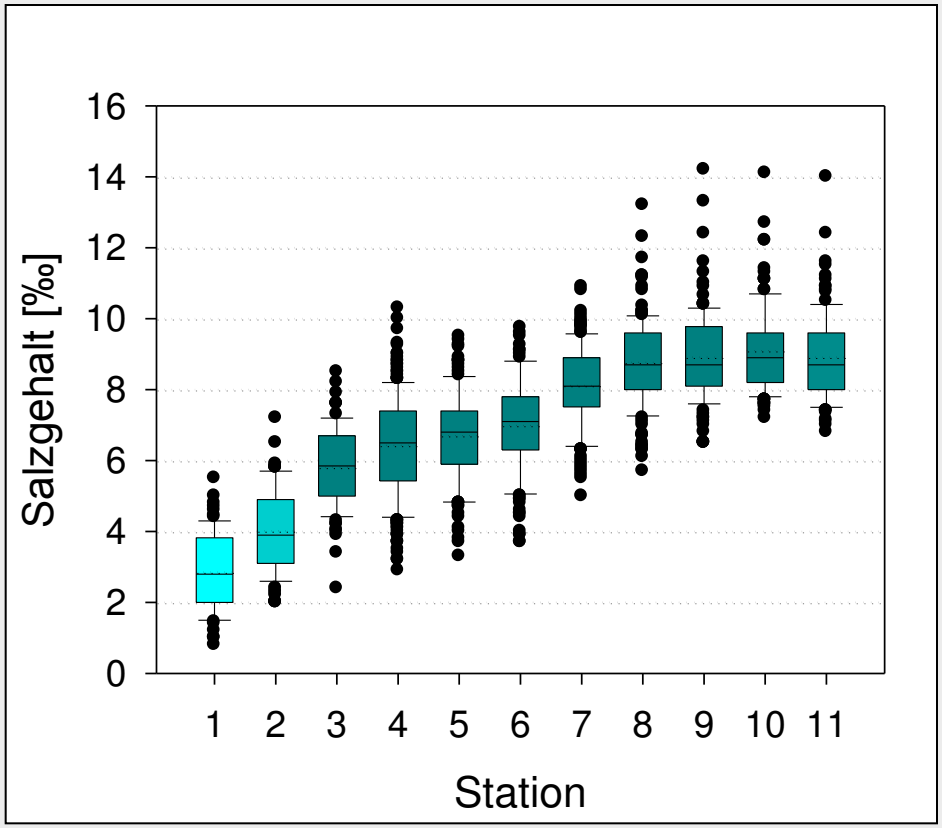
Another problem: hydrological variability

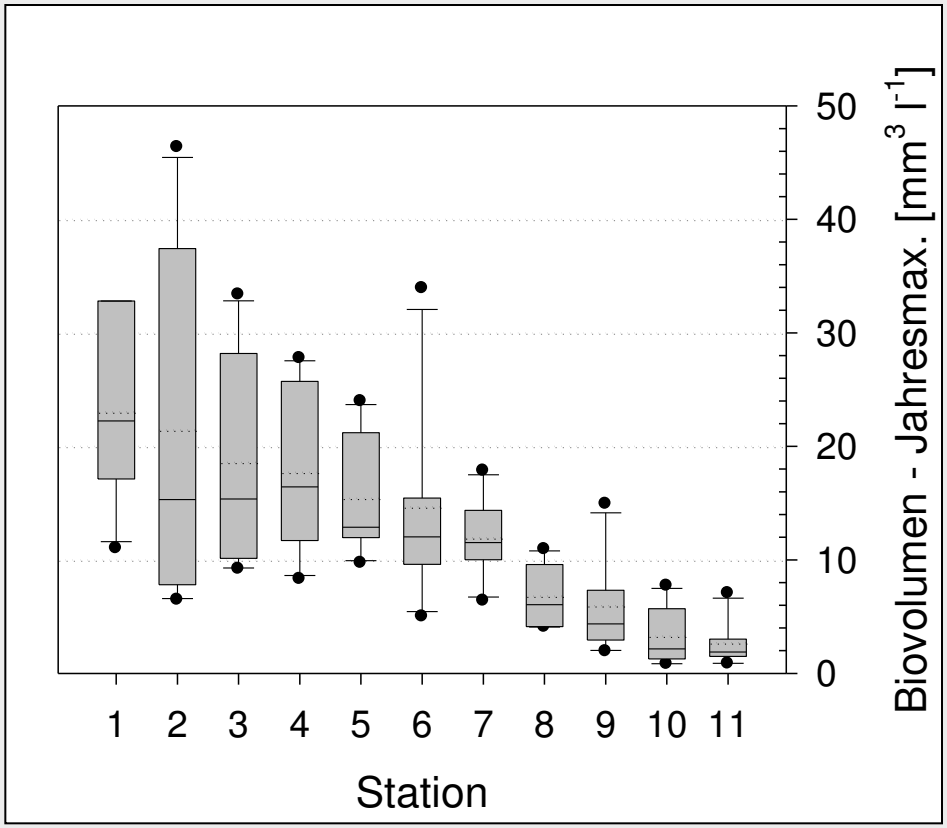
Example Zingst: daily measurements of salinity



Type limits can be passed within a day

Salinity - biomass





There seems to be also a response…..

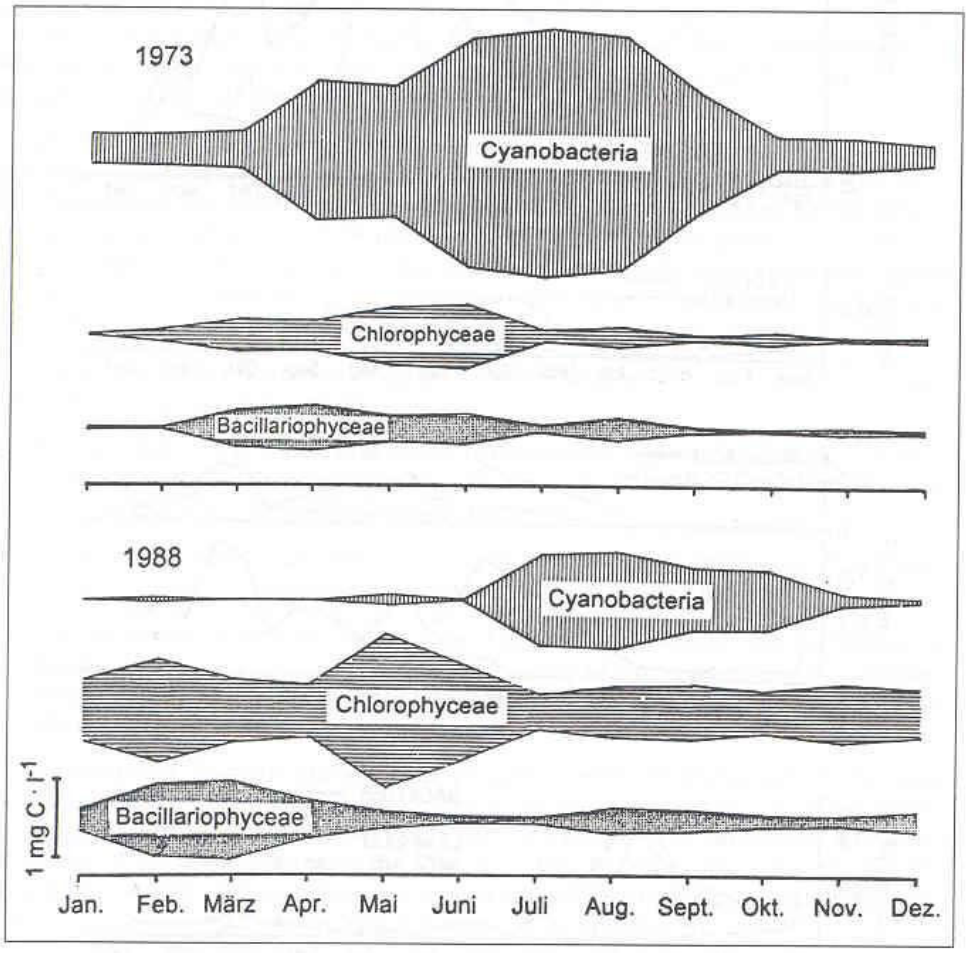
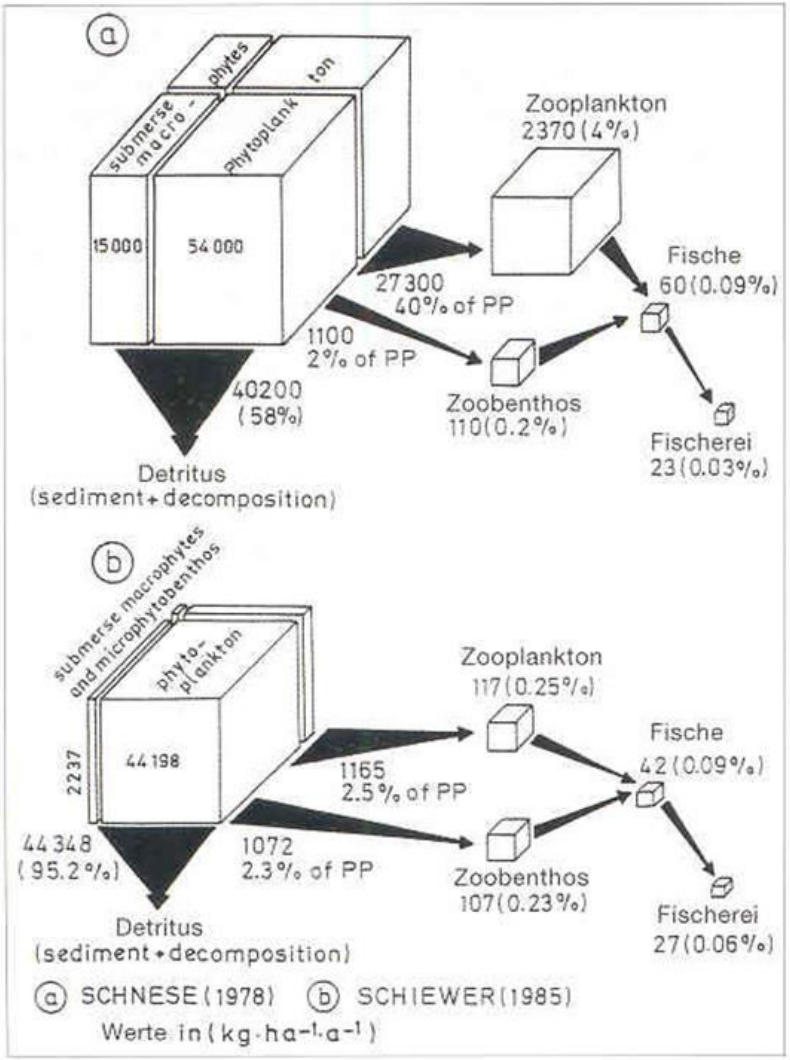


