Rott E.

Strategies used for the development of the TI Austria and approaches to regional calibration

***Workshop* - LE DIATOMEE NEL BIOMONITORAGGIO DEI CORPI IDRICI FLUVIALI E LACUSTRI: STATO DELL'ARTE A TRE ANNI DALL'APPLICAZIONE DEL DM 260/2010 E PROSPETTIVE FUTURE**

Trento, 21 marzo 2014

PROVINCIA AUTONOMA DI TRENTO
Agenzia provinciale per la protezione dell'ambiente
Settore informazione e monitoraggi

Arbeitsgruppe Hydrobotanik
AGHB
Institut für Botanik
Universität Innsbruck

Content

- Part 1: General consideration / bioindicators
- Part 2: TI development for Austria
- Part 3: Beltrami‘s trial to reg.calibration of TI
- Part 4: Reference species approach Austria
- Part 4: Examples from Switzerland;
- Part 5: Future visions and conclusion

Part 1
Generalities to bioindicators

Biological Methods to Assess Water Quality

- Physiological methods
  = experimental - ecological methods

- Ecological methods
  = descriptive - analytic field methods

Ecological Methods = Bioindication

- Community of organisms reflects the situation of the ecosystem
- Single Taxa have specific optima and tolerance ranges for selected environmental factor

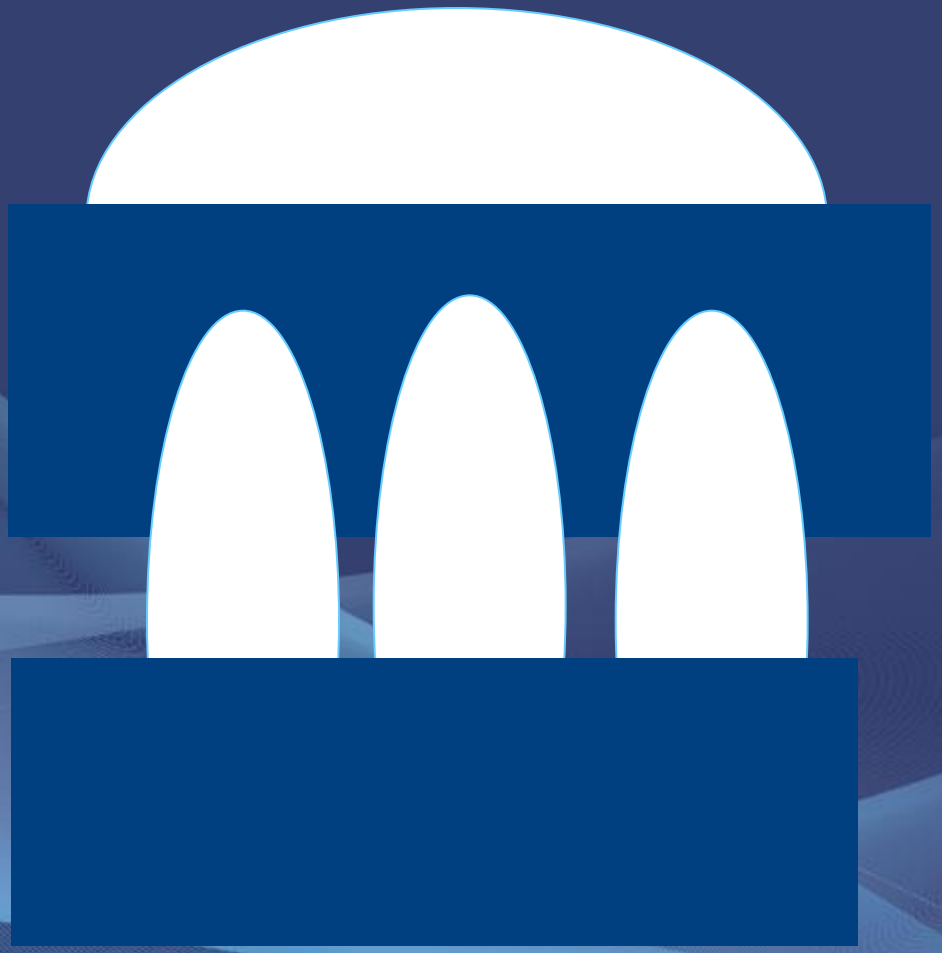
  = Bioindicators

Tolerance Range

- Euryoecious

- Stenoecious

= Indicator?!



Part 2:
TI for Austria

Key Cooperation partners TI

- Pipp Eveline IBK
- Pfister Peter Arge Limnologie IBK
- Van Dam Herman Aqua Sense, NL
- Binder Nico IBK

Primary assumptions for $TI_{Austria}$

- River algae only
- Species level mainly
- Environmental niche expressed in situ (related to numerical data)
- (A) All algae including diatoms primarily or (B) diatoms alone

AUSTRIA

- Stepwise Module approach
- Option for All algae method
- Option for separate Diatom method
- Aquatic mosses and Macrophytes combined biological quality element (rivers) but used as independent metric!

From Rott et al. 2003

Table 1. Diatom related methods for river quality analysis used in Austria

Method	Used since	Reference	Remark	Application
Saprobic System	1968	SLÁDEČEK (1973, 1981) WEGL (1983)	No diatom clean mounts, all algae and other organisms mixed	Austrian Water Quality mapping network (every 5 years)
Differentiating species groups	1984	LANGE-BERTALOT (1978, 1979)	Counts from cleaned mounts, diatoms only	First sporadically used, later all Austria water quality network
Species groups for ecological evaluation	1993	PIPP & ROTT (1993, 1994)	Counts from cleaned mounts, diatoms and other algae	Sporadically used, basis for new reference community approach for WFD
Trophic Indicative species groups	1995	PIPP (1997, 2001)	Counts from cleaned mounts, diatoms only	Used in Upper Austria mainly
Saprobic Index	1999	ROTT et. al. (1997)	Counts from cleaned mounts, diatoms and other algae	Used for water quality network since 1999
Trophic Index	1999	ROTT et. al. (1999)	Counts from cleaned mounts, diatoms and other algae	Used partly for eutrophication studies in network
Nitrogen based trophic Index	1999	ROTT et.al. (1999)	Counts from cleaned mounts, diatoms and other algae	Sporadically used

Pfister P. & E. Pipp (2013): Phytobenthos Austria: In English

Main recent activities Austria

PIPP, E. & E.ROTT 1993	140 sites, reference species groups
ROTT, E., HOFMANN, G., PALL, K., PFISTER, P. & E.PIPP 1997	450 sites, Saprobic Indication/ BOD, TP
ROTT, E., PIPP, E., PFISTER, P., VAN DAM, H., ORTLER, K., BINDER, N. & K. PALL 1999	700 sites, Trophic Indications/ TP, TN
PFISTER, P. & E. PIPP 2006 and 2013 (in English)	1800 sites (2250 datasets), Assessment of ecological status (based on Trophic Indication, Saprobic Indication and Reference Species metric)

Benthic algae approaches in rivers in Austria comprise EQR based on

1. Trophic indication according to Rott et al. 1999; Rott et al. 2003, Algol.Stud.110
2. Saprobic indication system according to Rott et al. 1997
3. RI Reference species Index/ community approach by Pfister/ Pipp 2006, 2013 resp.

From: Rott et al. 2003 Algol. Studies 110: 91-115.

Table 4: Formulas for calculation of saprobic and trophic indices based on diatoms and actually used in Austria (concept follows ZELINKA & MARVAN 1961)

Saprobic water quality	Trophic index (TP-based)	Trophic index (N-based)
$SI_{DIA} = \frac{\sum_{i=1}^{n} S_i G_i H_i}{\sum_{i=1}^{n} G_i H_i}$	$TI_{DIA} = \frac{\sum_{i=1}^{n} TW_i G_i H_i}{\sum_{i=1}^{n} G_i H_i}$	$TIN_{DIA} = \frac{\sum_{i=1}^{n} NZ_i G_i H_i}{\sum_{i=1}^{n} G_i H_i}$

G_i	Indicative Weight Number of species i (ranging from 0 – indifferent taxon to 5 – very good indicator)	SI_{DIA}	Saprobic Index of sample
		TI_{DIA}	Trophic Index of sample
		TIN_{DIA}	Trophic Index (N-based) of sample (sample classification according to TIN_{DIA} and portion of ammonia indicators in Table 7)
Hi	abundance of species i – relative counts %		
n	number of species		
NZ_i	Nitrogen Number of species i		
S_i	Saprobic Number of species i		
		TW_i	Trophic Number of species i

Table 5: Classification scheme for saprobic status assessment of samples acc. to ROTT et al. 1997 (BOD_5 ranks according to HAMM 1969, except for best class)

Saprobic index	Saprobic water quality class	BOD_5
≤ 1.3	**oligosaprobic**	≤ 1
1.4–1.7	oligo- to betamesosaprobic	1–2
1.8–2.1	**betamesosaprobic**	2–4
2.2–2.5	beta- to alphamesosaprobic	4–7
2.6–3.0	**alphamesosaprobic**	7–13
3.1–3.4	alphamesosaprobic to polysaprobic	13–22
≥ 3.5	**polysaprobic**	> 22

Environmental variables targeted for TI

- **TP** (acid-treated, non filtrated)
- **NO_3**
- **NH_4**
- pH
- Conductivity
- Cl
- SO_4

Abbildung 16: Gesamtverteilung der Variablen als Grundlage für die ökologischen Profile (Einheiten siehe Abb. 17. Der Pfeil zeigt den Medium-Wert an).

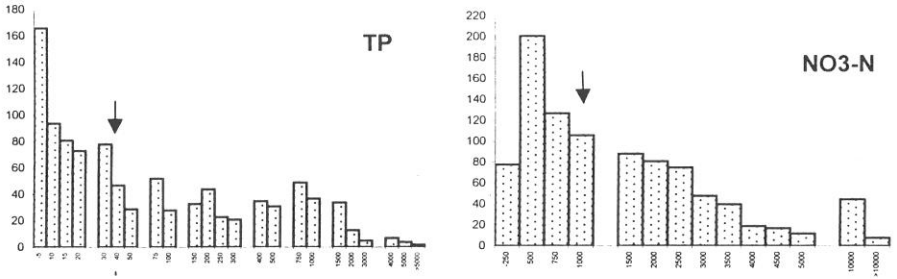


Abbildung 21: Ökologisches Profil *Fragilaria arcus* (Werte siehe Text zu Abb. 17).

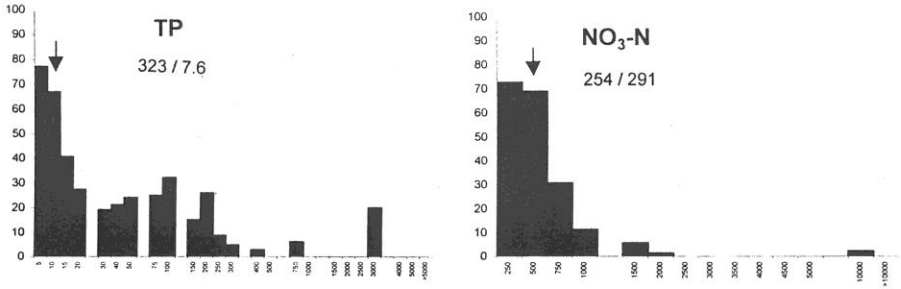


Abbildung 23: Ökologisches Profil *Navicula gregaria* (Werte siehe Text zu Abb. 17).

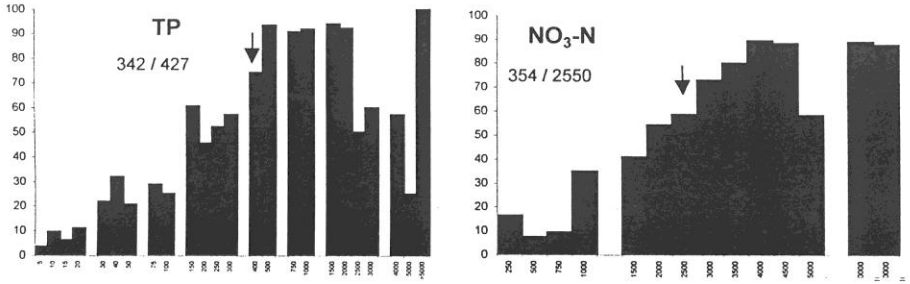
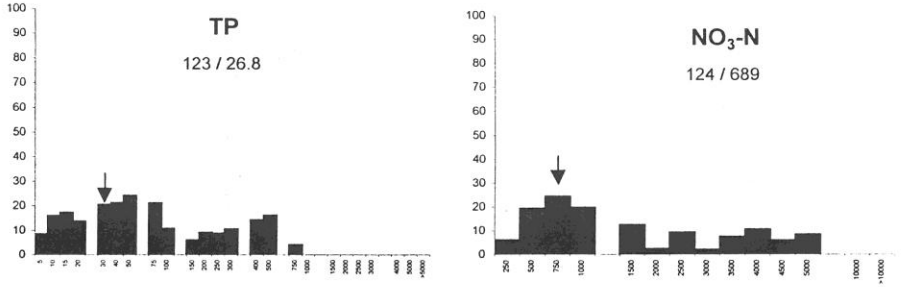


Abbildung 26: Ökologisches Profil *Nitzschia pura* (Werte siehe Text zu Abb. 17).



