Comparison of the EU Water Framework Directive and the Biological Condition Gradient

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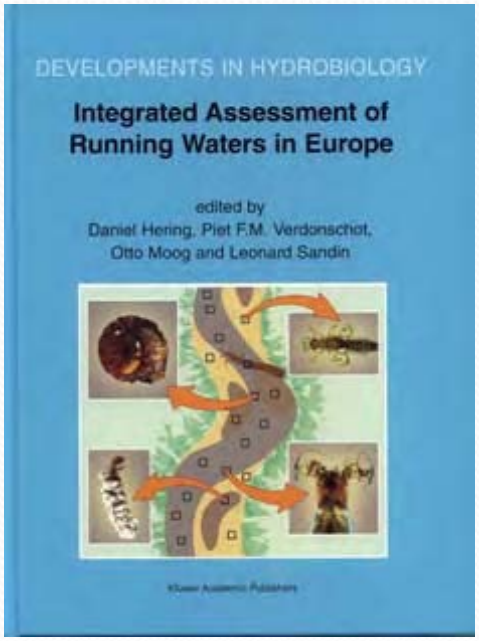
www.aqem.de

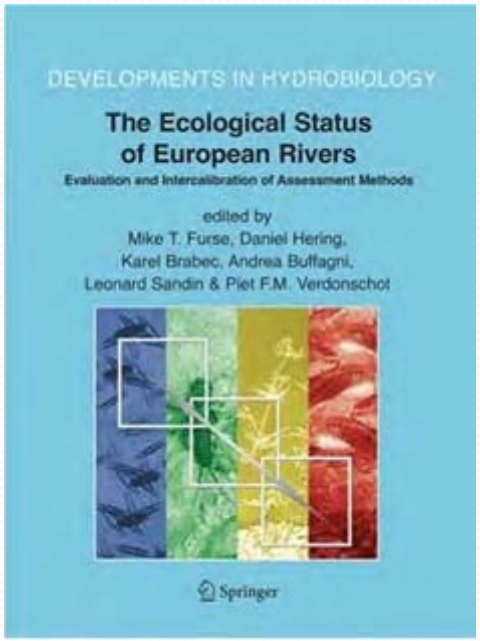
www.eu-star.at

Water bodies in Europe: Integrated Systems to Assessment to Assess Ecological Status and Recovery



Hydrobiologia 516

The Development and Testing of an Integrated Assessment System for the Ecological Quality of Streams and Rivers throughout Europe using Benthic Macroinvertebrates. Acronym: AQEM (2002)



Hydrobiologia 566

Standardisation of River Classifications:

Framework method for calibrating different biological survey results against ecological quality classifications to be developed for the Water Framework Directive (2005)

Main Topics

- The WFD - an outstanding European policy
- The Clean Water Act and the Water Framework Directive (WFD)
- Typology, classification and reference condition
- Ecological quality thresholds and assessment
- Intercalibration
- Crosswalk with the BCG
- Challenges and lessons to be learned

22.12.2000 EN Official Journal of the European Communities L 327/1

I

(Acts whose publication is obligatory)

DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 23 October 2000

establishing a framework for Community action in the field of water policy

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

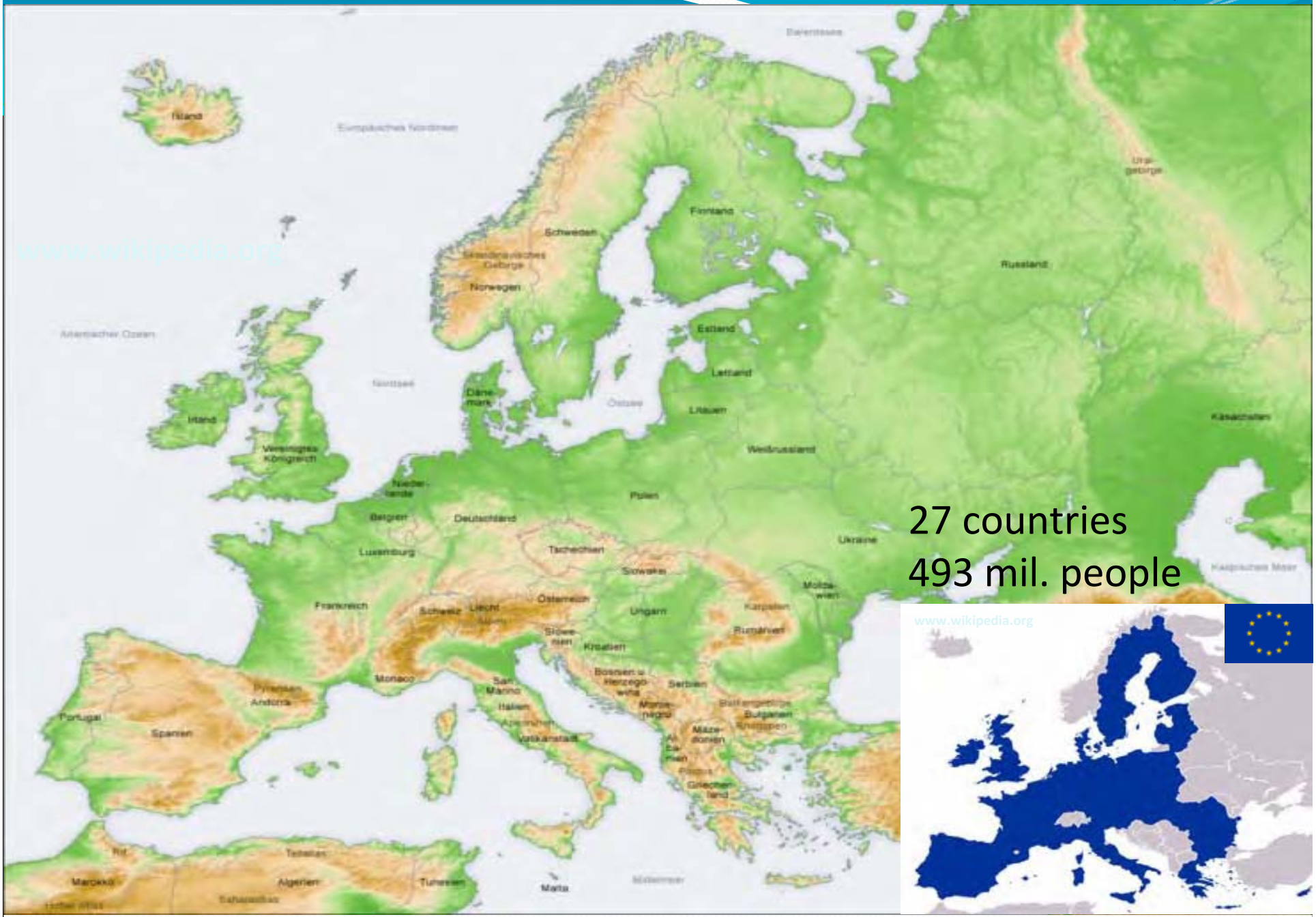
Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