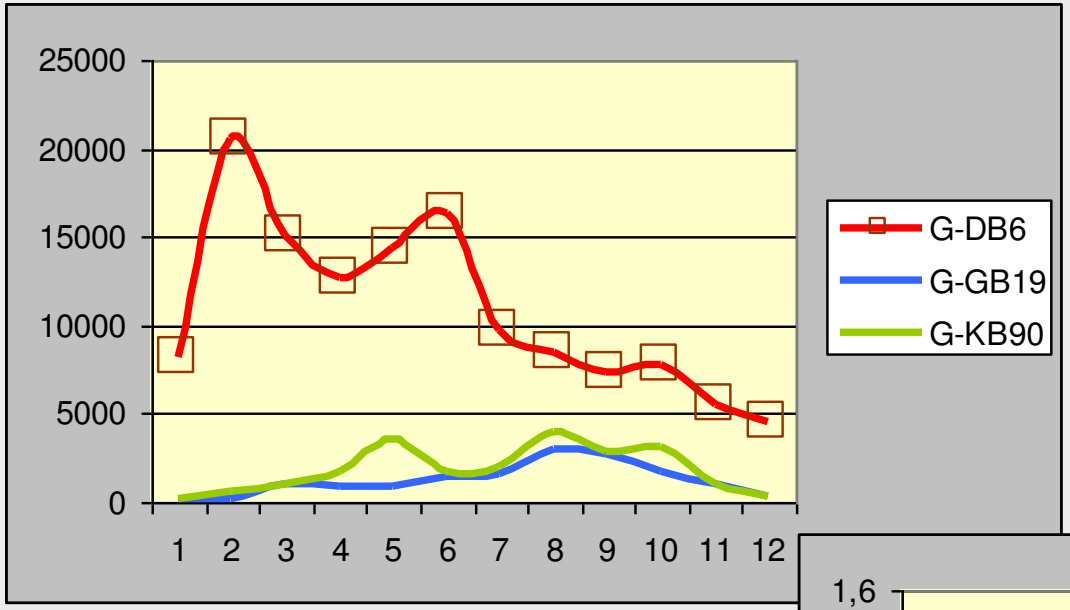
Abb. 1 Jahresgänge (Monatsmittelwerte) der Biomassen der drei größten Phytoplanktongruppen in den Jahren 1973 (Barther Bodden) und 1988 (Zingst), nach NASEV (unveröff.) und WASMUND (unveröff.).



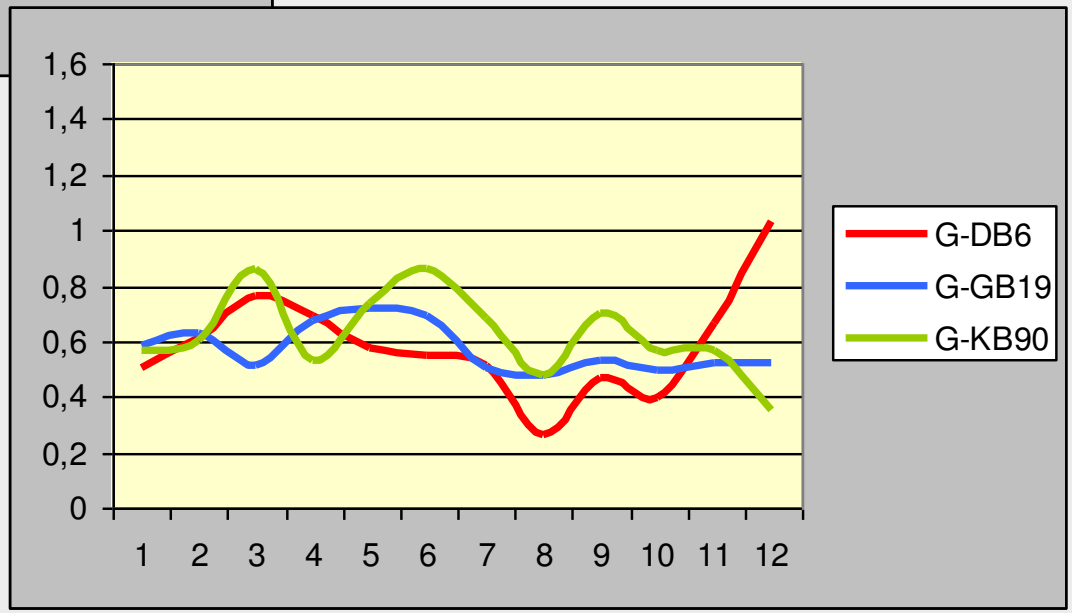
Quelle: Wasmund & Schiewer, 1994

But no response on diversity?