The dataset Austria from Binder (2001)

3 examples following

Abbildung 21: Ökologisches Profil *Fragilaria arcus* (Werte siehe Text zu Abb. 17).

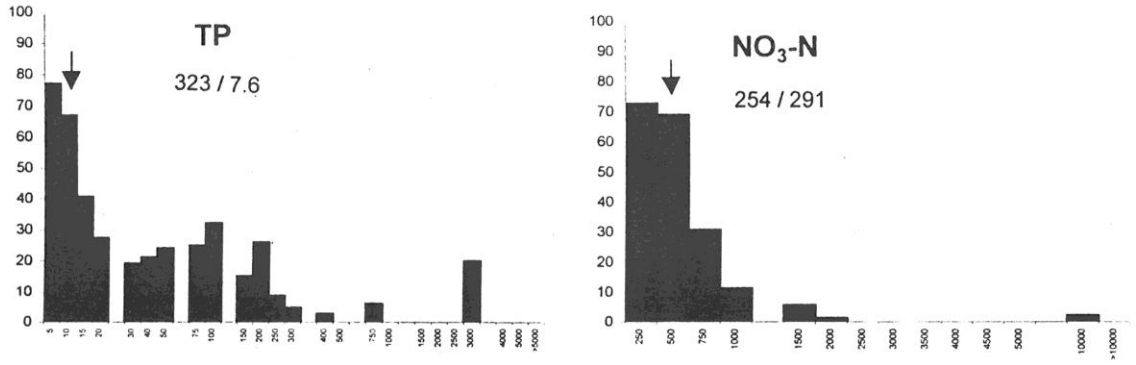


Abbildung 23: Ökologisches Profil *Navicula gregaria* (Werte siehe Text zu Abb. 17).

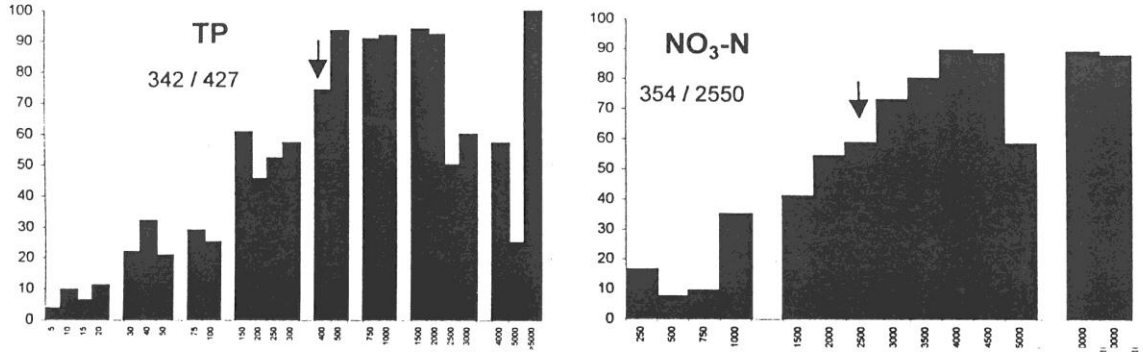
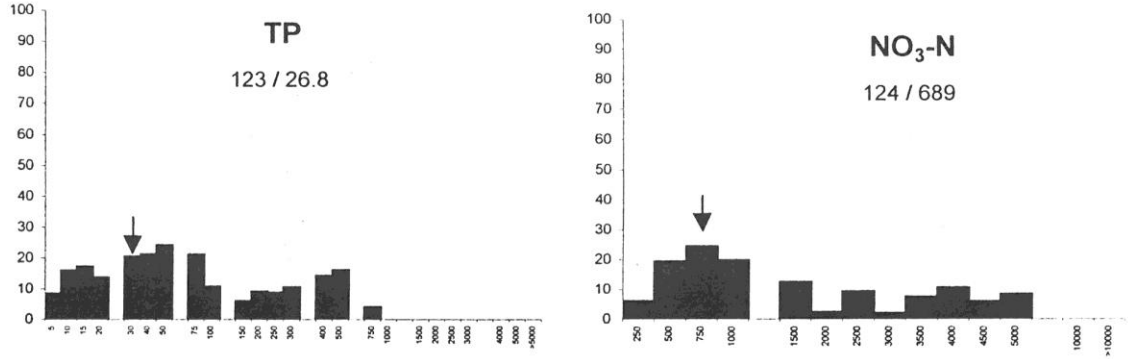


Abbildung 26: Ökologisches Profil *Nitzschia pura* (Werte siehe Text zu Abb. 17).



Three examples from Austria (Binder 2001)

Oligotrophentic

Hypertraphentic

Mesotraphentic

- Weighted average (from Binder 2001)

$$\ln Opt_{k,x} = \frac{\sum_{i=1}^{s} \ln x_i * a_{k,i}}{\sum_{i=1}^{s} a_{k,i}}$$

k.....Taxon

x_i.....Werte der Umweltvariable in Probe i

i.....Probe

s .....Gesamtanzahl der Proben für die Kombination aus Art und Umweltvariable

a .....Abundanz

ln $Opt_{k,x}$ .....Logarithmiertes gewichtetes Mittel als theoretischer Wert für das Optimum der Art k bezüglich der Variablen x.

An Indicator taxon has preferences / a niche

- Statistical models for niche : median, ln transformed data / preference spectra – frequency plots
- 20 points over whole range / range classes set from environmental data spectrum +/- deshrinking (data based)
- Additional empirical settings
- Indicating weight is related to niche extension

Tabelle A2: Präferenzspektren von 320 in der Datenbank enthaltenen Arten für NH_4-N mit n>1 (uot = ultraoligotraphent, ot = oligotraphent, omt = oligo-mesotraphent, mt = mesotraphent, met = meso-eutraphent, et = eutraphent, ept = eu-polytraphent, pt = polytraphent, TW = Trophiewert, G = Indikationsgewichtung, Gmittel = gewichtetes Mittel, n = Häufigkeit der Art für NH_4-N).

Art	uot	ot	omt	mt	met	et	ept	pt	TW	Wicht	Gmittel	Median	n
Cyanophyceae: Chroococcales													
Chamaesiphon confervicolus	2.3	3.1	1.9	1	0.7	0.8	0.3		1.1	3	12.2	13	136
Chamaesiphon fuscus	3.5	2.3	1.7	0.9	0.6	0.5	0.4		0.9	3	7.5	10	108
Chamaesiphon geitleri	2.3	2.9	2.8	1	0.5	0.2	0.3		0.9	2	9.3	10	70
Chamaesiphon incrustans	1.1	1.9	1.5	1.4	1.5	1.4	1	0.3	1.7	0	31.7	28	346
Chamaesiphon investiens	2.6	2.2	2.1	1.4	0.9	0.8			1	2	11.3	14	98
Chamaesiphon investiens var.roseus	5.2	3.8		1					0.4	5	5.7	7	5
Chamaesiphon minutus	1.9	4.1	3.2	0.8					0.7	4	7.9	10	24
Chamaesiphon niger	5	2.8		2.1					0.5	4	8.0	5	6
Chamaesiphon oncobyrsoides	1.5	2.4	1.7	1.1	0.6	1.3	1.2	0.2	1.5	1	24.1	17	82
Chamaesiphon polonicus	3.1	2.3	1.4	1.1	0.7	1	0.5	0.1	1.1	3	12.1	18	309
Heribaudiella fluviatilis													
Diatomophyceae													
Achnanthes biasolettiana	2.5	1	2.4	1.9	1.1	0.9	0.2	0	1.2	0	15.2	29	346
Achnanthes bioretii	2.1	0.5	2	1	1.9	0.8	1.7	0.1	1.7	0	30.4	20	25
Achnanthes clevei	0.6			0.9	3.7	2	2.9		2.6	0	79.3	62.16	7
Achnanthes conspicua	0.2	0.5	0.2	0.2		3	4.5	1.4	3	4	338.4	30	17
Achnanthes daui		2.4	1.7	4.3		1.6			1.5	4	34.2	30	7
Achnanthes exilis	3.5	4.3	0.5	0.3	0.3	0.2	0.9		0.8	4	10.7	8	13
Achnanthes flexella	6		4						0.5	0	5.3	2	7
Achnanthes helvetica	1.7	0.6	0.6	0.3	6.7	0.1			1.7	5	28.5	5.7	28
Achnanthes laevis	5					5			1.4	0	21.5	3	7
Achnanthes lanceolata	0.2	0.6	0.5	0.5	1.2	1.4	2	3.5	2.9	3	330.2	207	314
Achnanthes lanceolata ssp.frequentissima	0.4	2.1	1	1.8	0.5	1.7	1.2	1.2	2	0	66.2	30.7	16
Achnanthes lanceolata ssp.frequentissima var.rostratiformis				2.8		3.9	3.4		2.8	4	127.1	155	5
Achnanthes lapidosa	2.1	3.6	3.9	0.1	0.3				0.7	4	8.4	14	5
Achnanthes lauenburgiana							10		3.4	5	668.6	850	3
Achnanthes marginulata	1.1		0.3	2.8	4.2		1.7		2.1	4	39.3	20.3	11
Achnanthes minuscula			5.2	1.3	1.1	2.1		0.3	1.8	4	33.2	60	6
Achnanthes minutissima	2.5	1.9	1.6	1.4	1	0.9	0.5	0.1	1.2	1	15.5	28	715
Achnanthes minutissima var.affinis				10					1.7	5	32.7	33	3

Preference spectra of indicators for TP along 8 trophic classes (from Binder 2001 mod. from Rott et al. 1999)

Table 6: Verbal classification scheme for TP-based trophic status assessment of samples and corresponding TP ranges (acc. to ROTT et al. 1999)

Trophic Index	Trophic level	TP [µg l^{-1}] annual mean	TP [µg l^{-1}] annual max.
≤ 1.0	**ultraoligotrophic**	< 5	< 10
1.1–1.3	**oligotrophic**	< 10	< 20
1.4–1.5	oligo – mesotrophic	10–20	< 50
1.6–1.8	**mesotrophic**	< 30	< 100
1.9–2.2	meso – eutrophic	30–50	< 150
2.3–2.6	**eutrophic**	30–100	< 250
2.7–3.1	eu- polytrophic	> 100	< 250
3.2–3.4	**polytrophic**	250–650	> 650
> 3.4	poly – hypertrophic	> 650	> 650