Having regard to the proposal from the Commission [1],

Having regard to the opinion of the Economic and Social Committee [2],

(3) The declaration of the Ministerial Seminar on groundwater held at The Hague in 1991 recognised the need for action to avoid long-term deterioration of freshwater quality and quantity and called for a programme of actions to be implemented by the year 2000 aiming at sustainable management and protection of freshwater resources. In its resolutions of 25 February 1992 [6], and 20 February 1995 [7], the Council requested an action programme for groundwater and a revision of Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances [8], as part of an overall policy on freshwater protection.

Passed on December 20th, 2000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Niederlande
Belgien
Deutschland
Dänemark
Polen
Ukraine
Luxemburg
Tschechien
Slowakei
Frankreich
Schweiz
Liechtenstein
Österreich
Ungarn
Rumänien
Moldawien
Slowenien
Kroatien
Bosnien u. Herzegowina
Serbien
Montenegro
Bulgarien
Mazedonien
Griechenland
Monaco
San Marino
Italien
Vatikanstadt
Portugal
Spanien
Pyrenäen
Andorra
Marokko
Algerien
Tunesien
Malta
27 countries
493 mil. people
www.wikipedia.org

The WFD sets a framework for

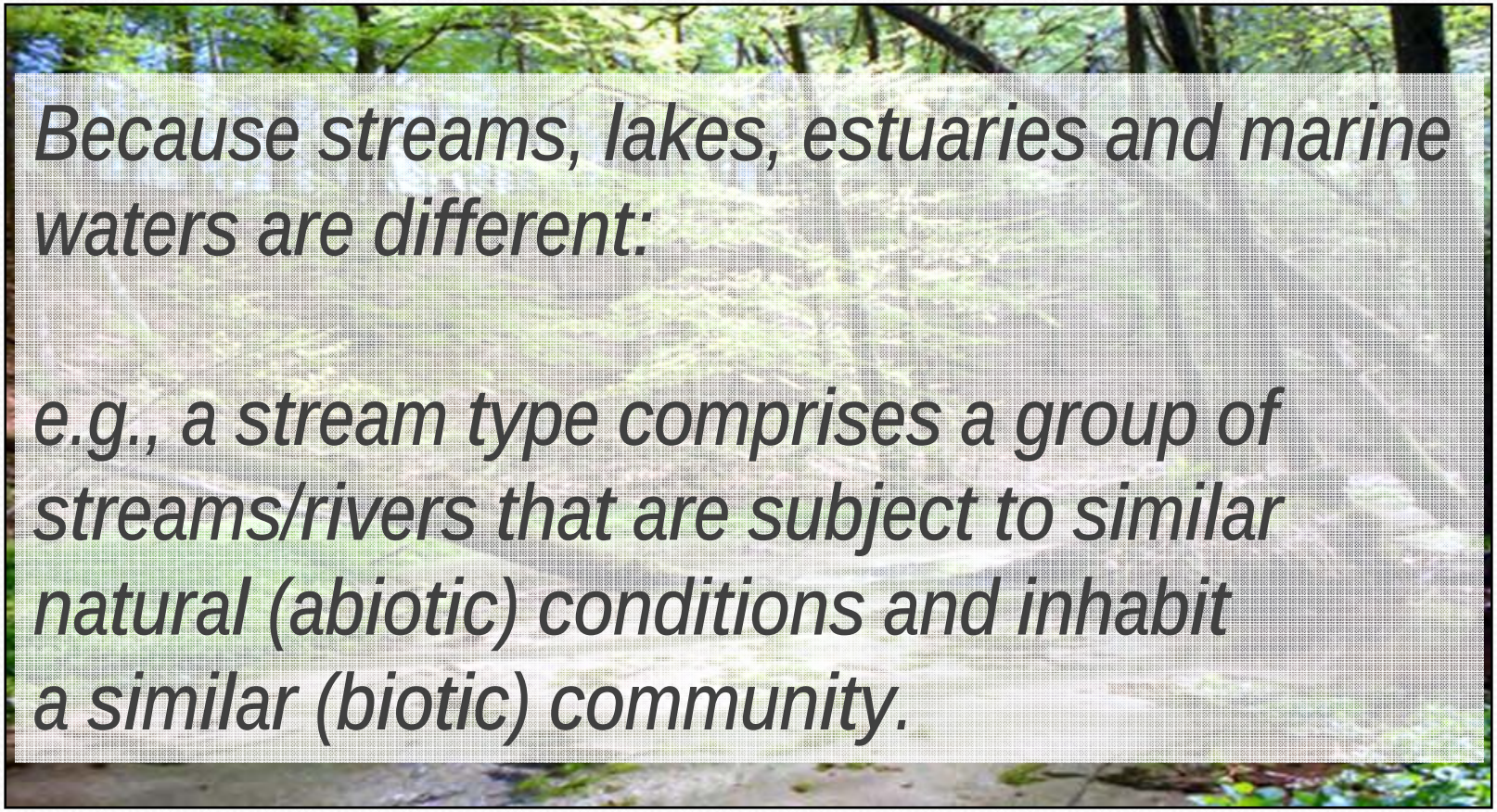
- **sustainable** water use inside the European Union
- fair water-related **marketing**
- sustainable **management** of water resources and ecosystems
- river basin management **across national borders**
- **ecological quality targets** including biological, physical-chemical, hydrological, and morphological conditions and specific pollutants
- **public participation** in all areas of water management