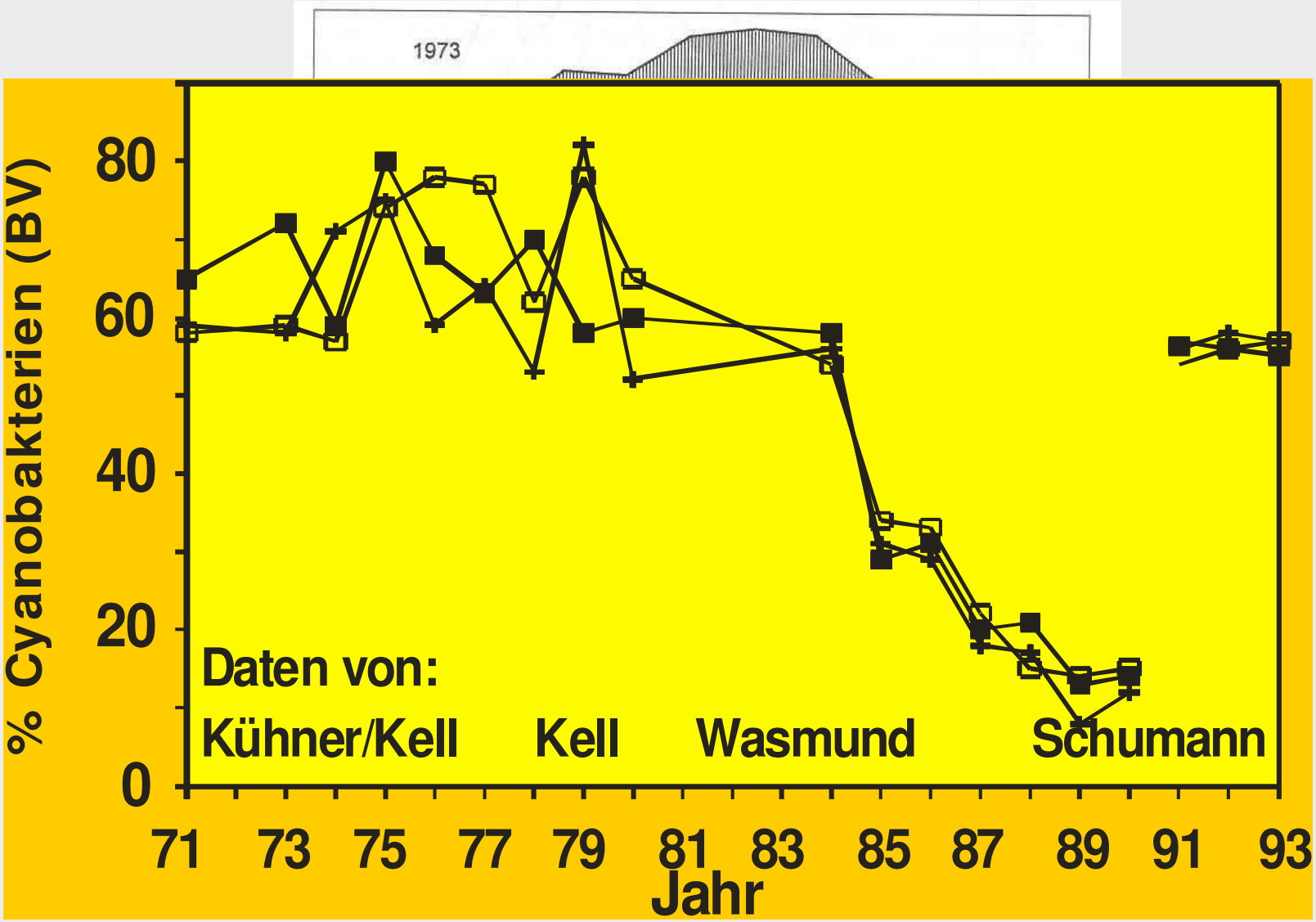
Biovolume



Shannon

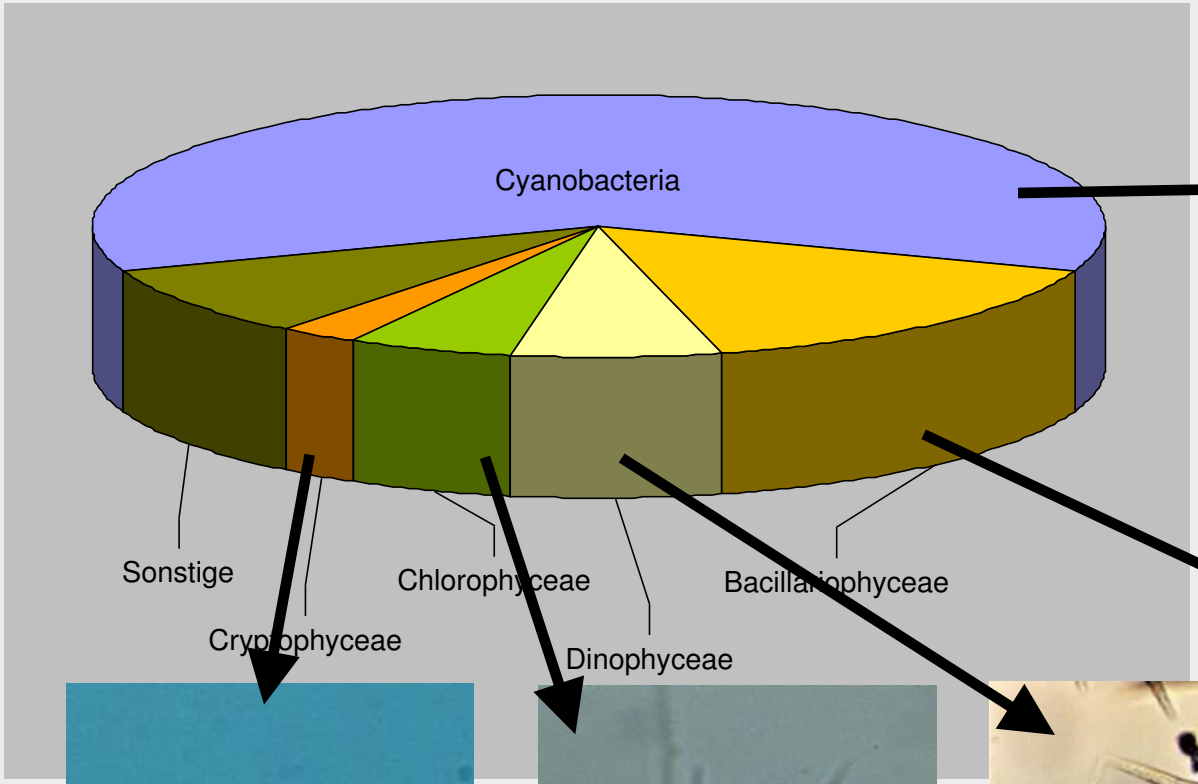


There seems to be also a response…..but what kind of?