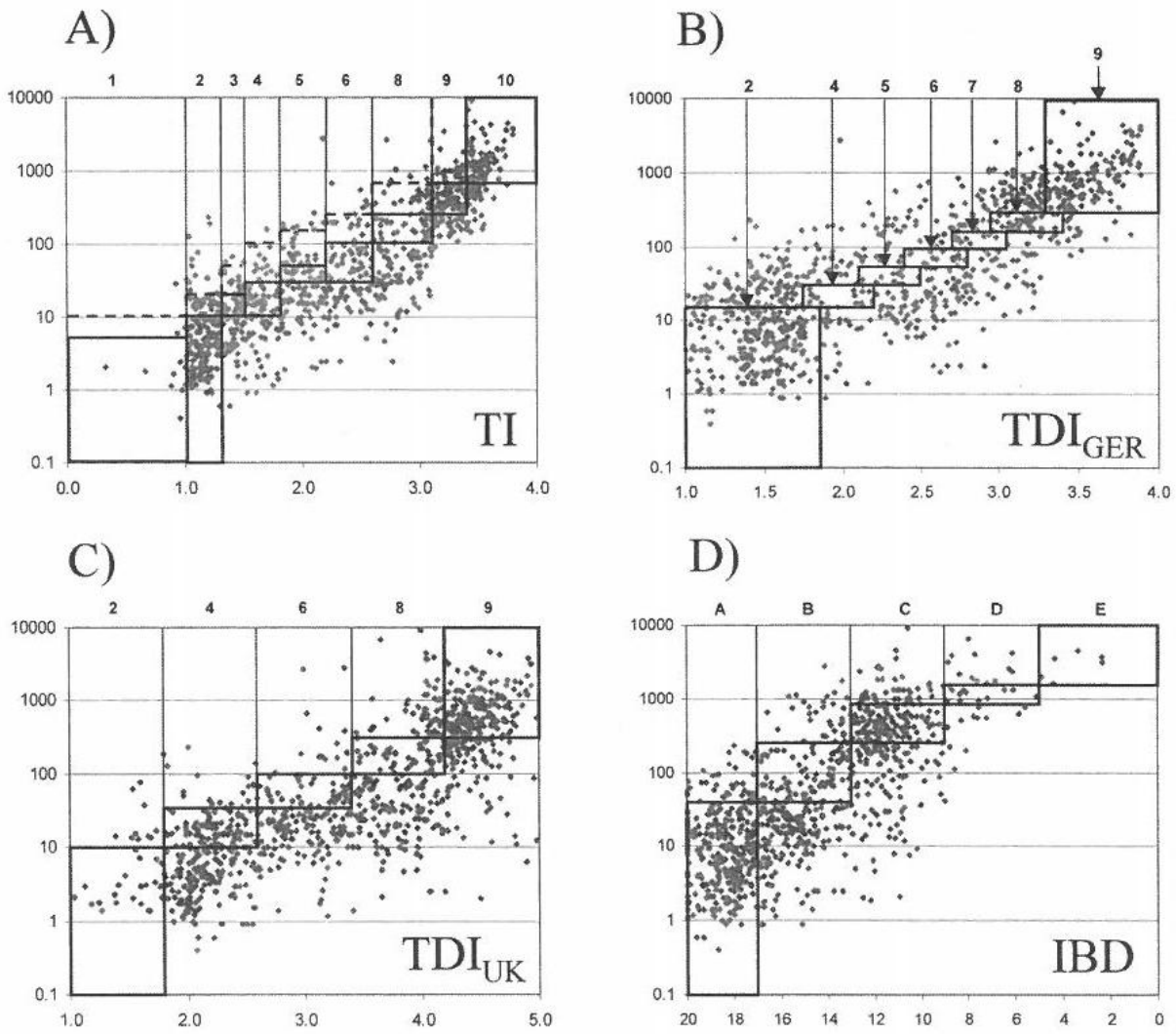
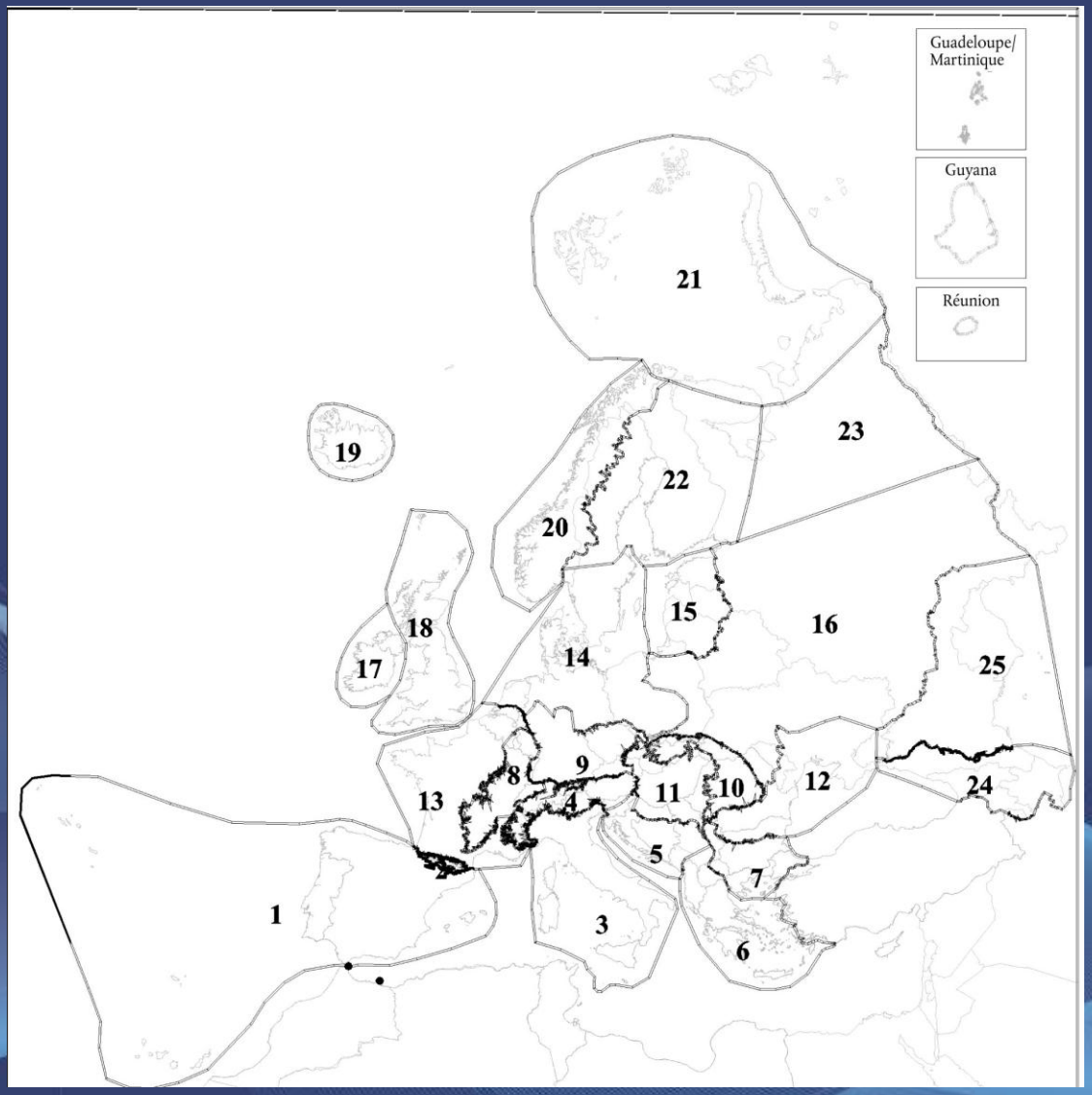


Fig. 2. Scatter plot of TP [µg.l^{-1}] and trophic indices obtained by application of methods from **A** – Austria (r=0.85), **B** – Germany (r=0.81), **C** – U.K. (r=0.78) and **D** – France (r=0.75) to the Austrian dataset (n=970); for explanation of trophic levels 1–10 (in A–C) and water quality classes A–E (in D) see Table 13 and of dashed lines in (A) showing annual maxima see Table 6

Key Trophic Indication methods applied to Austrian Site diatom data (From Rott et al. 2003)

Part 3
Regional calibration example

What the WFD means with Ecoregions

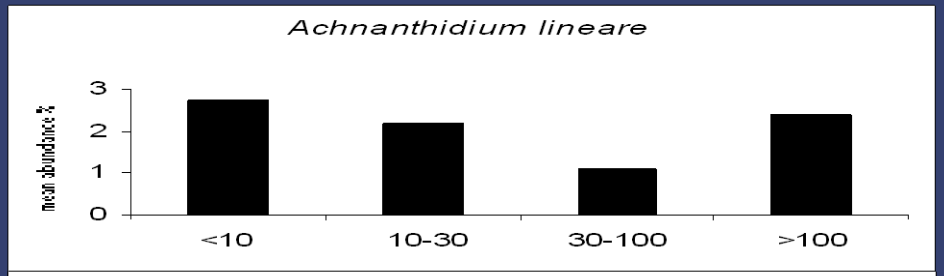


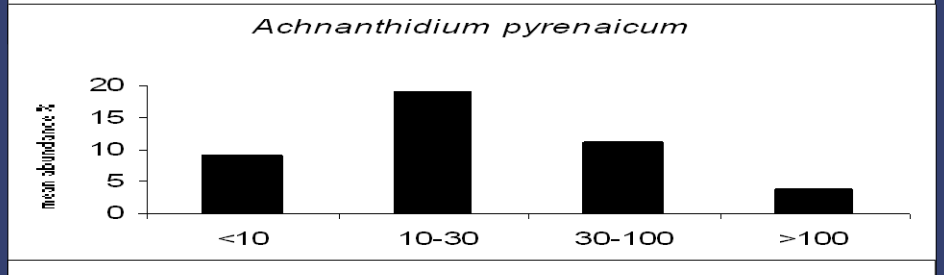
Aus: Amtsblatt der Eur.Gem. 2000 L 327/71

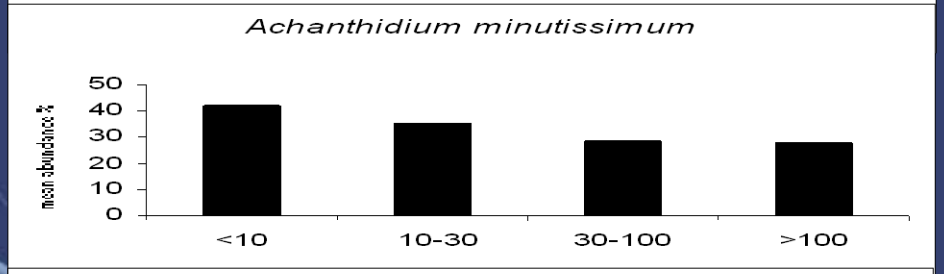
From: Beltrami (2010)

General trial for a local calibration of diatom species in relation to TP (River Adige catchment)

Examples on following 3 pages


Achnanthidium lineare
mean abundance %
3
2
1
0
<10
10-30
30-100
>100


Achnanthidium pyrenaicum
mean abundance %
20
15
10
5
0
<10
10-30
30-100
>100


Achanthidium minutissimum
mean abundance %
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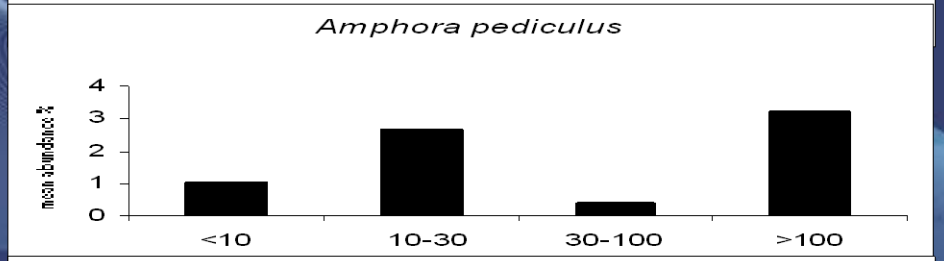
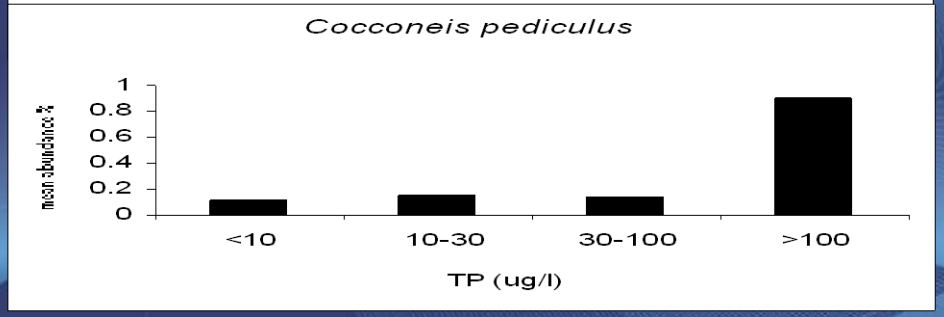
40
30
20
10
0
<10
10-30
30-100
>100