- ➔ *Binding on all categories of water bodies: rivers, lakes, transitional (brackish) -, coastal - and groundwater !*

Ecological quality targets

- **'good ecological quality'** by the end of 2015 based on
- comparison with **reference conditions** (high quality), which have to be
- **type-specific**
- classification into **five quality classes** (high, good, moderate, poor, bad)
- assessment **based on biological quality elements** (BQE) (fish, benthic macroinvertebrates, benthic algae & macrophytes, phytoplankton), physical-chemical and hydromorphological quality elements considered only "supporting"
- applies to stream sites **≥ 10 km²** catchment and lakes **≥ 50 ha** surface area (= 0.5 km²)
- unit subject to assessment: **water body**

Why typologies?



Example: German Stream Typology

"Philosophy"

- one common typology for the entire country and all quality elements
- as many types as necessary, as few types as possible
  ➔ influences number of water bodies, design of monitoring network, and assessment systems
- scientifically sound and politically acceptable
- simple approach: first "top-down" based on abiotic descriptors, then "bottom-up" validation

➔biologically meaningful typology

Typology descriptors

Obligatory parameters (Annex II, WFD)

- Ecoregion (Illies, 1978)
- Altitude: < 200 m; 200–800 m; > 800 m
- Geology (calcareous, siliceous, organic)
- Catchment size: 10–100 km²
  100–1,000 km²
  1,000–10,000 km²
  >10,000 km²

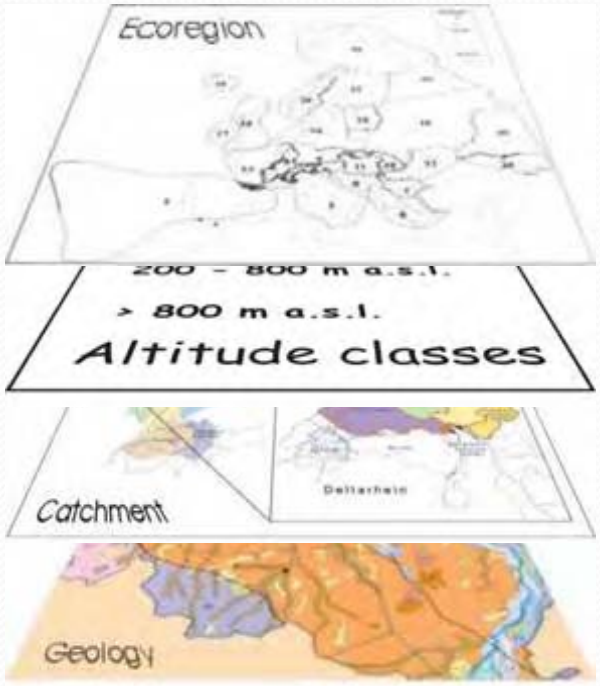
Top-down approach

Optional parameters

- Sub-ecoregions (river landscapes)
- Dominating bottom substrate
- Valley shape
- Slope (“Talweg”)




Methodological approach for stream typology



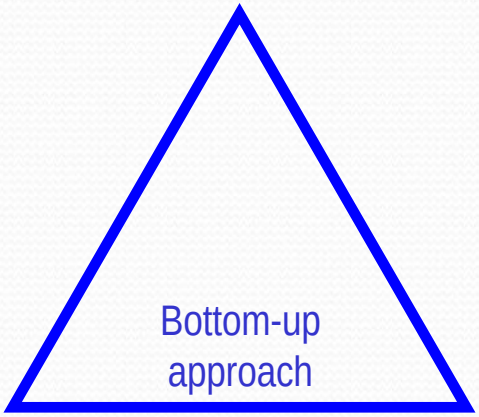
+ River landscapes
+ Substrate grain size