Quelle: Wasmund & Schiewer, 1994

Phytoplankton composition

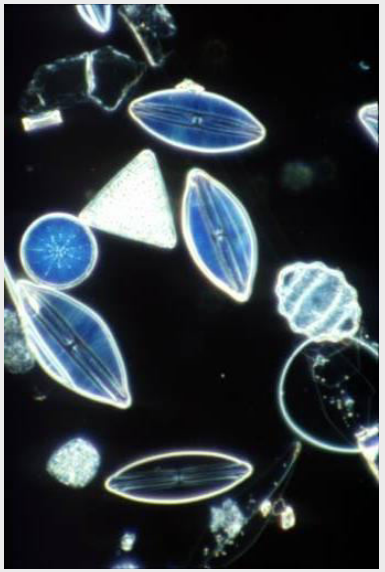




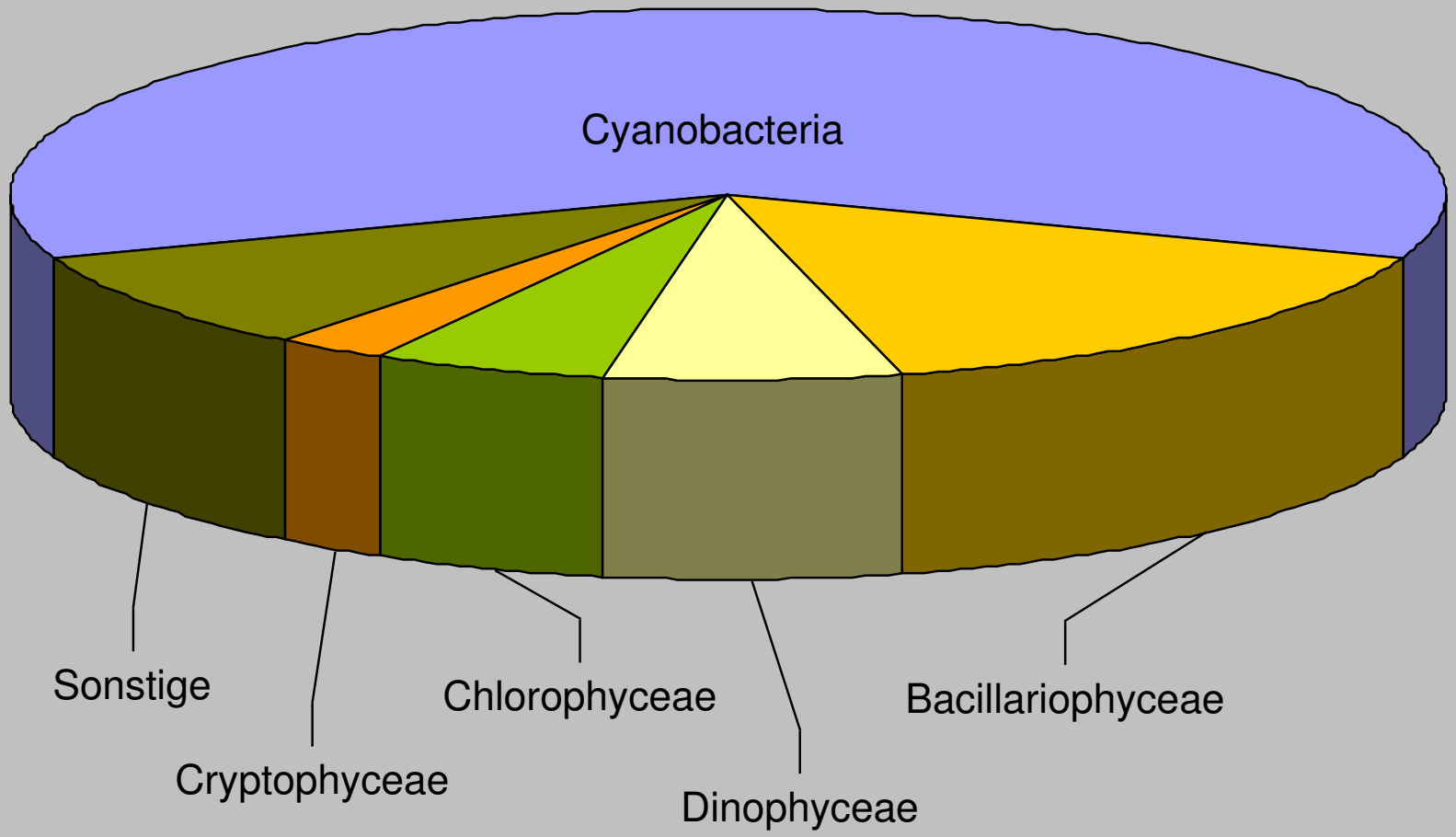




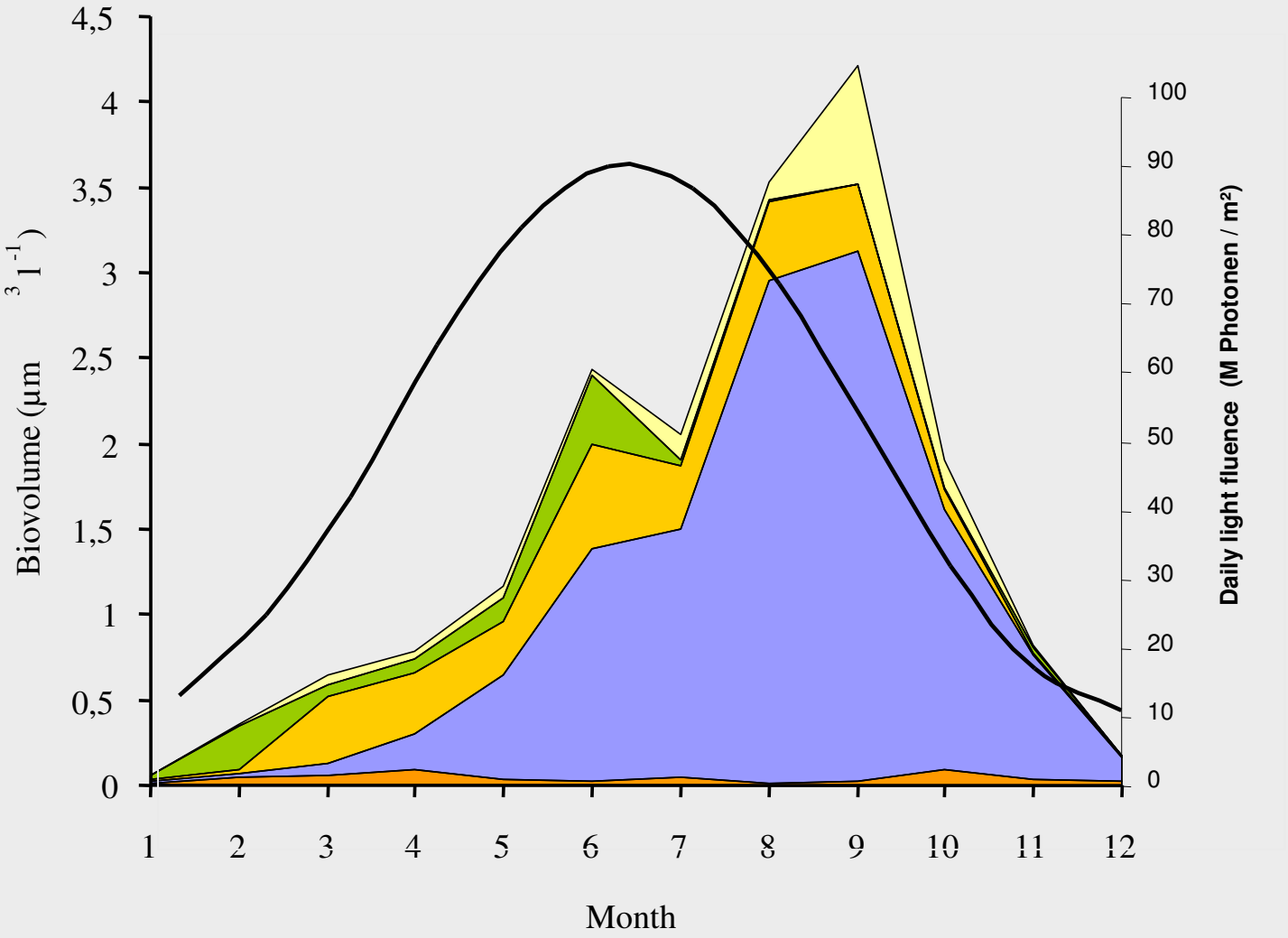




Seasonal variability - composition



Succession trigger



Seasonal variability - solutions

2 problems – 1 solution:

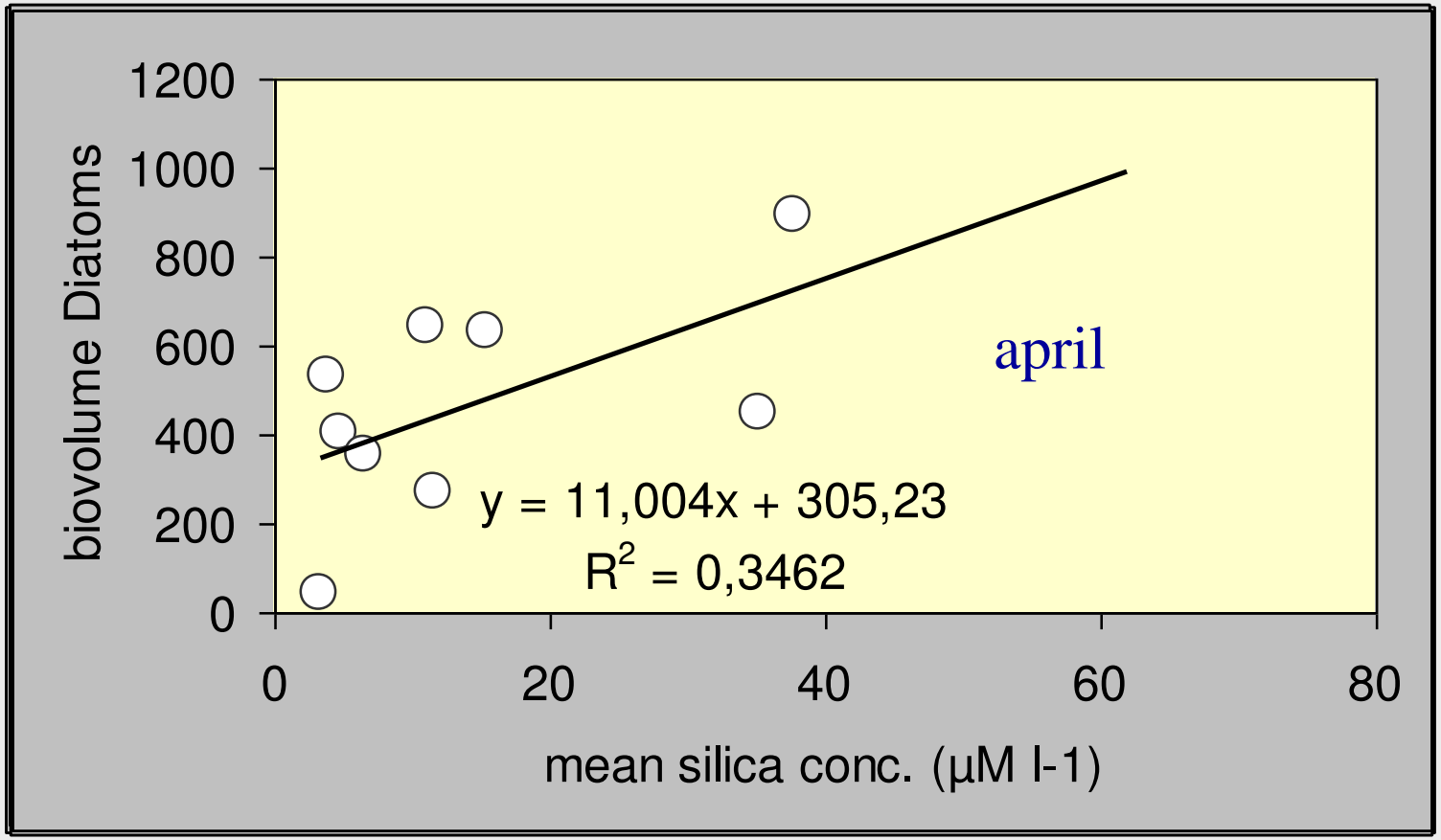
Eutrophication increases biomass (at least to a certain level)
– but biomass varies in an annual cycle as well

Eutrophication is believed to influence species composition
– which changes also in annual cycles