Amphora pediculus
mean abundance %
4
3
2
1
0
<10
10-30
30-100
>100


Cocconeis pediculus
mean abundance %
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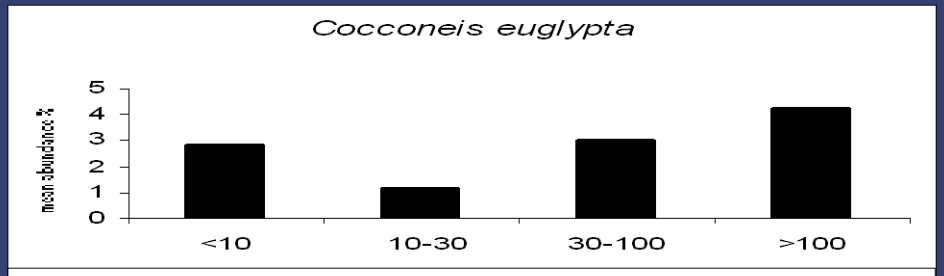
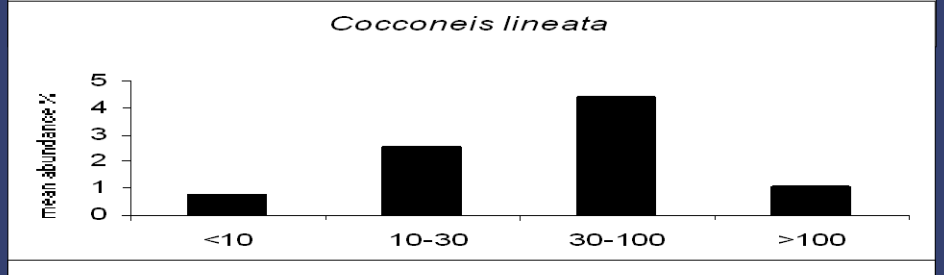
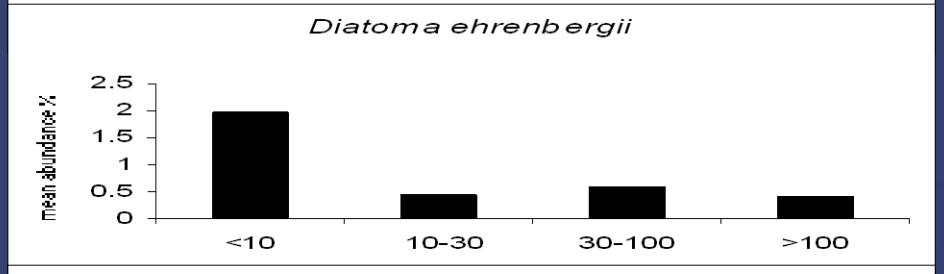
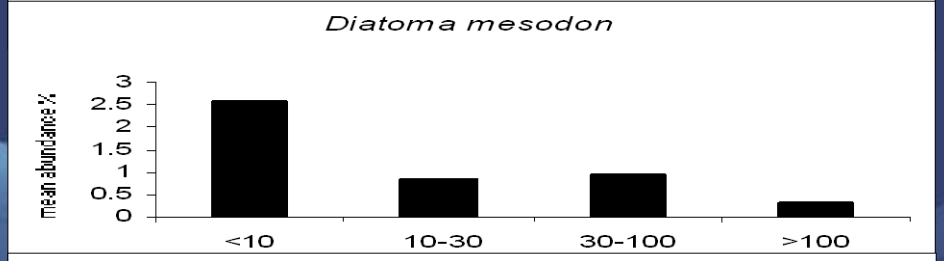
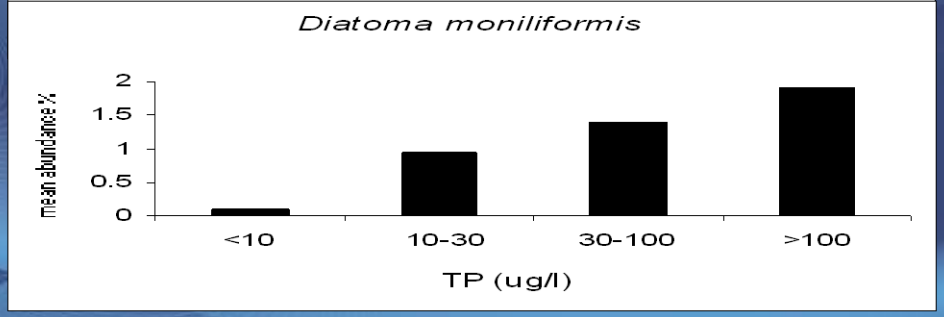
0.8
0.6
0.4
0.2
0
<10
10-30
30-100
>100
TP (ug/l)

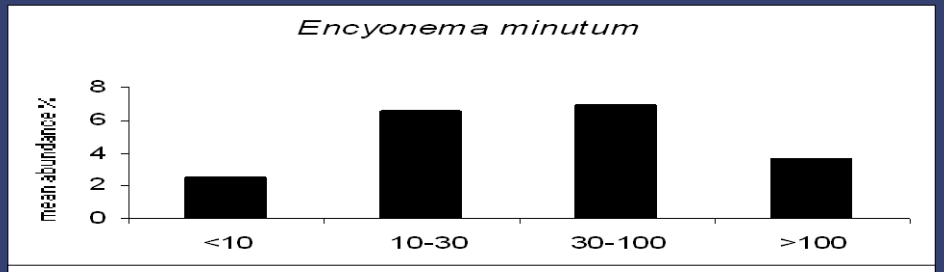

Cocconeis euglypta
mean abundance %
5
4
3
2
1
0
<10
10-30
30-100
>100

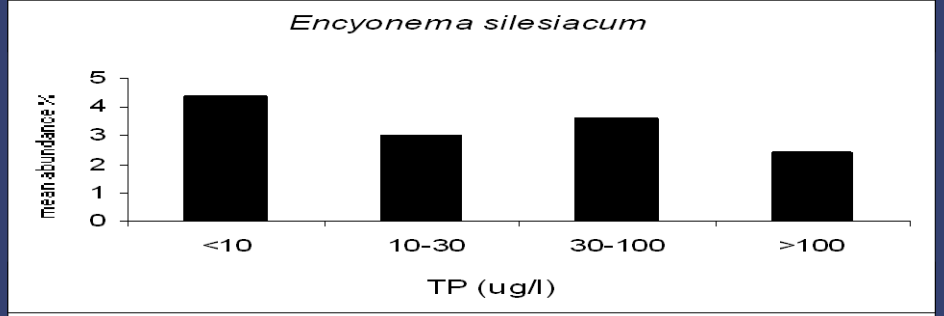

Cocconeis lineata
mean abundance %
5
4
3
2
1
0
<10
10-30
30-100
>100

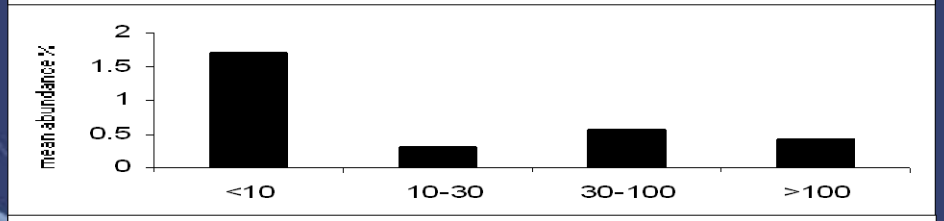

Diatoma ehrenbergii
mean abundance %
2.5
2
1.5
1
0.5
0
<10
10-30
30-100
>100

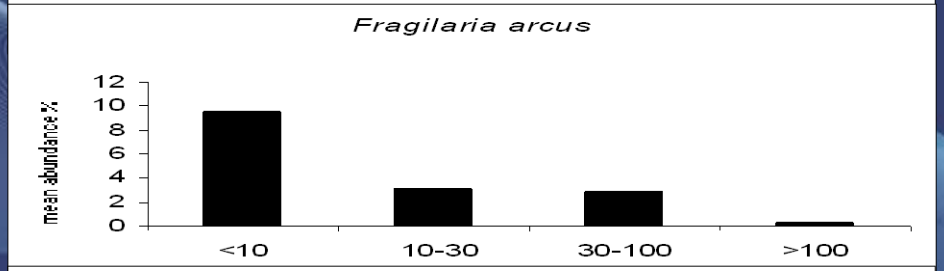

Diatoma mesodon
mean abundance %
3
2.5
2
1.5
1
0.5
0
<10
10-30
30-100
>100

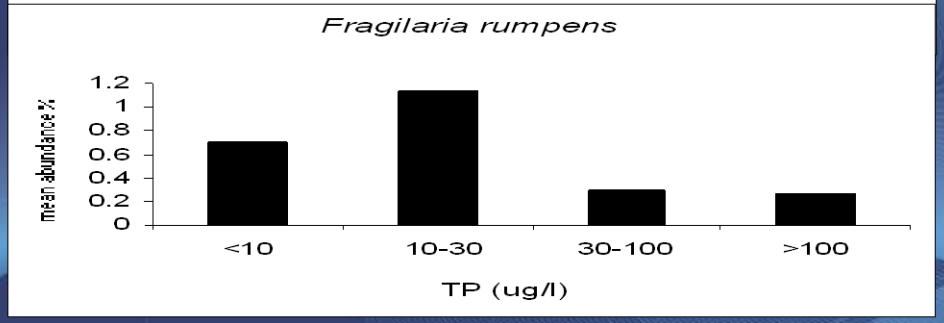

Diatoma moniliformis
mean abundance %
2
1.5
1
0.5
0
<10
10-30
30-100
>100
TP (ug/l)

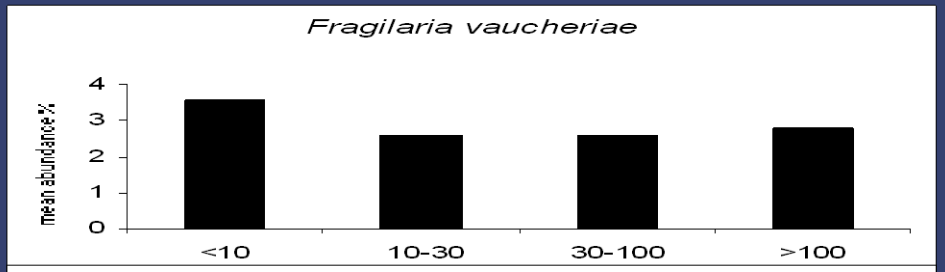

Encyonema minutum
mean abundance %
0
2
4
6
8
<10
10-30
30-100
>100

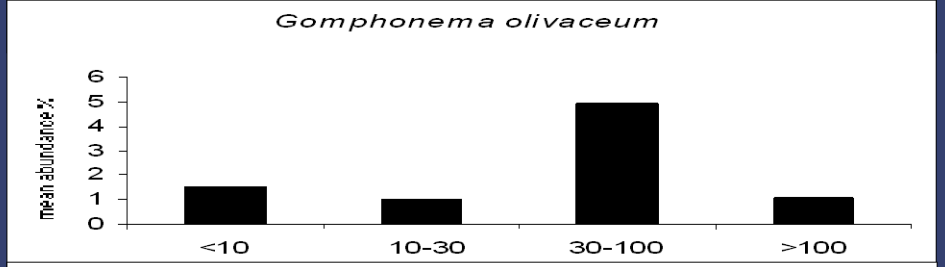

Encyonema silesiacum
mean abundance %
0
1
2
3
4
5
<10
10-30
30-100
>100
TP (ug/l)

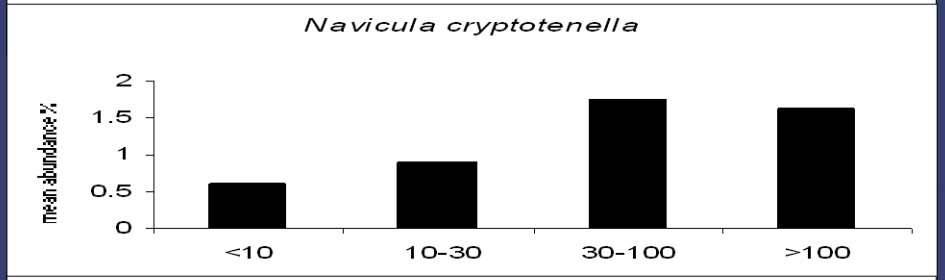

mean abundance %
0
0.5
1
1.5
2
<10
10-30
30-100
>100

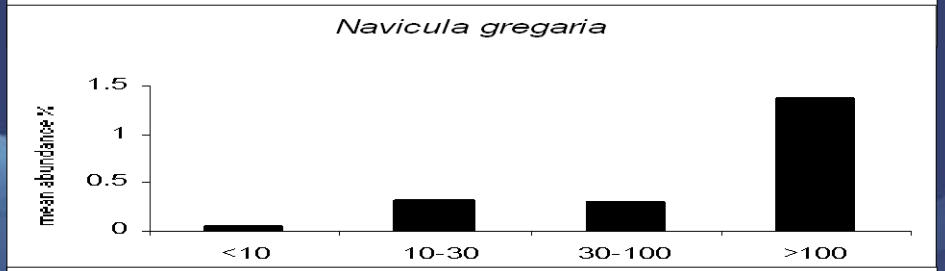

Fragilaria arcus
mean abundance %
0
2
4
6
8
10
12
<10
10-30
30-100
>100

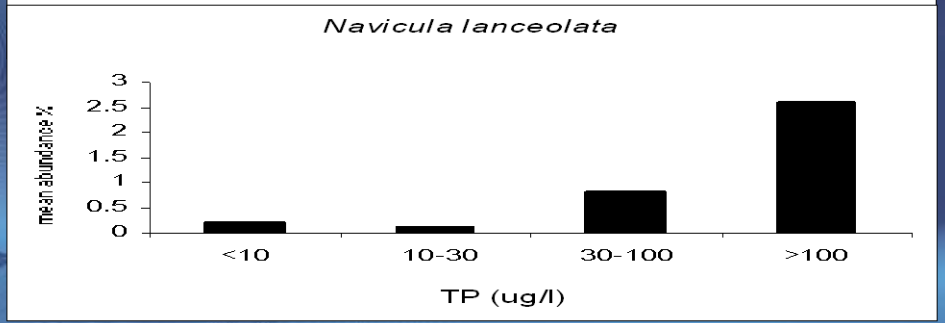

Fragilaria rumpens
mean abundance %
0
0.2
0.4
0.6
0.8
1
1.2
<10
10-30
30-100
>100
TP (ug/l)