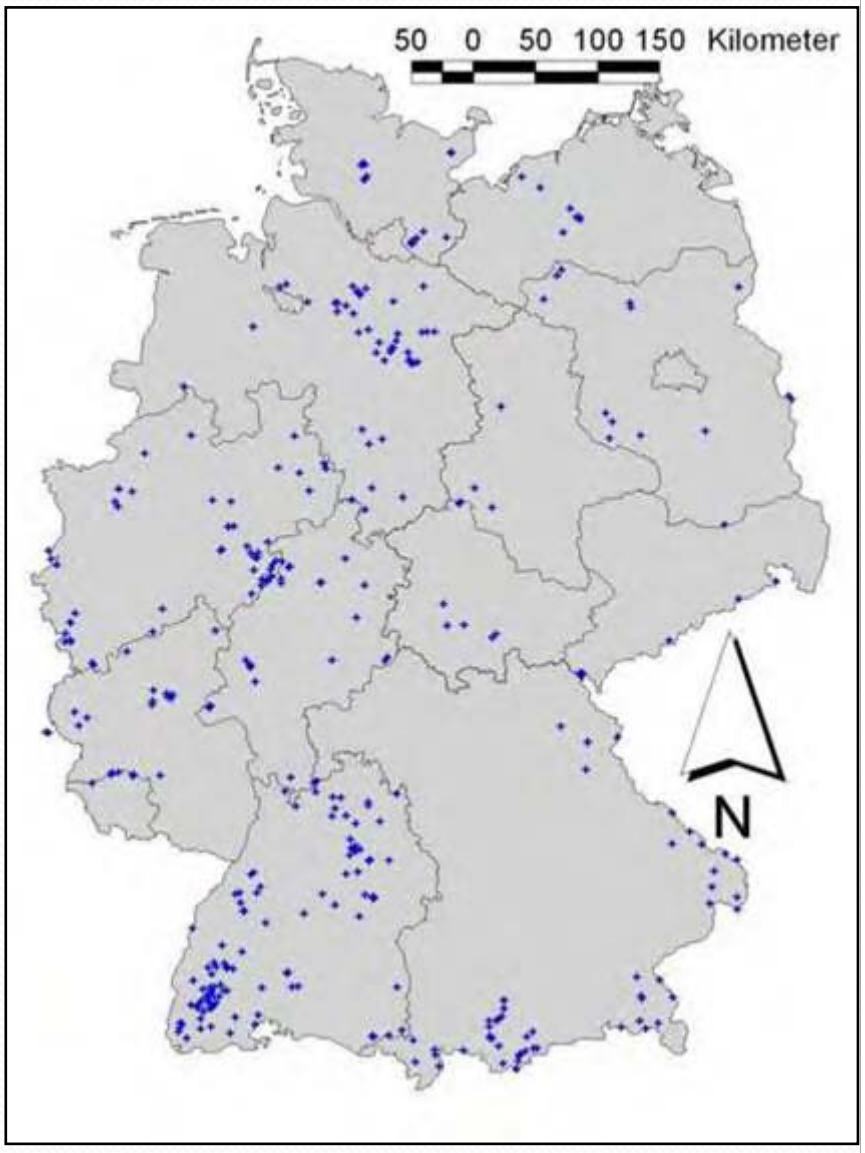
www.wasserblick.net **Selected river landscapes and regions according to Briem (2003)**	**biocoenotically type** Size class[1) 2)] small river	mid-sized river	large river	very large river
Ecoregion 4: Alps, altitude > 800 m				
Calcareous Alps, Flysch-Alps				
Ecoregion 9 (and 8): Central highlands and Alpine foothills, altitude ca. 200 - 800 m and higher				
Alpine foothills				
Tertiary hills, river terraces, lower river terraces, old moraines	2[3)]			
Pleistocene moraine landscapes	3[3)]		4	
Floodplains (over 300 m wide)				
Central highlands				
Gneiss, granites, schists, volcanis regions	5	9		
Buntsandstein sandstone, sandy deposits	5.1			
Loess regions, upper Triassic rocks, middle and lower Jurassic	6	9.1		
Lacustrine limstones, lower and middle Jurassic stones, upper Jurassic limestone, Cretaceous rocks	7			
Floodplains (over 300 m wide)				
Ecoregion 14: Central plains, altitude < 200 m				
Outwash plains, sandy deposits, ground and terminal moraines	14	15		
Loess regions	18			
Ground and terminal moraines, lower river terraces	16	17		
Floodplains (over 300 m wide)				20
Marshland of the coastal plains				
Young moraine landscape: ground moraines				
Ecoregion independent stream types				
Outwash plains, loess regions, floodplains (paludificated)	11	12		
Floodplains (over 300 m wide)	19			
Outwash plains, ground and terminal moraines				

Bottom-up validation

Validation of abiotic stream types

- Multivariate analysis of approx. 400 taxa lists of (near-)natural sites all over Germany
- Biotic classification into groups of similar samples ➔ similar communities
- Comparison of biotic and abiotic classification





See Lorenz et al. (2004), Limnologica 34(4), 390-397

www.wasserblick.net

Selected river landscapes and regions according to Briem (2003)