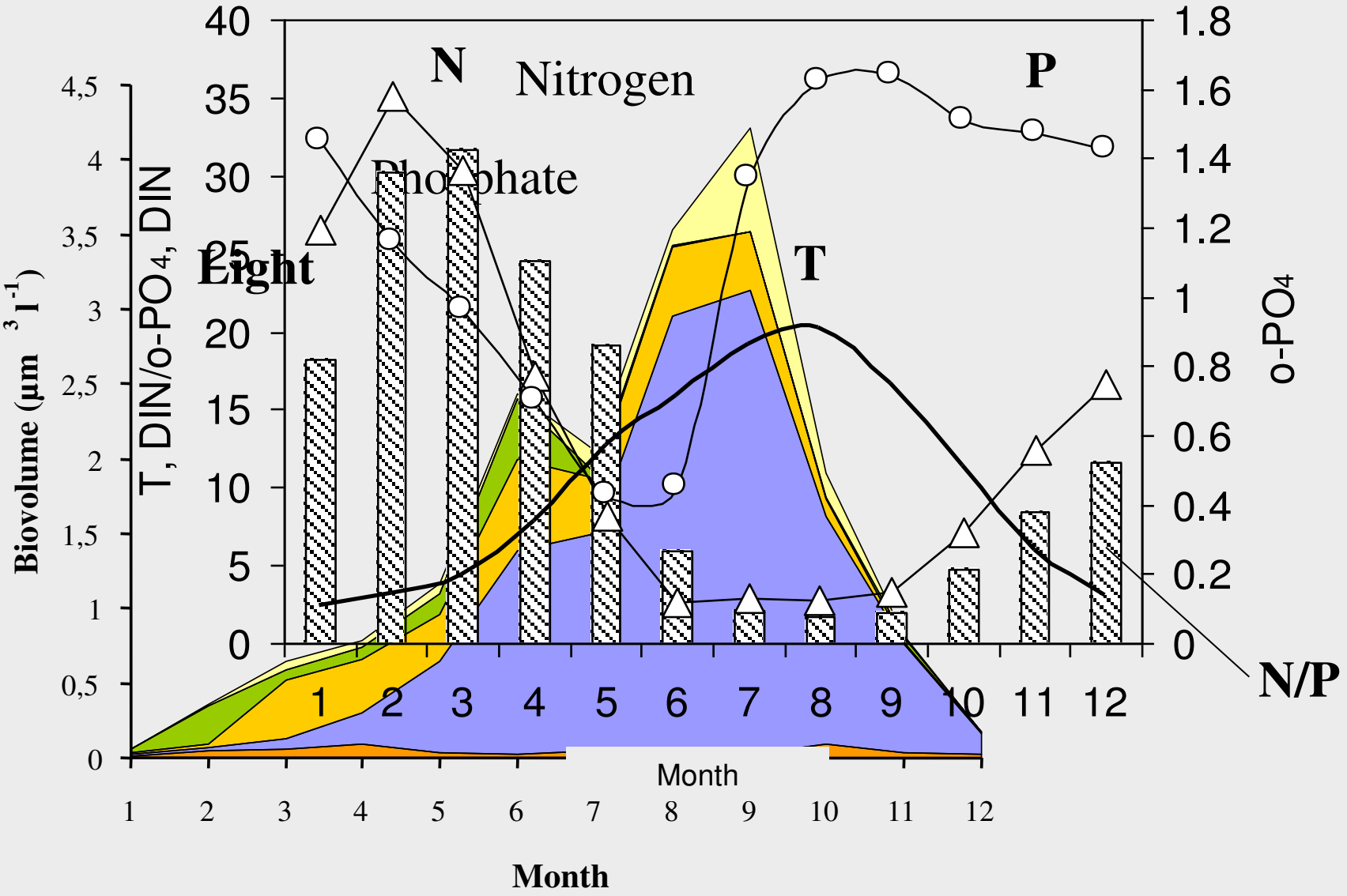
Regarding the fact, that phytoplankton is responding very fast,
„indicative periods“
(i.e. periods, in which the factor targeting on is the „master“ one)
must be identified

Time frames

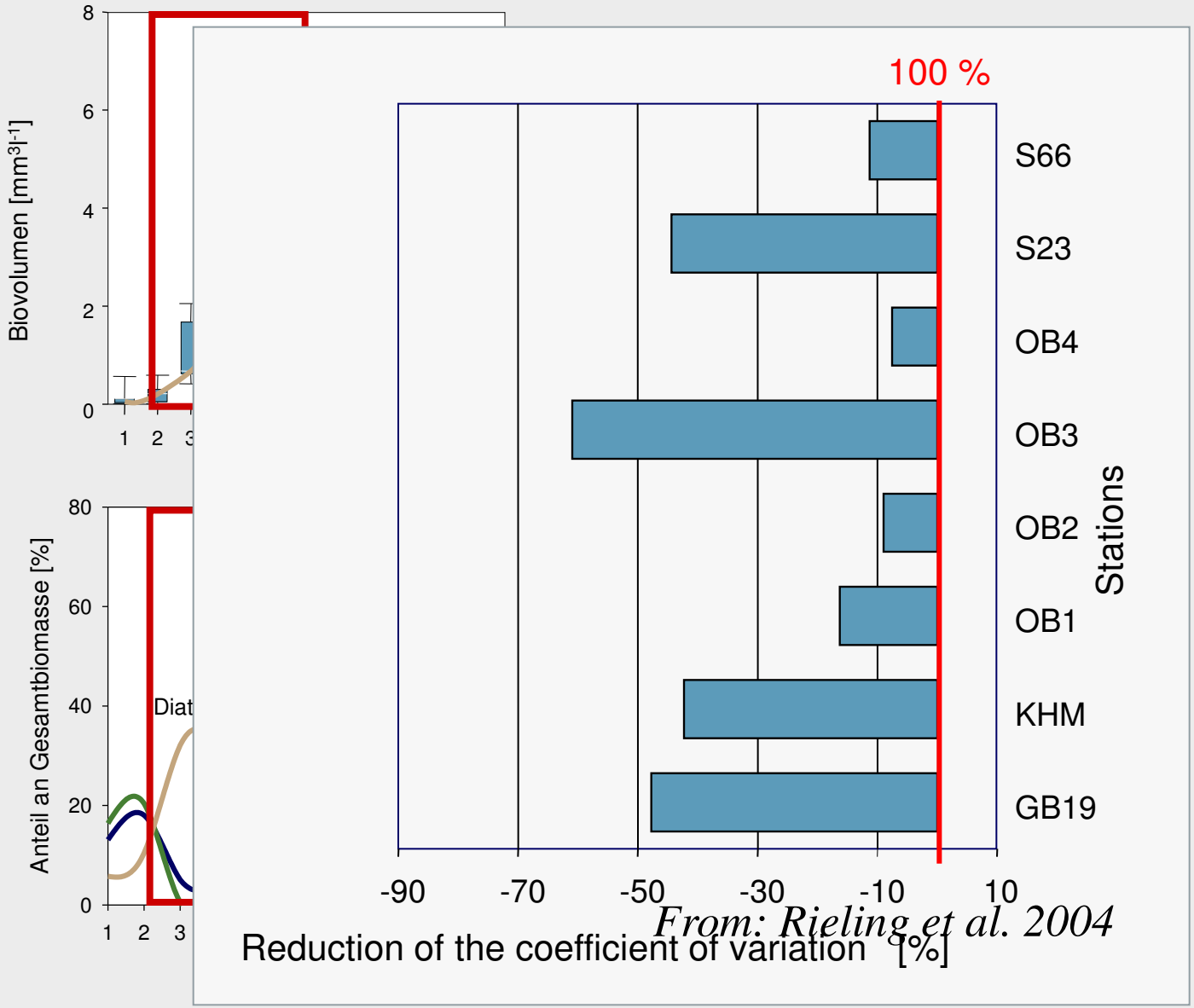
Example: silica vs. diatom biomass, data from 10 stations, 1989-1999



Example: Strelasund / Kubitzer Bodden



Time frames II



From: Rieling et al. 2004

Greifswald Bodden

Identification of the indicative parameter(s?)

Potential indicators – triggering and responding ones

- total Phosphorous
- Total nitrogen
- Chlorophyll a
- Secchi-depth

Corr.

PCA

Corr.

“Synthetic degradation index”

ca. 300 parameters

- Biovolume-species
- Biovolume higher tax. groups
- Biovolume morphological groups
- Biovolume functional groups (r-/K-selected, N-fixation)
- Percentage BM selected groups
- Diversity (several indices)

“Synthetic degradation index” / PCA

Principal component analysis: by means of TN, TP, Secchi-Tiefe, Chl a

No.	Eigenvalue	Individual Percent	Cumulative Percent	Scree Plot
F1	2,716	68	68	||||||||||||
F2	0,649	16	84	||||
F3	0,365	9	93	||
F4	0,267	7	100	||

Variables	F 1	F 2	F 3	F 4	Communality
Chl a	0,651	0,348	0,000	0,000	1,000
Secchi	0,290	0,005	0,004	0,699	1,000
TP	0,561	0,004	0,432	0,000	1,000
TN	0,953	0,046	0,000	0,000	1,000

Correlation analysis (Spearman rank): "Synthetic degradation index" *vs.* Phytoplankton-parameters