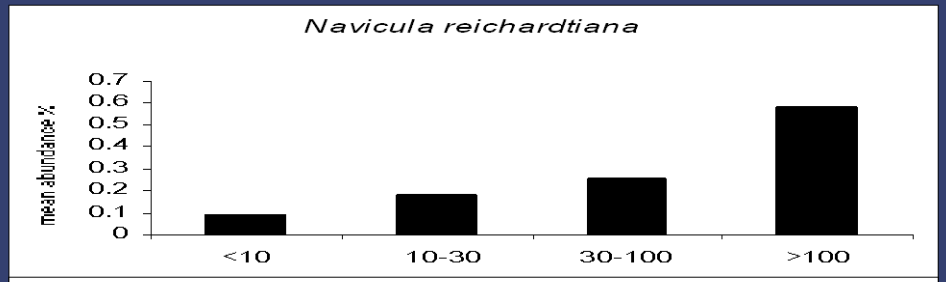

Fragilaria vaucheriae
mean abundance %
0
1
2
3
4
<10
10-30
30-100
>100

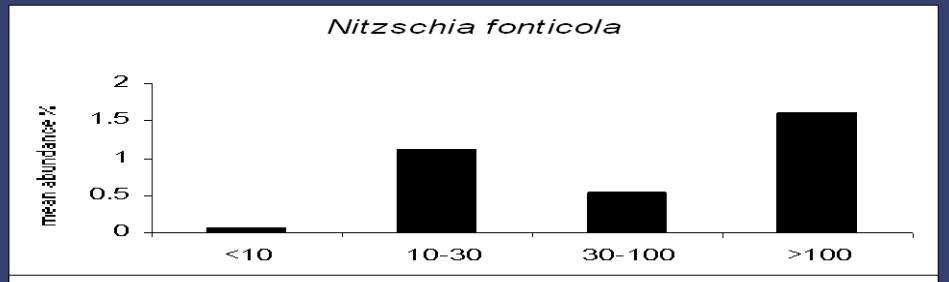

Gomphonema olivaceum
mean abundance %
0
1
2
3
4
5
6
<10
10-30
30-100
>100

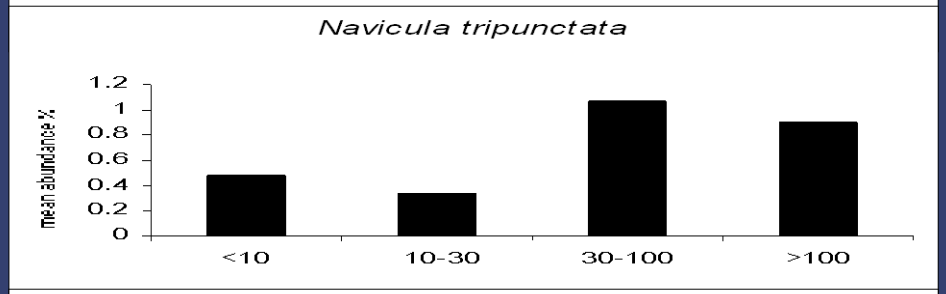

Navicula cryptotenella
mean abundance %
0
0.5
1
1.5
2
<10
10-30
30-100
>100

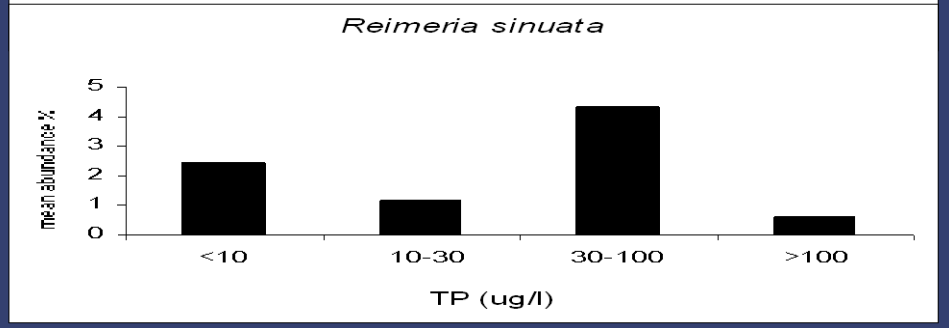

Navicula gregaria
mean abundance %
0
0.5
1
1.5
<10
10-30
30-100
>100

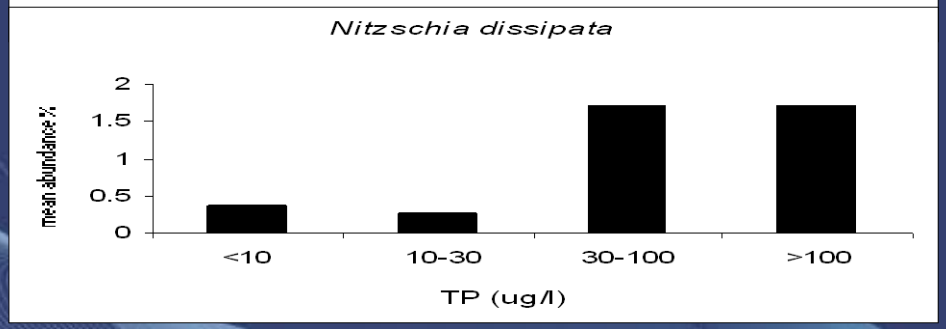

Navicula lanceolata
mean abundance %
0
0.5
1
1.5
2
2.5
3
<10
10-30
30-100
>100
TP (ug/l)


Navicula reichardtiana
mean abundance %
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
<10
10-30
30-100
>100


Nitzschia fonticola
mean abundance %
2
1.5
1
0.5
0
<10
10-30
30-100
>100

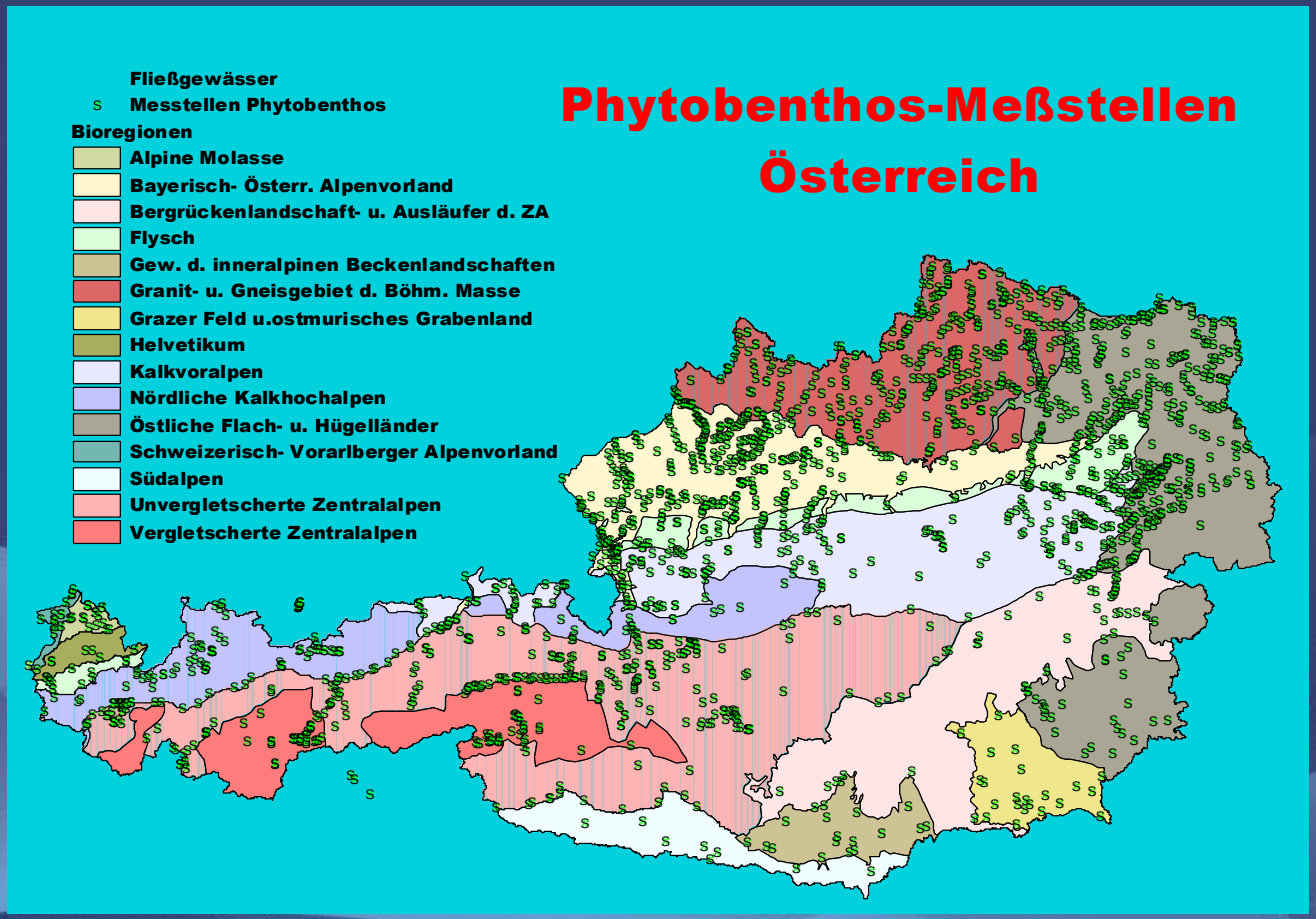

Navicula tripunctata
mean abundance %
1.2
1
0.8
0.6
0.4
0.2
0
<10
10-30
30-100
>100


Reimeria sinuata
mean abundance %
5
4
3
2
1
0
<10
10-30
30-100
>100
TP (ug/l)


Nitzschia dissipata
mean abundance %
2
1.5
1
0.5
0
<10
10-30
30-100
>100
TP (ug/l)

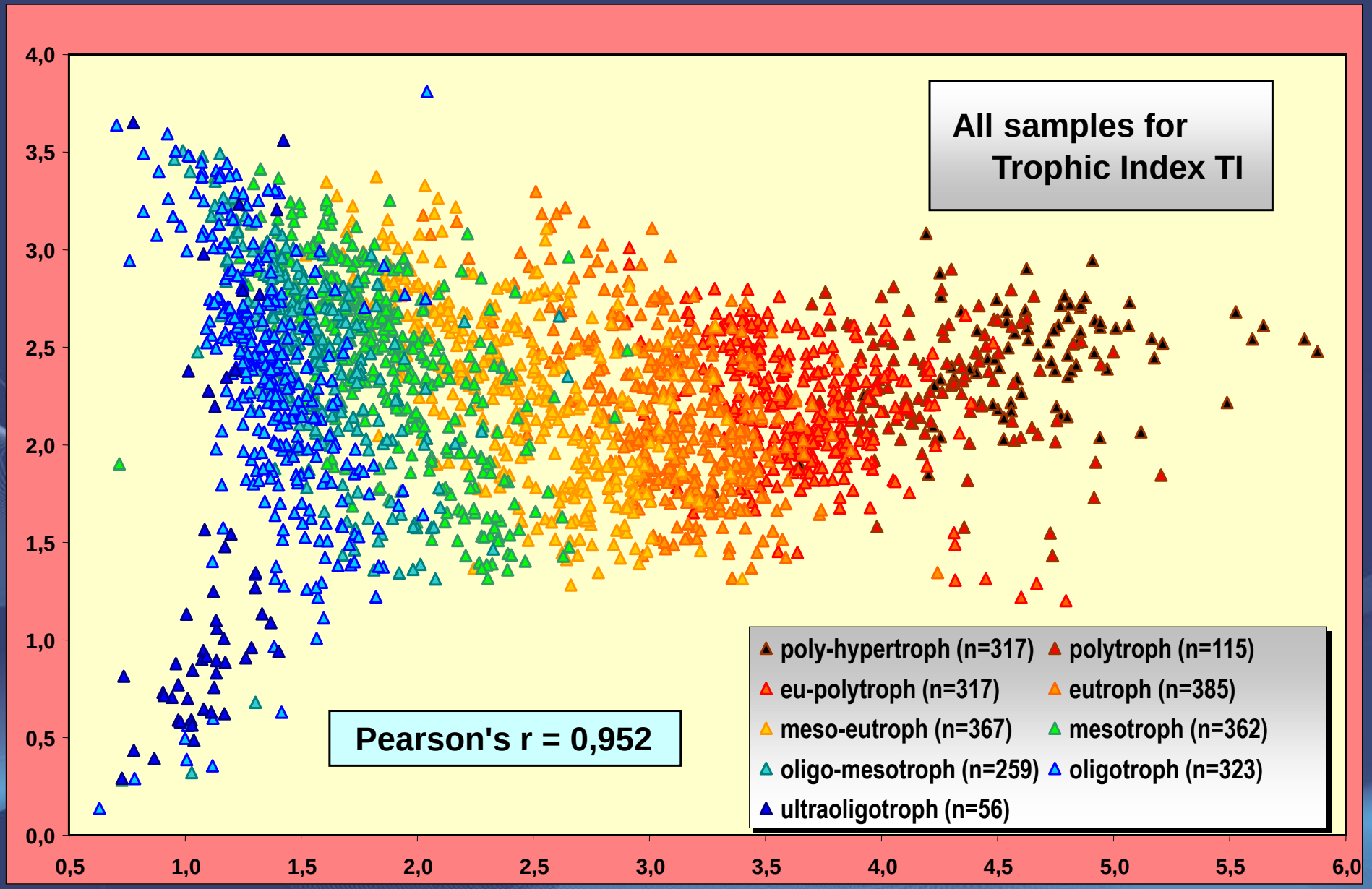
Part 4
Reference species approach Austria

Benthic algae data related to Austrian bioregional stream types



After Wimmer et al. 2000

TI based site classification CCA Austria (based on taxon. Composition and dominance (From Pipp E. pers. comm.)