	biocoenotically type			
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Tertiary hills, river terraces, lower river terraces, old moraines	2[3)]		4	
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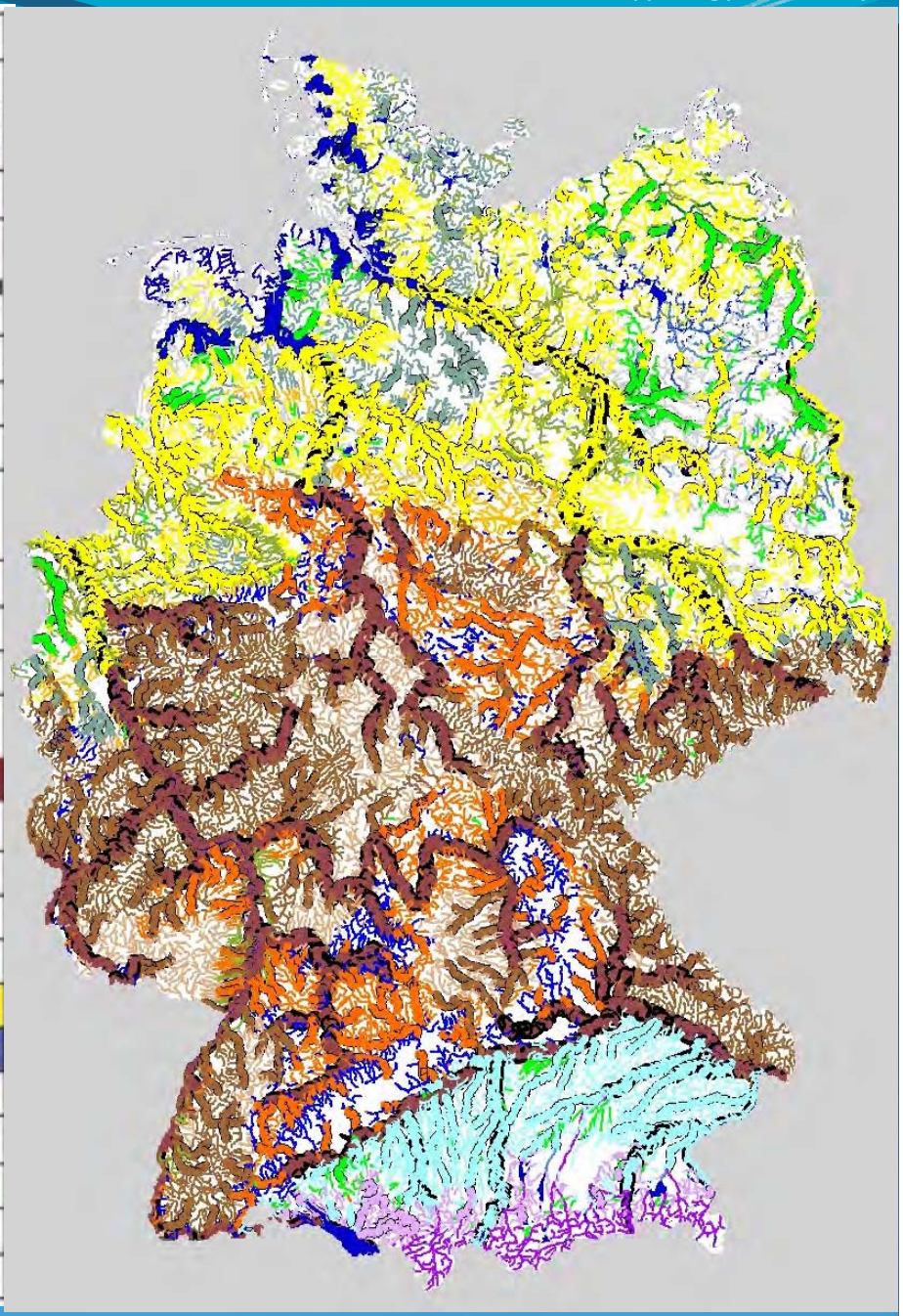
Marshland of the coastal plains	[illegible]			
Young moraine landscape: ground moraines	23			
Ecoregion independent stream types				
Outwash plains, loess regions, floodplains (paludificated)	11	12		
Floodplains (over 300 m wide)	19			
Outwash plains, ground and terminal moraines	21			



Reference conditions

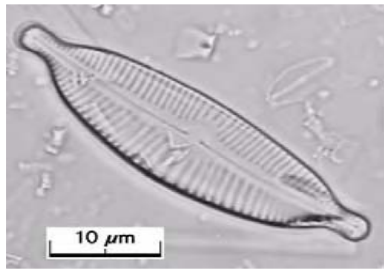
Reference conditions

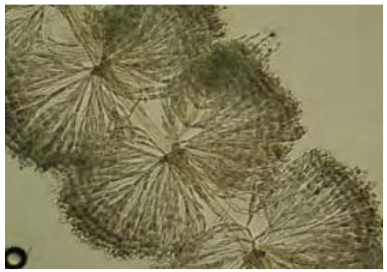
➔ high ecological status
"…no or only minor deviation from undisturbed conditions (hydromorphology, water quality and BQEs…"

- benchmark for ecological assessment systems

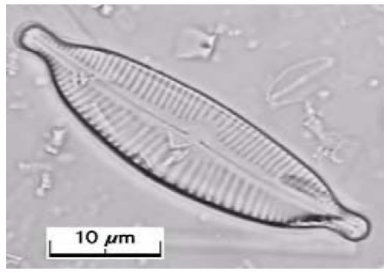
Defining reference conditions

1. using existing reference (= natural + undisturbed !) sites
2. using comparable reference sites in neighbouring countries (comparable type !)
3. (re)construction based on historical records
4. ecological modelling
5. expert judgement





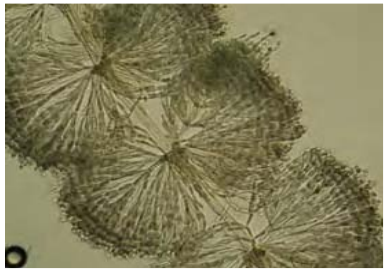
Criteria for defining reference sites



Minimum anthropogenic pressure regarding

- catchment and riparian land use
- water chemistry
- stream hydrology
- stream morphology

➔ valid for all Biological Quality Elements (BQE)



Similarities between the CWA and WFD

Criteria:	Goals	Control	Implementation	Intercalibration
WFD	Protect / enhance all waters to reach 'good status' (ecological, chemical)	EU Commission	EU Member States	European Intercalibration Process as legal obligation
CWA	Maintain / restore the chemical, physical, and biological integrity of the Nation's waters	EPA	US States and Territories	no formal effort occurs or required to occur; integrated report guidance

Similarities between the CWA and WFD

Criteria:	Reference conditions	Quality classes
WFD	Reference = high ecological status with no or very minor anthropogenic alterations	Five ecological quality classes
CWA	Reference = based on State water quality standards for aquatic life protection	No specific quality classes defined, attainment or non-attainment of WQS

Classification based on type-specific references

- O/E approach: test site's metric results are being compared with type-specific reference values of the metric
- EQR: Ecological Quality Ratio = O/E
- Normalised results scaled 0-1 (= 0-100%) => comparable among member states
- Conversion of metric values into EQRs, for example, using "anchor points"