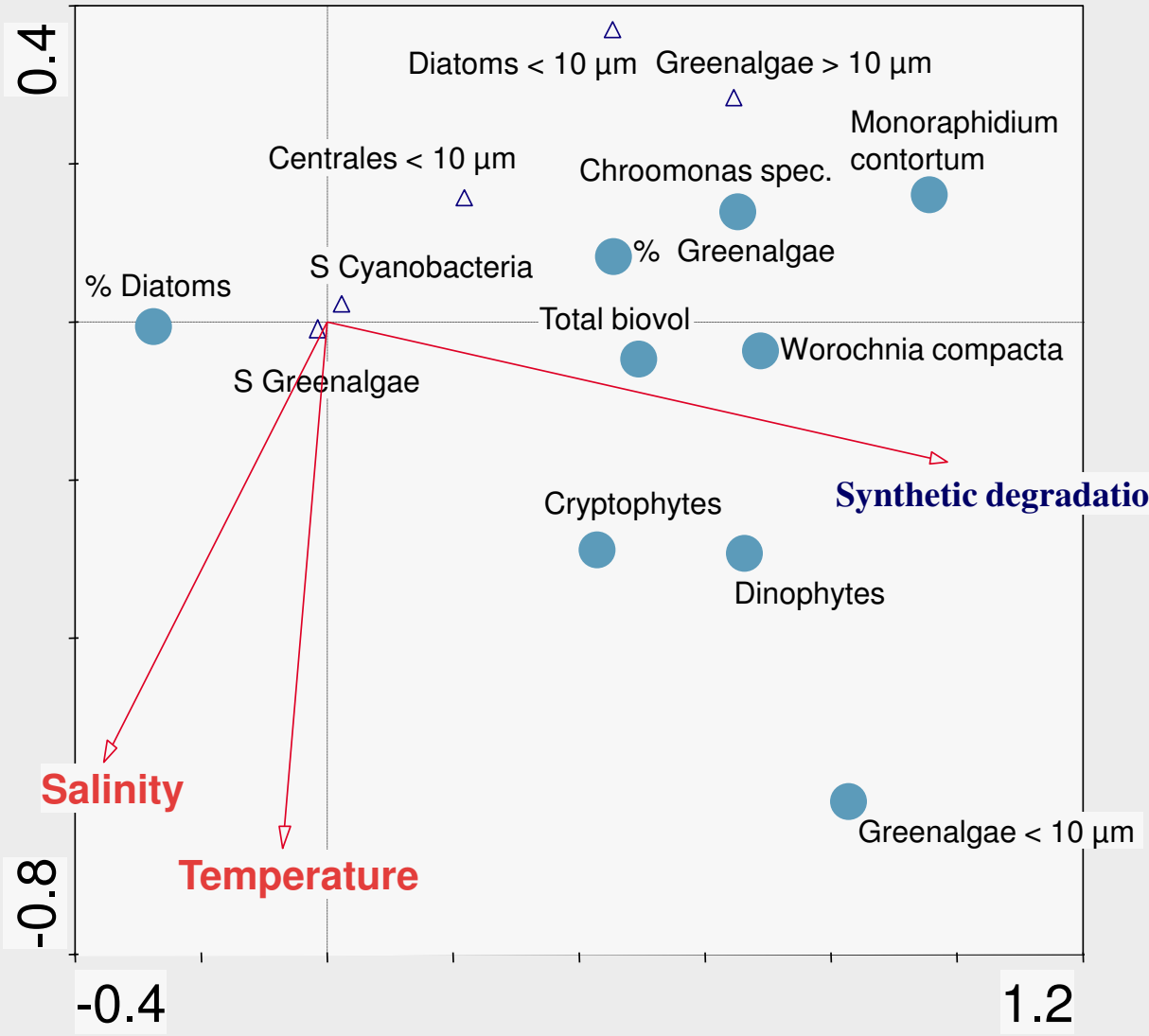
r	Parameter
-0,24	Percentage diatoms
0,26	BV Diatoms > 10 µm
0,26	BV Diatoms < 10 µm
0,26	BV Chlorophytes > 10 µm
0,28	Number of Cyanobacteria
0,30	Number of Chlorophytes
0,30	BV Dinophytes
0,34	*BV Monoraphidium contortum*
0,34	BV Cryptophytes
0,35	*BV Woronichinia compacta*
0,36	BV Chlorophytes < 10 µm
0,42	percentage Chlorophytes
0,44	BV *Chroomonas* spec.
0,75	Total biovolume

14 parameters were significantly correlated with the SDI

CCA

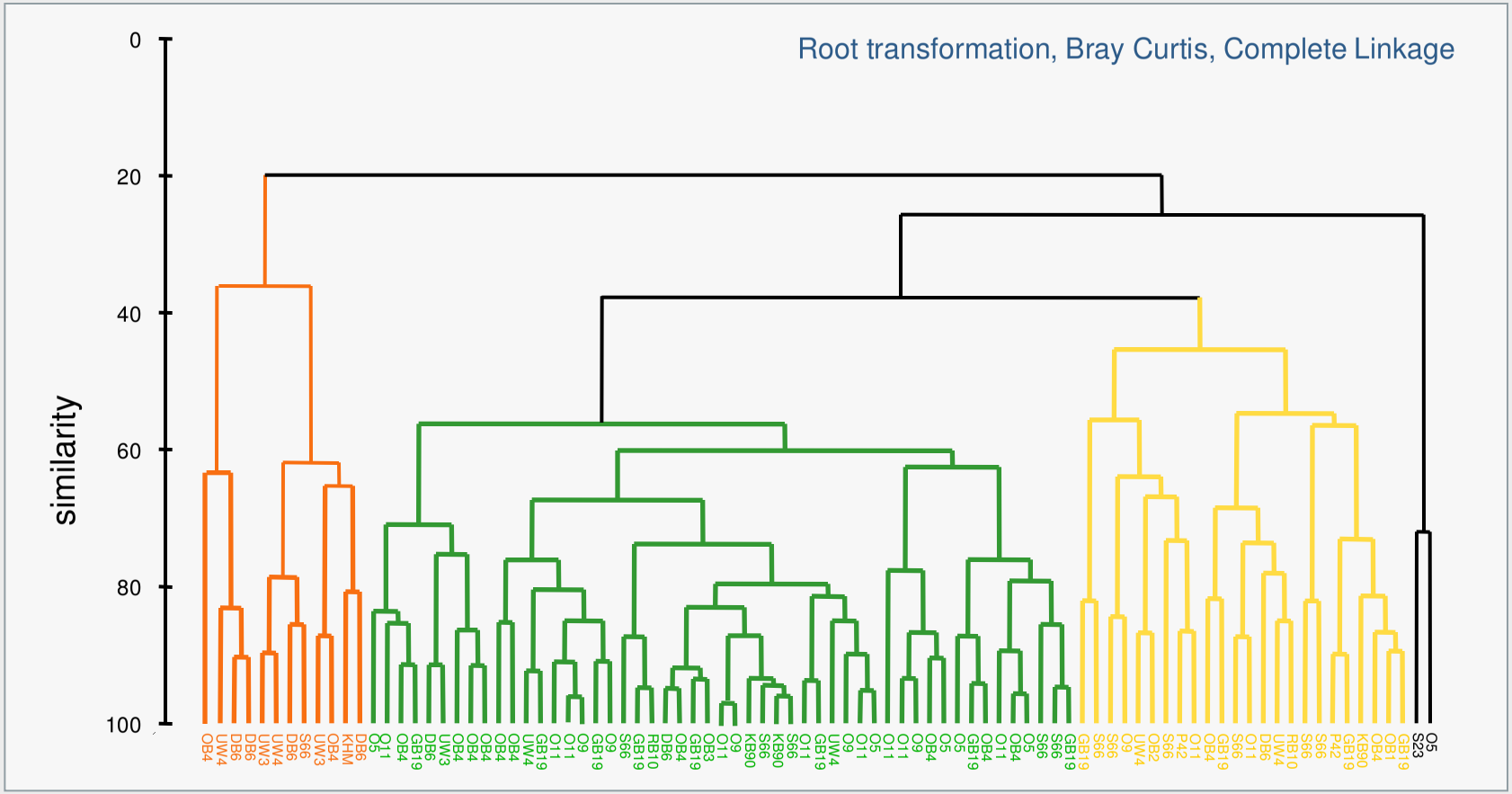
Test for their sensitivity to temperature and salinity