Reference species for ecological quality monitoring of rivers in Austria (mod. from Pister & Pipp 2006, as in following 5 pages)

General reference species (Examples)	
Diatoma mesodon	Achnanthes biasolettiana
Gomphonema pumilum	Bangia atropurpurea
Fragilaria arcus	Cymbella minuta
Phormidium corium	Hydrurus foetidus
Hyella fontana	Phormidium autumnale

Bioregion specific Reference species (Examples)	VZA3	UZA3	VZA1-1,2	UZA1,2	BR3	BR2	BR1	GG3	GG2	GG1	KH3	KH2	KV2	KV1	SA1,2,3	FL3	FL1,2	HV2,3	AM1,2	VAV1,2	AV1	AV2	GF1	IB1,2	FH1
Chamaesiphon fuscus	X	X	X	X	X	X	X	X	X	X															
Chamaesiphon geitleri											X	X	X	X	X										
Schizothrix tinctoria	X	X	X	X				X	X	X	X	X	X	X											
Nitzschia fonticola									X	X							X			X	X	X	X		X
Hildenbrandia rivularis										X											X		X		X

Trophic reference status for different bioregions in Austria / preliminary

Bioregion	> 800 m	500 – 800 m	< 500 m
AM		oligo-mesotroph	*mesotroph*
AV		oligo-mesotroph	mesotroph
BR	*oligo-mesotroph*	mesotroph	*meso-eutroph 1*
FH			meso-eutroph 2
FL	oligotroph	oligo-mesotroph	mesotroph
GF			*meso-eutroph 2*
GG	*mesotroph*	meso-eutroph 1	*meso-eutroph 2*
HV	*oligotroph*	*oligo-mesotroph*	
IB		*mesotroph*	meso-eutroph 1
KH	oligotroph	oligotroph	*oligo-mesotroph*
KV	*oligotroph*	oligo-mesotroph	oligo-mesotroph
SA	*oligotroph*	oligotroph	*oligo-mesotroph*
UZA	*oligotroph*	oligo-mesotroph	mesotroph
VAV		*oligo-mesotroph*	mesotroph
VZA	oligotroph	*oligo-mesotroph*	

EQR based on TI all algae / Austria

	Trophic reference classification				
Ecological Quality class Acc. to TI	oligotroph	oligo-mesotroph	mesotroph	meso-eutroph 1	meso-eutroph 2
I - high	> 0,80	> 0,80	> 0,80	> 0,80	> 0,80
II - good	0,64 - 0,80	0,57 - 0,80	0,58 - 0,80	0,57 - 0,80	0,59 – 0,80
III - moderate	0,53 – 0,63	0,45 - 0,56	0,47 - 0,58	0,45 - 0,56	0,41 - 0,58
IV - poor	0,41 - 0,52	0,32 - 0,44	0,33 - 0,46	0,32 - 0,44	0,28 - 0,40
V - bad	0,40	0,31	0,32	0,31	0,27

Ecoregional distribution diatoms

Ref.Art-Typ = Referenzarten-Typ

A = Allgemeine Referenzarten - für jeweils alle Bioregions-/Höhenstufen-kombinationen gültig

B = Bioregionsspezifische Referenzarten - nur für einzelne Bioregionen oder Bioregions-gruppen und/oder Höhenstufen gültig); Abkürzungen der Bioregionen siehe Tabelle 1.

Die Zahl hinter der Bioregion stellt die jeweilige Höhenstufe dar (1 = <500m, 2 = 500-800m, 3 = >800m).

AM	Alpine Molasse
AV	Bayerisch-österreichisches Alpenvorland
BR	Bergrückenlandschaft und Ausläufer der Zentralalpen
FH	Östliche Flach- und Hügelländer
FL	Flysch
GF	Grazer Feld und Grabenland
GG	Granit-Gneisgebiet der Böhmischen Masse
HV	Helvetikum
IB	Inneralpine Becken
KH	Nördliche Kalkhochalpen
KV	Kalkvoralpen
SA	Südalpen
UZA	Unvergletscherte Zentralalpen
VAV	Vorarlberger Alpenvorland
VZA	Vergletscherte Zentralalpen

Art	Ref.Art-Typ	AM1	AM2	AV1	AV2	BR1	BR2	BR3	FH1	FL1	FL2	FL3	GF1	GG1	GG2	GG3	HV2	HV3	IB1+2+3	KH1	KH2	KH3	KV1+2+3	SA1	SA2	SA3	UZA1+2+3	VAV1	VAV2	VZA2+3
Achnanthes altaica	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes biasolettiana	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes biasolettiana var.subatomus	B					+			+				+	+	+															
Achnanthes bioretii	B			+	+									+	+	+							+	+			+	+	+	+
Achnanthes chlidanos	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes curtissima	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes daonensis	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes daui	B													+	+	+														
Achnanthes exilis	B	+	+						+	+	+	+	+				+	+		+	+	+	+	+	+	+	+			+
Achnanthes flexella	B	+	+							+	+						+			+	+			+	+		+			+
Achnanthes flexella var.alpestris	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes grischuna	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes kryophila	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes laevis	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes lapidosa	B													+	+	+											+			+
Achnanthes laterostrata	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes levanderi	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes marginulata	B															+											+			+
Achnanthes minutissima	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes minutissima var. gracillima	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes minutissima var. scotica	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes montana	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes nodosa	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes oblongella	B			+	+				+				+	+	+	+												+	+	
Achnanthes oestrupii	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes petersenii	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes pusilla	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes rechtensis	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes subatomoides	B					+	+		+				+	+	+	+			+											
Achnanthes suchlandtii	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Achnanthes trinodis	A	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Module: Reference species

Tabelle 10: Zuordnung der Bioregions-/Höhenstufenkombinationen und Flussabschnitte zu den Bioregionstypen "Alpin", "H2" und "H1" (Erläuterungen siehe Text)

Bioregion/ Flussabschnitt	Bioregionstyp "Alpin"	Bioregionstyp "H2"	Bioregionstyp "H1"
AM		AM2	AM1
AV		AV2	AV1
BR		BR2+3	BR1
FH			FH1
FL	FL3	FL2	FL1
GF			GF1
GG		GG2+3	GG1
HV	HV1+2+3		
IB		IB2	IB1
KH	KH1+2+3		
KV	KV1+2+3		
SA	SA1+2+3		
UZA	UZA1+2+3		
VAV		VAV2	VAV1
VZA	VZA1+2+3		

$$EQR_{RI} = \frac{RI_{PHB\_Aufnahme}}{Erwarteter Wert}$$

Tabelle 11: Erwartete Referenzartenindex-Werte pro Bioregions-Typ (Erklärung der Bioregionstypen siehe Text)

Erwarteter Wert	Bioregionstyp "Alpin"	Bioregionstyp "H2"	Bioregionstyp "H1"
Alle taxonomischen Gruppen	0,93	0,81	0,77
Nur Kieselalgen	0,90	0,83	0,78

Tabelle 12: EQR-Klassengrenzen pro Bioregionstyp für die Bewertung nach dem Modul Referenzarten (Zuordnung der Bio-regions-/Höhenstufenkombinationen und Flussabschnitte zu den Bioregionstypen Alpin, H1 und H2 siehe Tabelle 10)

A) Aufnahmen aller taxonomischen Gruppen

EQR-Klassengrenzen	Bioregionstyp "Alpin"	Bioregionstyp "H2"	Bioregionstyp "H1"
1 - sehr gut	≥ 0,84	≥ 0,80	≥ 0,79
2 - gut	0,50-0,83	0,50-0,79	0,50-0,78
3 - mäßig	0,30-0,49	0,30-0,49	0,30-0,49
4 - unbefriedigend	0,16-0,29	0,16-0,29	0,16-0,29
5 - schlecht	≤ 0,15	≤ 0,15	≤ 0,15

B) Nur auf Kieselalgen beruhende Aufnahmen

EQR-Klassengrenzen	Bioregionstyp "Alpin"	Bioregionstyp "H2"	Bioregionstyp "H1"
1 - sehr gut	≥ 0,80	≥ 0,74	≥ 0,75
2 - gut	0,40-0,79	0,40-0,73	0,40-0,74
3 - mäßig	0,20-0,39	0,20-0,39	0,20-0,39
4 - unbefriedigend	0,10-0,19	0,10-0,19	0,10-0,19
5 - schlecht	≤ 0,09	≤ 0,09	≤ 0,09

Trophic reference status for different bioregions in Austria / preliminary

Bioregion	> 800 m	500 – 800 m	< 500 m
AM		oligo-mesotroph	*mesotroph*
AV		oligo-mesotroph	mesotroph
BR	*oligo-mesotroph*	mesotroph	*meso-eutroph 1*
FH			meso-eutroph 2
FL	oligotroph	oligo-mesotroph	mesotroph
GF			*meso-eutroph 2*
GG	*mesotroph*	meso-eutroph 1	*meso-eutroph 2*
HV	*oligotroph*	*oligo-mesotroph*	
IB		*mesotroph*	meso-eutroph 1
KH	oligotroph	oligotroph	*oligo-mesotroph*
KV	*oligotroph*	oligo-mesotroph	oligo-mesotroph
SA	*oligotroph*	oligotroph	*oligo-mesotroph*
UZA	*oligotroph*	oligo-mesotroph	mesotroph
VAV		*oligo-mesotroph*	mesotroph
VZA	oligotroph	*oligo-mesotroph*	

What are for Austrian methods

Advantages

- Fine tuned ecoregional approach
- All algae
- Clear geochemical responses
- Clear altitudinal responses in accordance with higher „natural“ nutrient concentrations in lower altitudes

Problems

- Poor representation of heavily polluted sites
- Reference conditions of lowlands hard to define
- Unclear toxicological responses
- Link to macrophytes open

Part 4

Developments in Switzerland

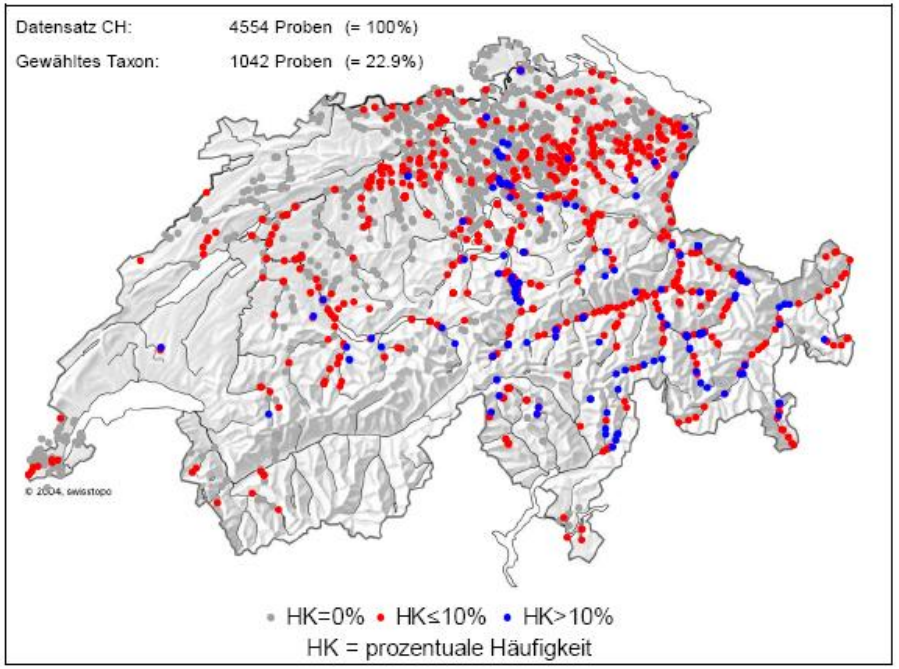
AquaPlus

Elber Hürlimann Niederberger

Switzerland focus on diatoms and macroalgae – conditions in praxis
(Hürlimann J. pers. Comm. Maps and info available from: *www.bafu.admin.ch/publikationen/.).*