Definition of upper and lower anchors and normalisation

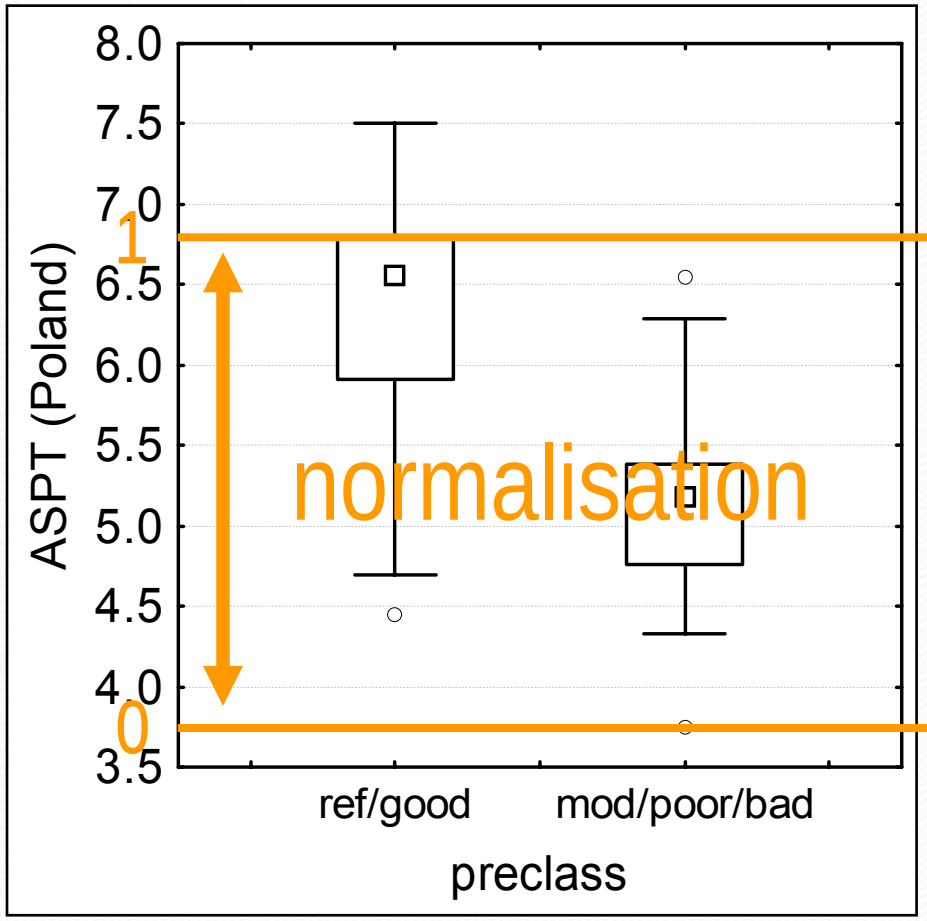
HERING et al. (2006), Hydrobiologia 566

- **Upper** and **Lower Anchors** mark the indicative range of a metric, i.e. the values that are empirically set and defined as "1" (Upper Anchor) and "0" (Lower Anchor) to normalise a metric's result

- **Upper Anchor:** Upper limit of the metric's value under reference conditions

- **Lower Anchor:** Lower limit of the metric's value under worst attainable conditions