CCA test - results



Cluster analysis

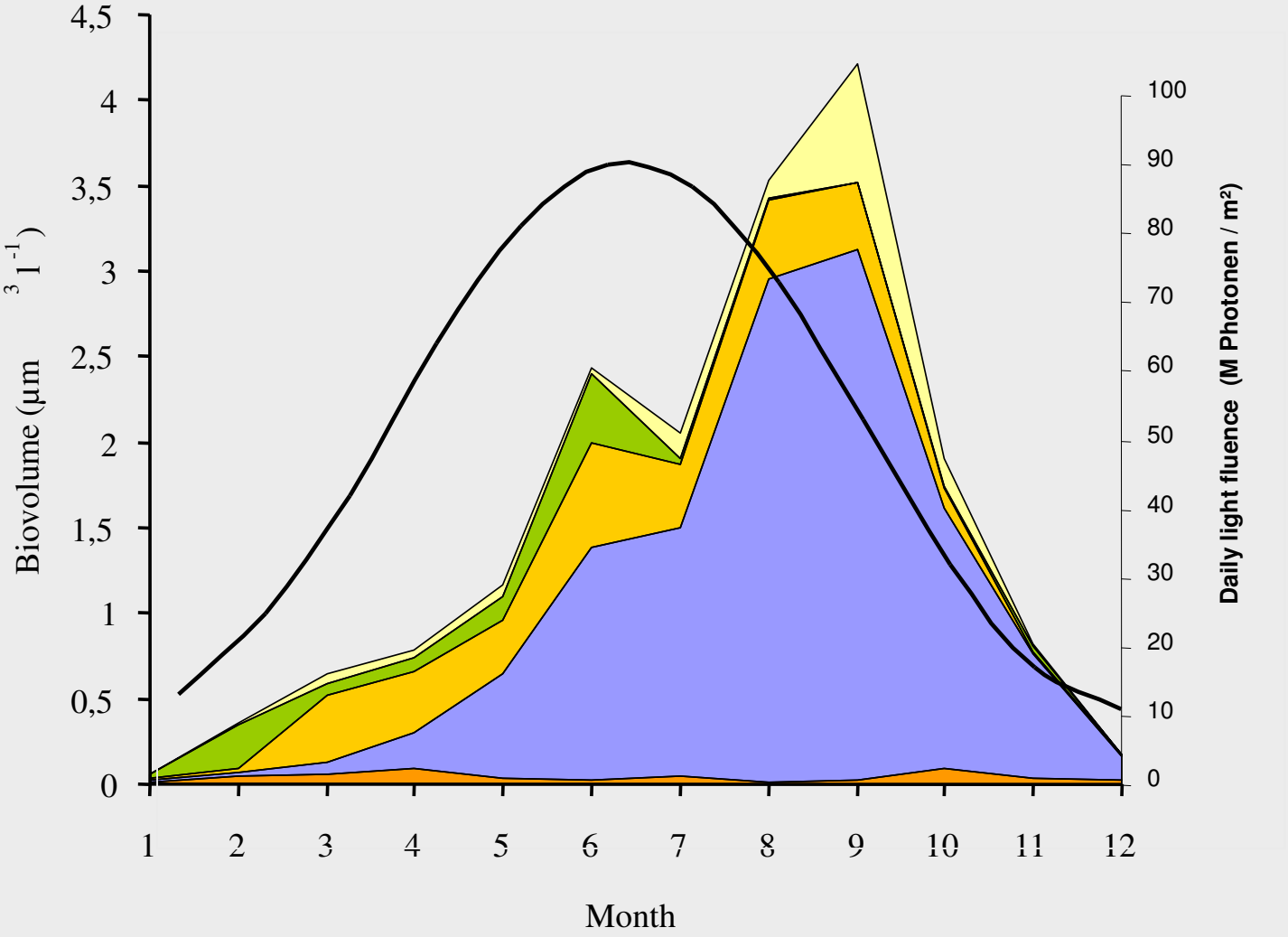
Cluster analysis, results



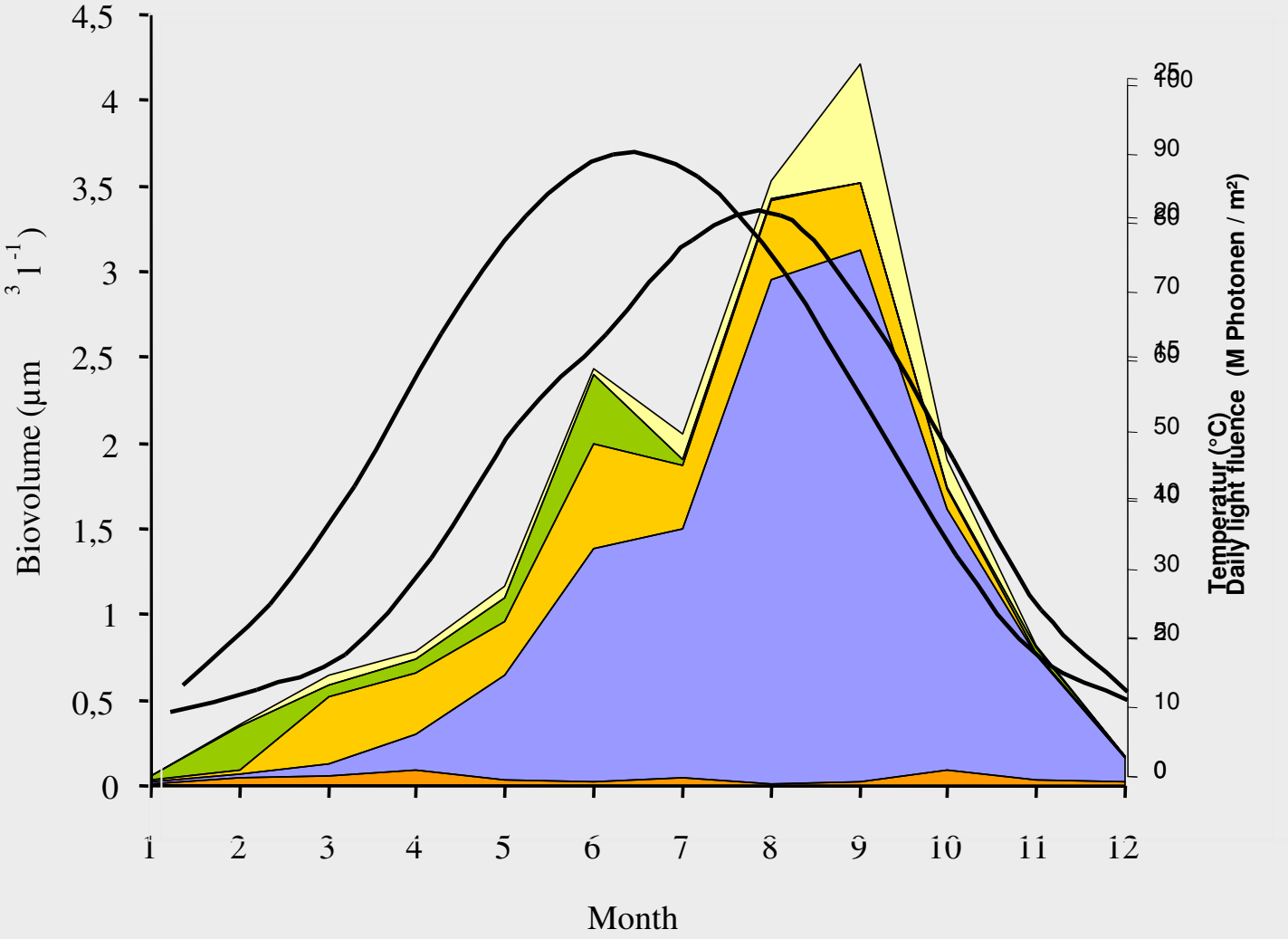
First attempt – 3 classes according to the three clusters found

	Ecological state group		
	I	**II**	**III**
Biomass [mm³ l⁻¹]	1-5	5-10	10-30
Chlorophytes [%]	5-10	10-30	30-60
Diatoms [%]	30-80	10-30	5-10
Dinoflagellates [%]	1-5	1-5	5-30
Chlorophytes <10µm [mm³ l⁻¹]	0,2-0,5	0,5-1	1-10
***Worochinia compacta* [mm³ l⁻¹]**	0,5-1	1-2	2-5
Secchi depth [m]	4-6	1,5-4	0,8-1,5
Chl a [µg l⁻¹]	10-20	20-50	50-120