- Nation-wide uniform method development
- Central databank abiotic and biotic data (private initiative)
- Annual ringtests for qualification of labs
- Calibration check, regional verification all 10 years postulated

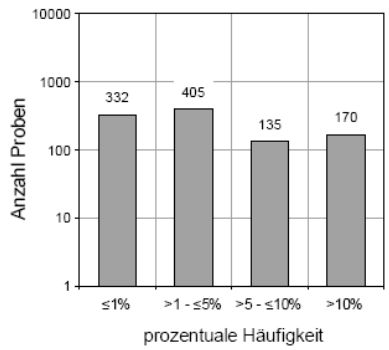
Geografische Verteilung



Oligotraphentic

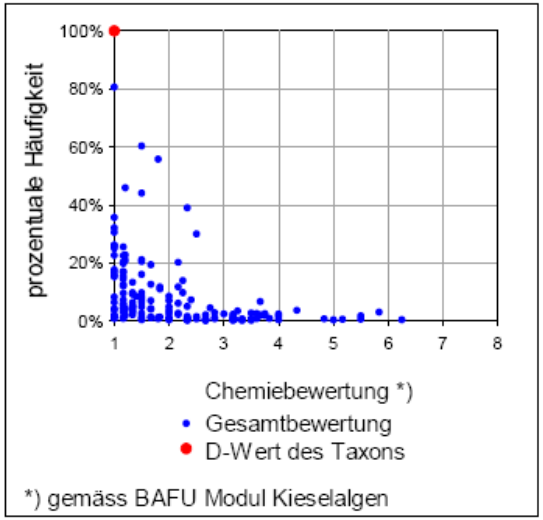
Achnanthes minutissima var. jackii (RABENHORST) LANGE-BERTALOT

Anzahl Proben und Vorkommen

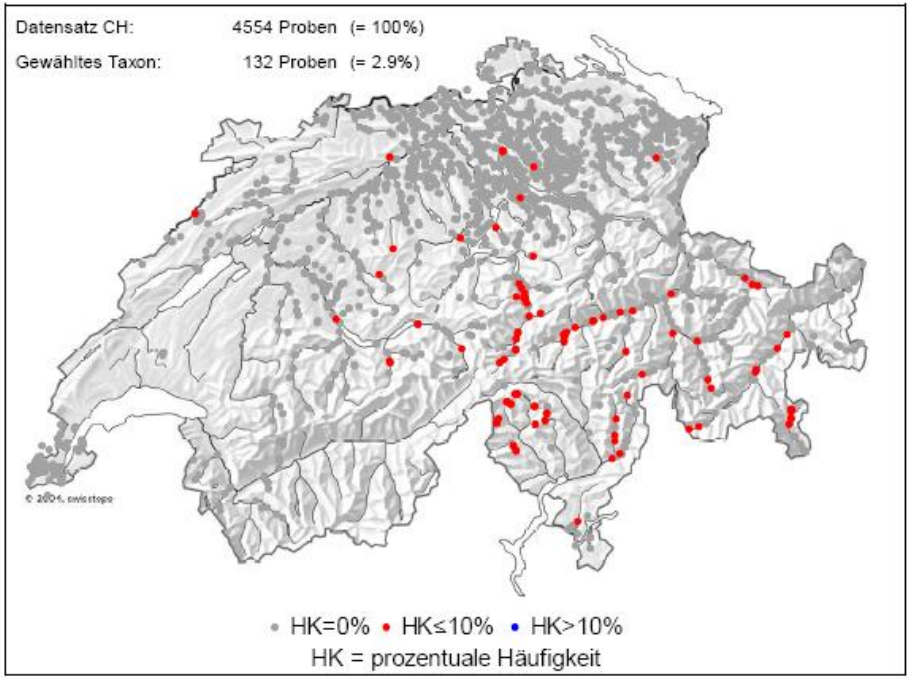


Fliessgewässer:	924 /	4031	22.9%
See:	115 /	468	24.6%
Kläranlagen:	0 /	46	0.0%
Sonstige:	3 /	9	33.3%
Total:	1042 /	4554	22.9%

Chemiebewertung



Geografische Verteilung

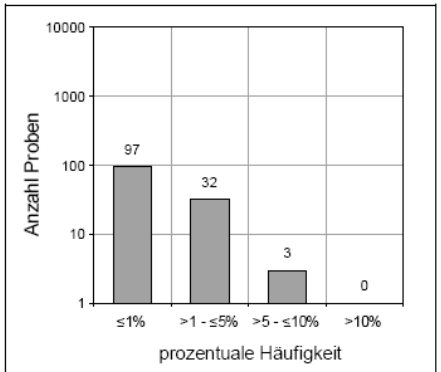


Oligotraphetic

Alpine

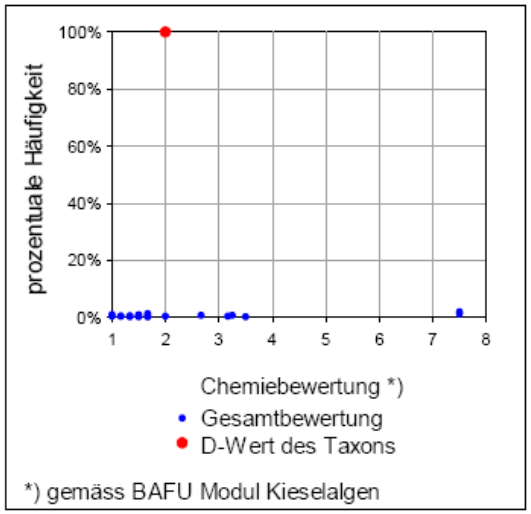
Achnanthes bioretii GERMAIN

Anzahl Proben und Vorkommen

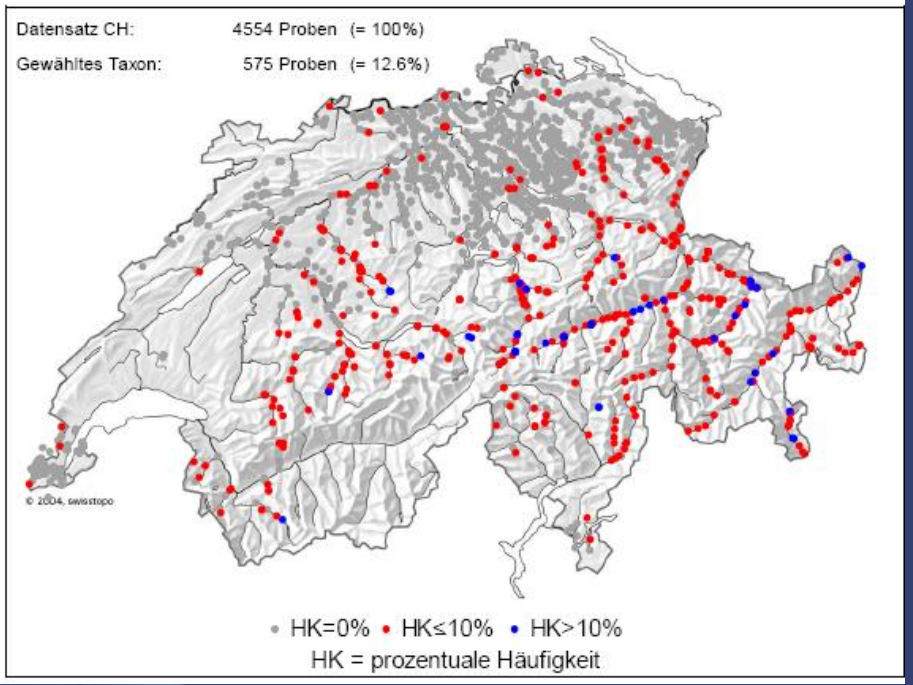


Fliessgewässer:	96 / 4031	2.4%
See:	34 / 468	7.3%
Kläranlagen:	1 / 46	2.2%
Sonstige:	1 / 9	11.1%
Total:	132 / 4554	2.9%

Chemiebewertung



Geografische Verteilung

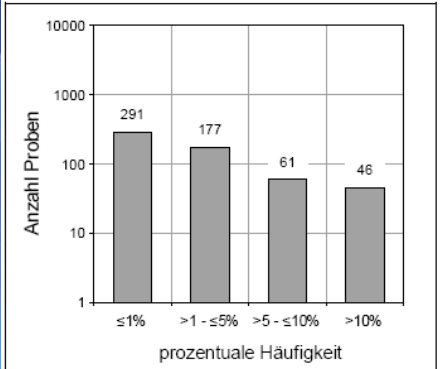


Oligo alpine

lotic

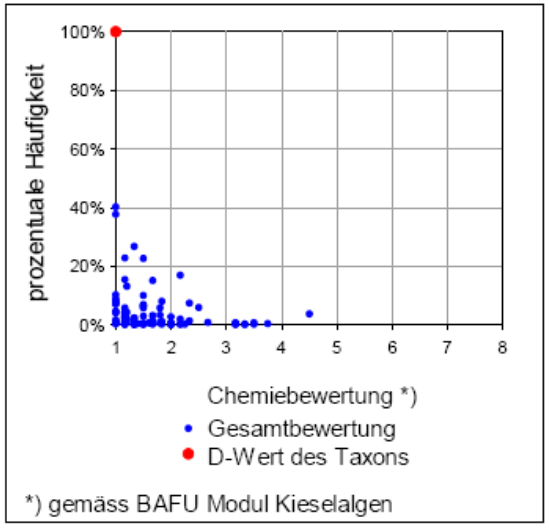
Fragilaria arcus (EHRENBERG) CLEVE

Anzahl Proben und Vorkommen

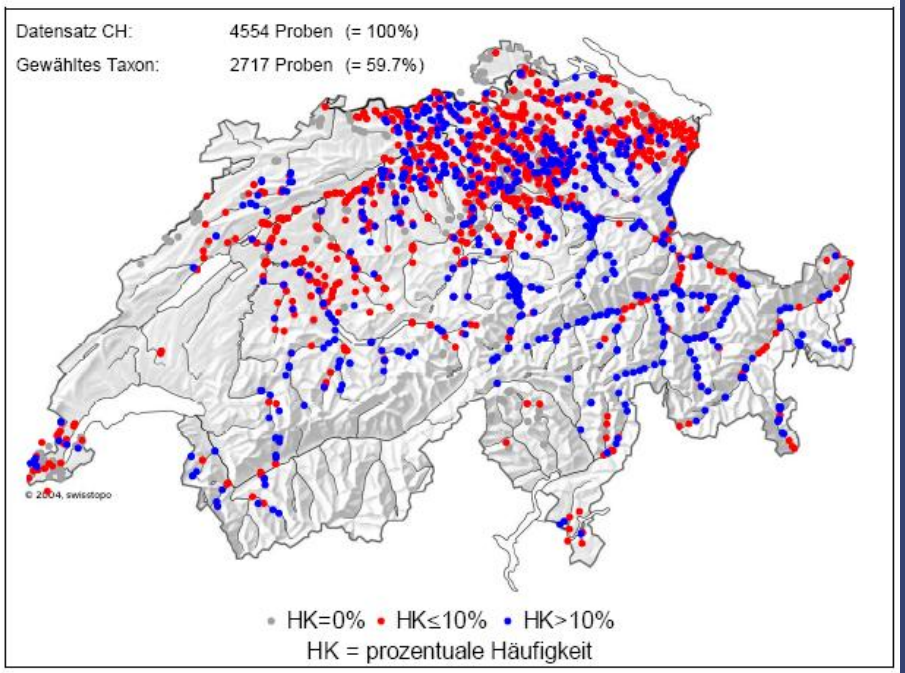


Fliessgewässer:	553 / 4031	13.7%
See:	22 / 468	4.7%
Kläranlagen:	0 / 46	0.0%
Sonstige:	0 / 9	0.0%
Total:	575 / 4554	12.6%