Definition of Upper and Lower Anchors and Normalisation

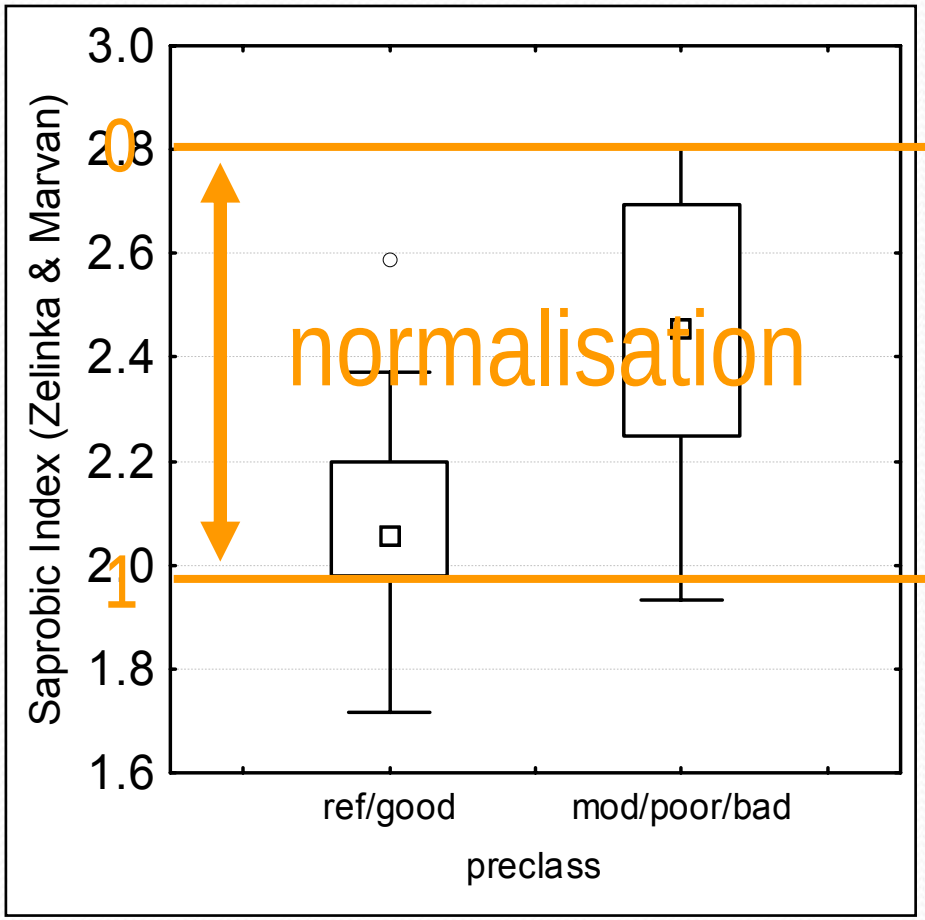


Upper Anchor
= 75th percentile value of reference sites

Lower Anchor
= worst value in the dataset

Impairment ↑ Metric ↓

Definition of Upper and Lower Anchors and Normalisation



Lower Anchor
= worst value in the dataset

Upper Anchor
= 25th percentile value of reference sites

Impairment ↑ Metric ↑

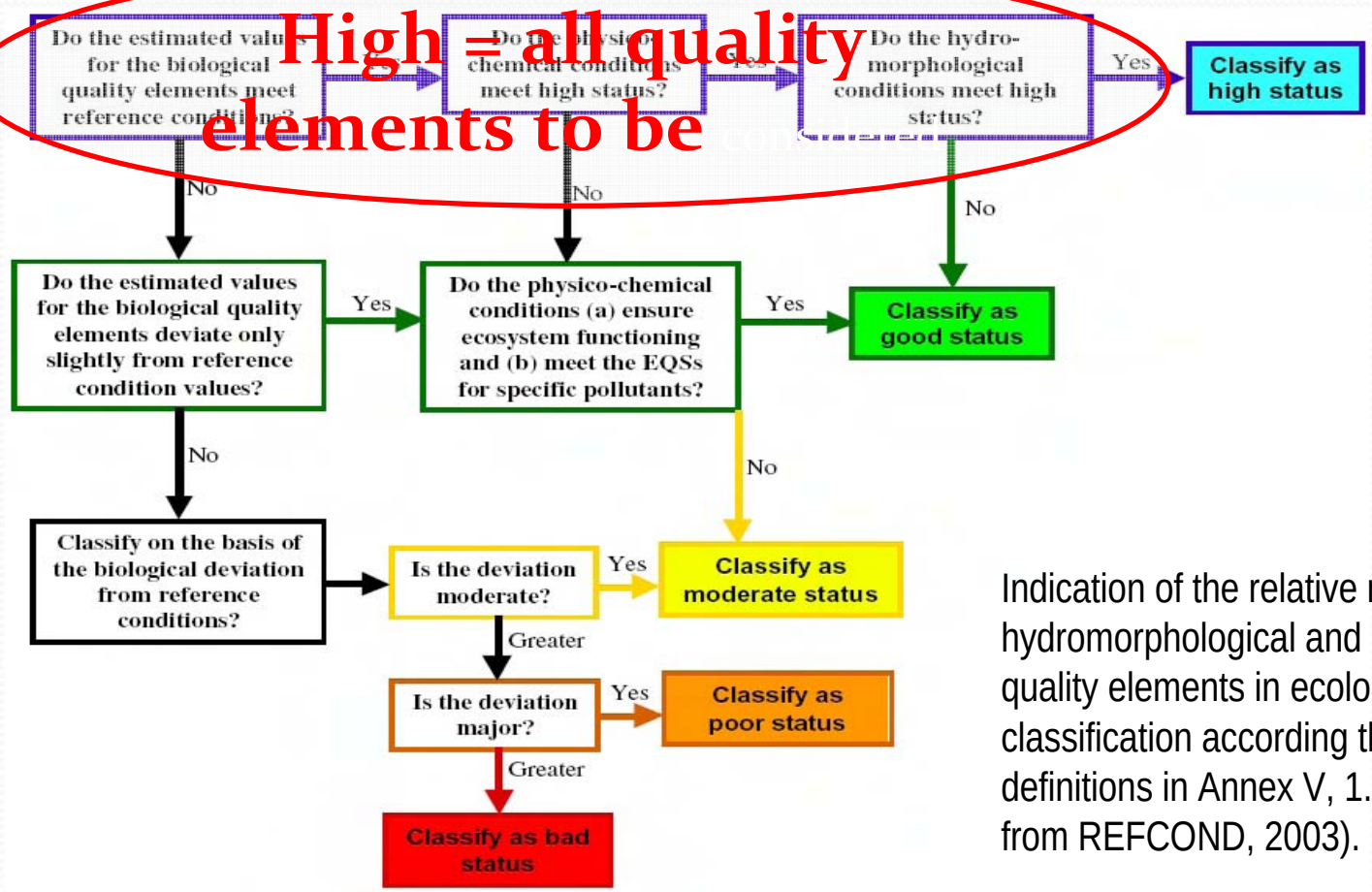
Classification of Ecological Status

PERLODES example (German macroinvertebrate standard)

PERLODES status class	Boundaries
1 High	> 0.8
2 Good	> 0.6 – 0.8
3 Moderate	> 0.4 – 0.6
4 Poor	> 0.2 – 0.4
5 Bad	<= 0.2

PERLODES Ecological Quality Classes and class boundaries (according to Meier et al., 2006).

Ecological Quality Assessment Process



Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological status classification according the normative definitions in Annex V, 1.2 of the WFD (taken from REFCOND, 2003).

The WFD focuses on the deviation from reference conditions…..