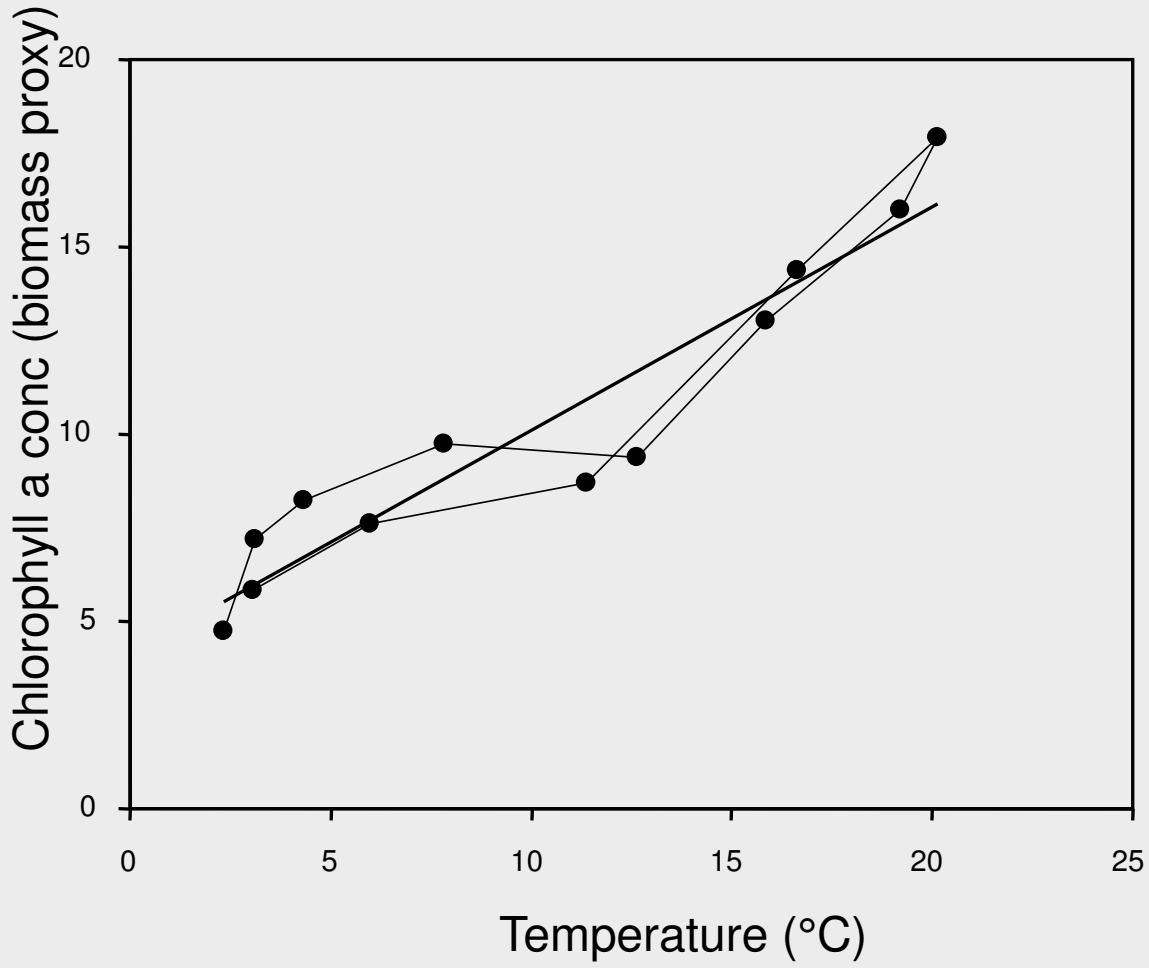
Succession trigger – light?



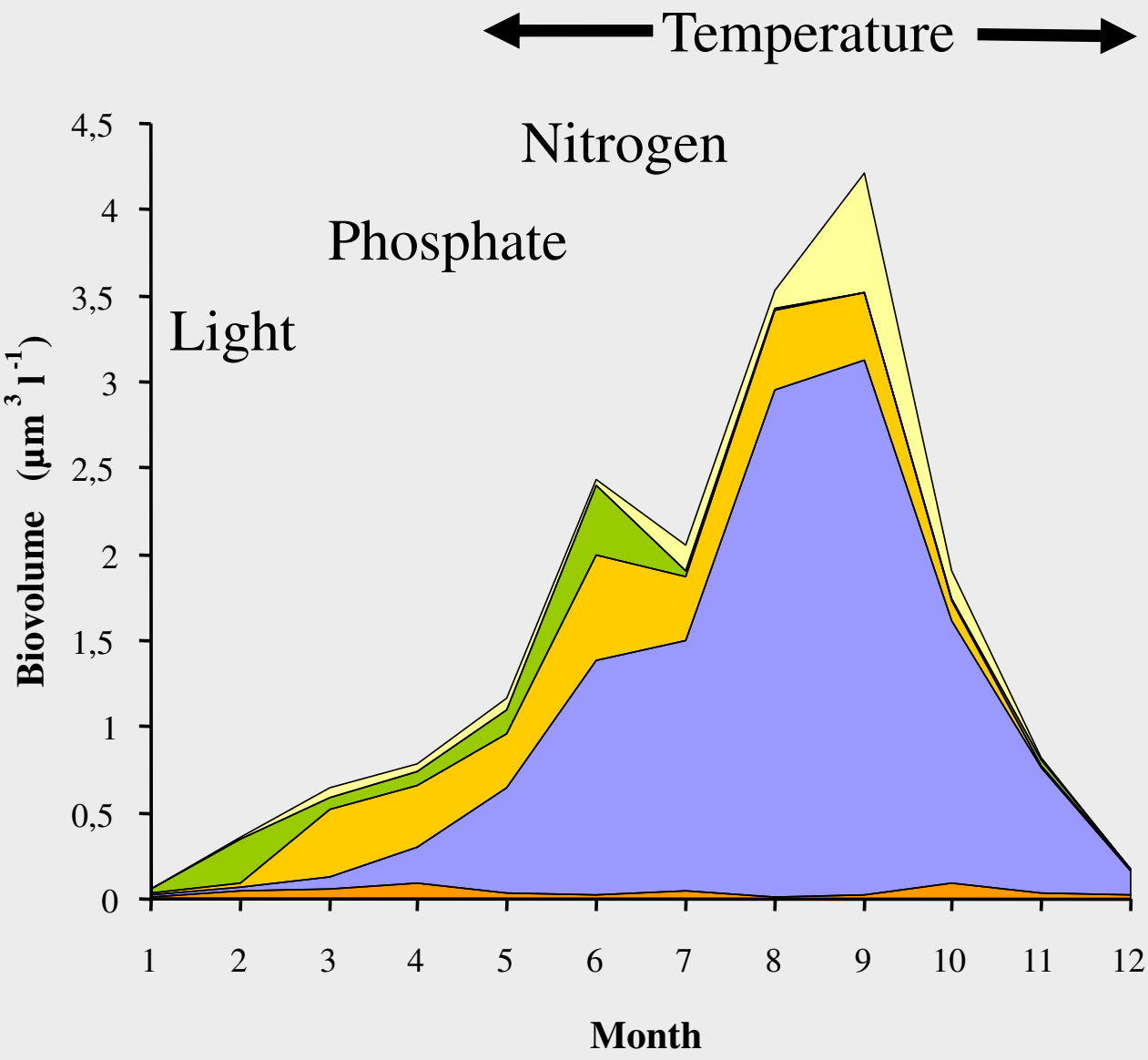
Succession trigger



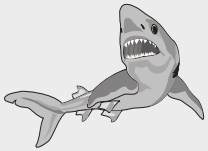
Temperature as trigger?

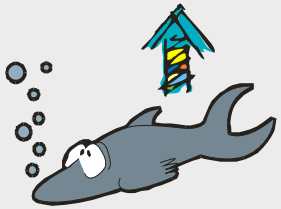


„Additional“ Blackman – limitation ?



Trophic interactions as possible trigger













Predators (plankt.)

Plankton-feeder

Zooplankton

Algal biomass



Energy

nutrients



Thank you for your attention!

Group I: „pristine“ / „very good “ ?

Cluster 1 similar to „pristine“ or can it be even better?

Pristine ecological status

?

I	II	III	
1-5	5-10	10-30	**Biovolume**
5-10	10-30	30-60	**Chlorophyctes**
30-80	10-30	5-10	**Diatoms**
1-5	1-5	5-30	**Dinoflagellates**
0,2-0,5	0,5-1	1-10	**Small Chlorophytes**
0,5-1	1-2	2-5	***Worochinia compacta***
4-6	1,5-4	0,8-1,5	**Secchi depth**
10-20	20-50	50-120	**Chl a**

?

5th class – worse than the 3rd class observed

reconstruction of secchi depth resulted in penetration depths around 7-8 m at ca. 1930, recent cluster 1 values were between 4-6 m

A „better“ ecological status can be postulated

Phytoplankton classification scheme (5-10 PSU)

Ecological state group

Parameter	I (very good)	II (good)	III	IV	V
Biomass [$mm^3\ l^{-1}$]	< 1	1-5	5-10	10-30	> 30
Chlorophytes [%]	< 5	5-10	10-30	30-60	> 60
Diatoms [%]	> 80	30-80	10-30	5-10	< 10
Dinoflagellates [%]	< 1	1-5	1-5	5-30	> 50
Chlorophytes <10µm [$mm^3\ l^{-1}$]	< 0,2	0,2-0,5	0,5-1	1-10	> 10
Worochinia compacta [$mm^3\ l^{-1}$]	< 0,5	0,5-1	1-2	2-5	> 5
Secchi depth [m]	> 5	3-5	1,5-3	0,8-1,5	< 1,5
Chl a [$\mu g\ l^{-1}$]	< 10	10-20	20-50	50-120	> 120

Weighting of the parameters for classification

The degree of correlation (SDI vs. parameter) determines the weighting factor for the respective factor

r	parameter	Weighting factor
0,75	Total biovolume	x 3
0,42	Percentage Chlorophytes (BV)	x 2
0,36	BV Chlorophytes < 10 µm	x 1,5
0,30	BV Dinophytes	x 1
-0,24	Percentage Diatoms (BV)	x 1
0,35	BV *Woronichinia compacta*	x 0,5