Chemiebewertung



Geografische Verteilung

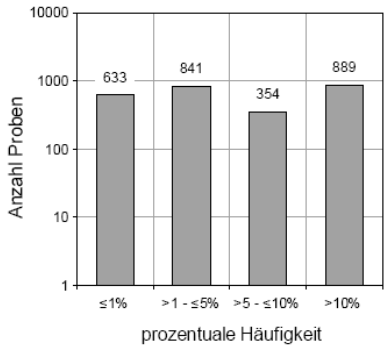


Oligo-meso

Achnanthes biasolettiana GRUNOW

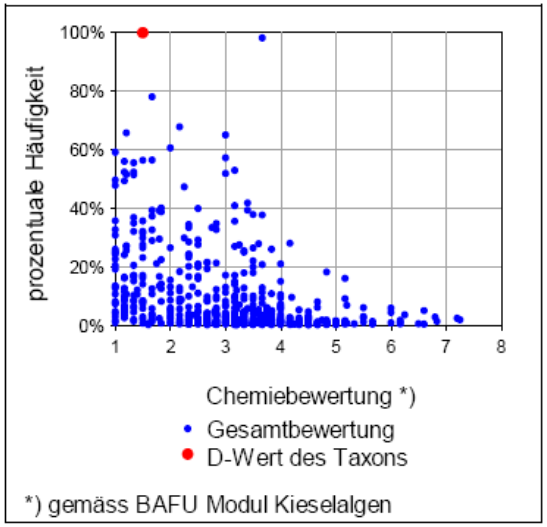
Habitat preference

Anzahl Proben und Vorkommen



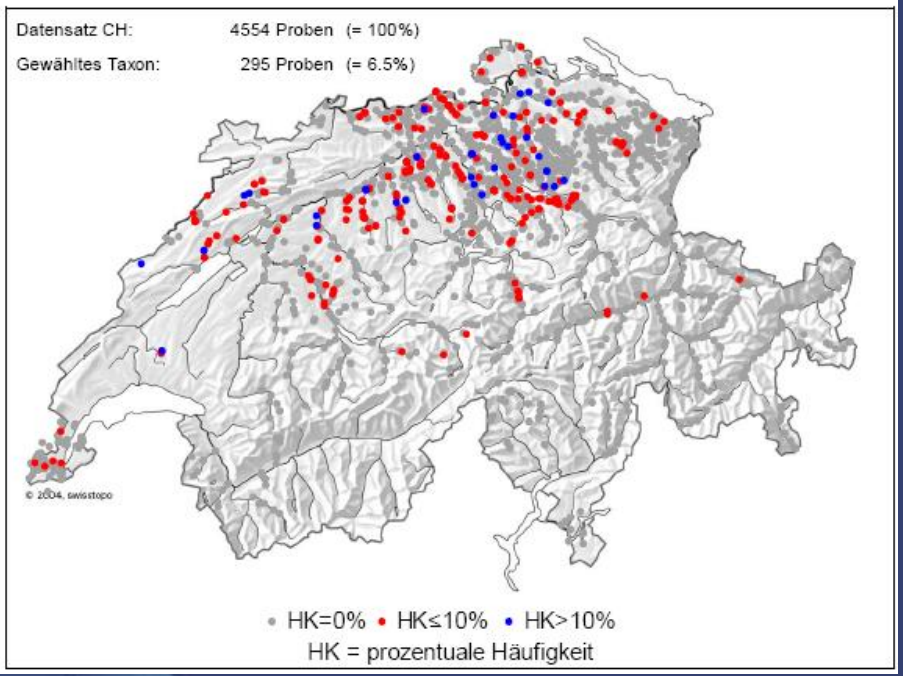
Fliessgewässer:	2594 / 4031	64.4%
See:	118 / 468	25.2%
Kläranlagen:	1 / 46	2.2%
Sonstige:	4 / 9	44.4%
Total:	2717 / 4554	59.7%

Chemiebewertung



Chemical scores

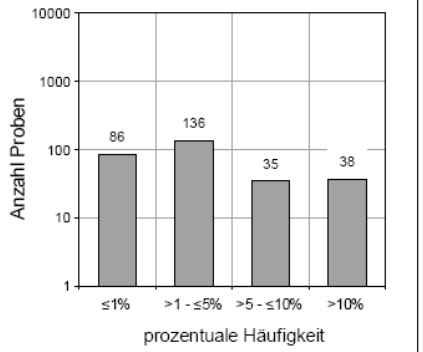
Geografische Verteilung



Eutraphentic

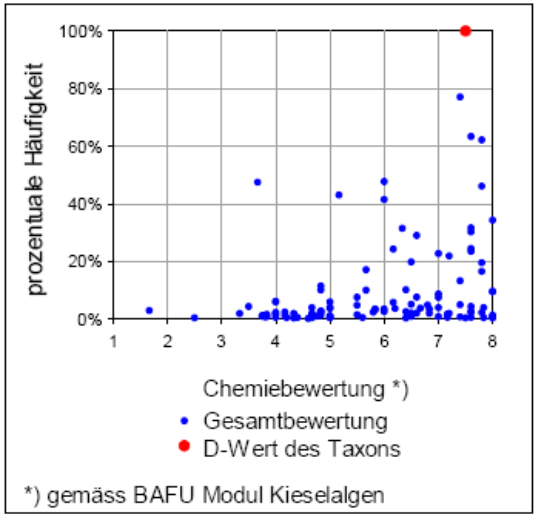
Achnanthes minutissima var. saprophila KOBAYASI et MAYAMA

Anzahl Proben und Vorkommen

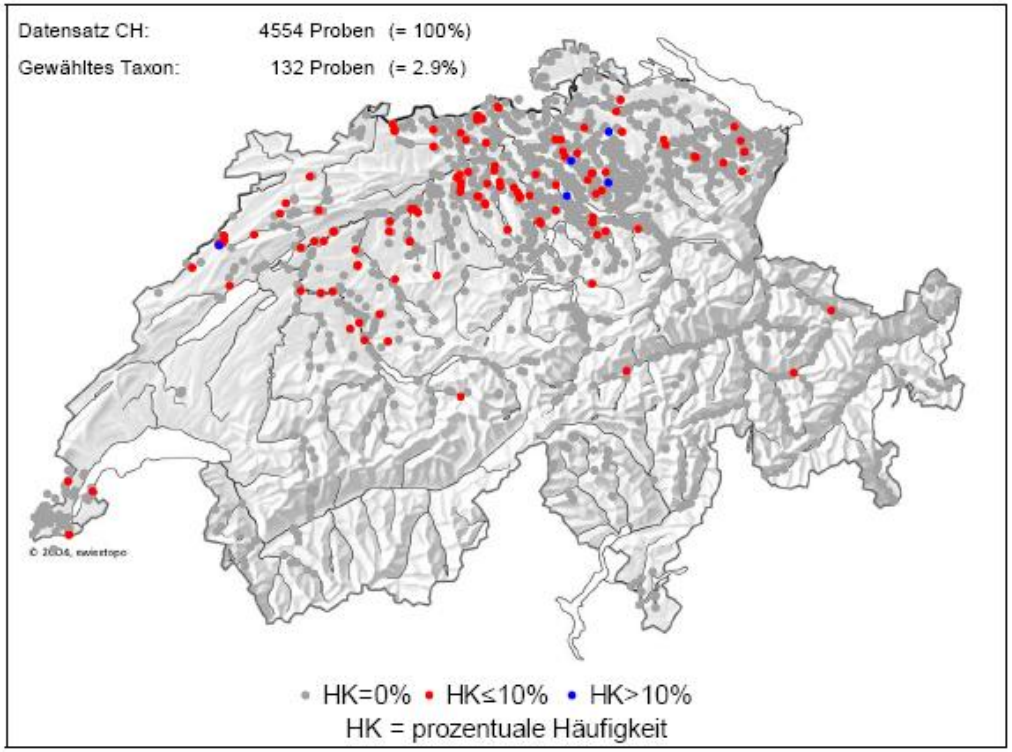


Fliessgewässer:	257 /	4031	6.4%
See:	0 /	468	0.0%
Kläranlagen:	38 /	46	82.6%
Sonstige:	0 /	9	0.0%
Total:	295 /	4554	6.5%

Chemiebewertung



Geografische Verteilung

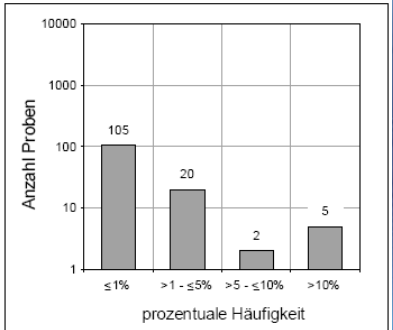


Saprophilous

Polytraphentic

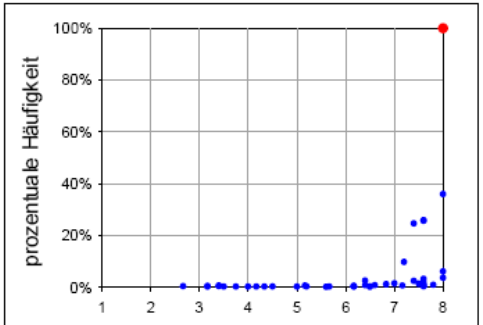
Navicula accomoda

Anzahl Proben und Vorkommen



Fliessgewässer:	113 / 4031	2.8%
See:	0 / 468	0.0%
Kläranlagen:	19 / 46	41.3%
Sonstige:	0 / 9	0.0%
Total:	132 / 4554	2.9%

Chemiebewertung



*) gemäss BAFU Modul Kieselalgen

General Conclusions 1

- Standardization is fossilisation (Prof. John LUND) = i.e. we tend to be self-sufficient and to loose information
- Strong relation of algal approaches to key issues (monitoring targets – criteria specific for eutrophication N vs P, organic enrichment , acidification etc.) indispensable
- Multimetric recommended – no mathematical averaging e.g. of all plants
- A joined EU effort would be desirable (Biogeographic and ecological databank! On the way?)

Conclusion part 2

- Both diatoms and all algae methods can be used for:

  (A) Bioregional and (B) criteria specific ecological quality classification of running waters – all algae more criteria specific?!
- We miss (A) A coordinated taxonomic approach for the Alps, (B) integration of knowledge on small streams and springs (to be suppl. by M. Cantonati)
- Mapping network approach (especially for rare- redlist? taxa) Alp wide

Key points for future development my personal recommendation

- Test species responses / preference graphs for regions / river types against key variables (incl. Experimental testing!) based on a common databank
- Avoid progressing divergence between taxon expertise and hindered progress of autecological knowledge
- Use all algae approach for specific issues
- Do not mix indices mathematically

Species traits / based on multivariate„preference spectra“

Table 5. Common diatom taxa from high altitude streams in the E- and S-Alps with a focus on glacial streams and niche descriptors supplemented by maximum frequency (D = dominant, R = rare but widespread, SD = subdominant), geochemical data from Cantonati et al. 2001 (n.d. no data; for abbreviations see Table 4) and trophic values from Rott et al. 1999 (for details see Table 4).

Taxon	Microhabitat preference	Maximum frequency	Geochemical preference	TW
Achnanthes acidoclinata Lange-Bertalot	I	SD	ACB	n.d.
Achnanthes biasolettiana Lange-Bertalot	F	SD	ALF	1.3
Achnanthes bioreti Germain	A	R	IND	1.8
Achnanthes daonensis Lange-Bertalot	F	R	CN	n.d.
Achnanthes flexella (Kützing) Brun	F	R	CN	0.3
Achnanthes helvetica Lange-Bertalot	F	R	ACF	0.6
Achnanthes kryophila Petersen	F	R	n.d.	n.d.
Achnanthes lanceolata (Brebisson) Grunow	F	D	ALF	3.3
Achnanthes marginulata Grunow	A	SD	ACF/ACB	0.2
Achnanthes minutissima Kützing	F	D	CN	1.2
Achnanthes subatomoides (Hustedt) Lange-Bertalot & Archibald	F	SD	ACF	2.1
Adlafia bryophila (Petersen) Lange-Bertalot	A	SD	IND	1.3
Brachysira brebissoni Ross	I	SD	ACF	1.1
Brachysira neoexilis Lange-Bertalot	I	SD	CN	1.2
Brachysira vitrea (Grunow) Ross	I	SD	ACF	0.7
Cocconeis placentula var. *euglypta* Ehrenberg	I	SD	ALF	2.3
Cymbopleura subaequalis (Grunow) Krammer		R	CN	1.0
Diadesmis gallica var. *perpusilla* (Grunow)Mann	A	SD	CN	1.2
Diatoma hyemalis (Roth) Heiberg	F	SD	CN	1.0
Diatoma mesodon (Ehrenberg) Kützing	F	D	CN	0.7
Encyonopsis falaisensis Krammer & Lange-Bertalot	I	R	CN	0.4
Encyonema neogracile Krammer agg.	I	R	ACF	0.6
Encyonema minutum (Hilse) Mann agg.	F	SD	IND	2.0
Encyonema silesiacum (Bleisch) Mann agg.	F	D	IND	2.0
Eunotia exigua (Brebisson) Rabenhorst	F	SD	ACB	0.5
Eunotia intermedia (Krasske) Nörpel-Schempp & Lange-Bertalot	I	R	ACF	0.6

From: Rott et al.2006, Hydrobiol.562:195-216


Thank you for your attention

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