Level 1: Ecological Quality Class

poor

Level 2: Results of the different modules

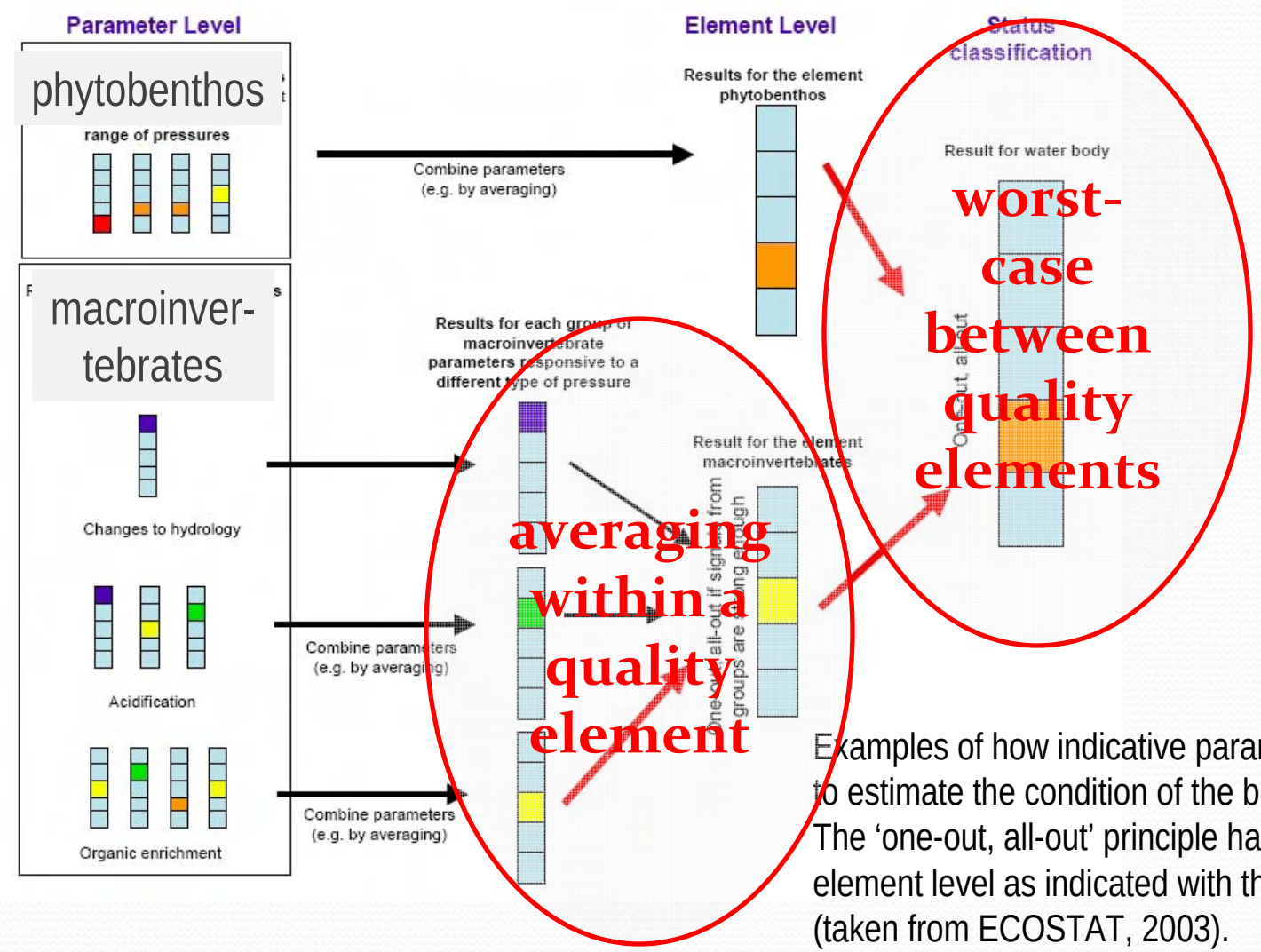
- Saprobic Index — good → SI = 2.29
- General Degradation — poor → Score = 0.23

Level 2: Results of the different metrics for general degradation

• German Fauna Index	0,09	bad
• # Trichoptera	0,13	bad
• EPT-Taxa [%]	0,25	poor
• *Littoral [%]*	*0,24*	poor
• *Pelal [%]*	*0,87*	high

- German Fauna Index (bad) → lack of sensitive and type-specific indicator species
- # Trichoptera (bad) → poor habitat diversity, e.g. lack of organic substrata (woody debris, CPOM)
- EPT-Taxa [%] (poor) → low species-richness, few and dominant taxa
- *Littoral [%]* (poor) → lack or disturbance of natural (type-specific) flow regime (e.g., stagnation, large macrophyte stands due to lack of shading)
- *Pelal [%]* (high) → no sign of siltation (e.g., accumulation of fine sediments due to stagnation)

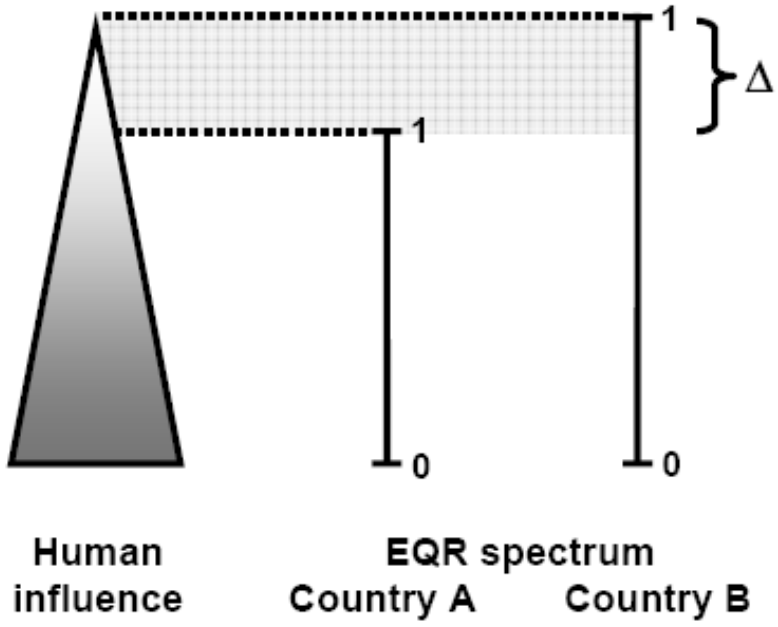
Combining indicators to estimate conditions



Examples of how indicative parameters may be combined to estimate the condition of the biological quality elements. The 'one-out, all-out' principle has to be used on the quality element level as indicated with the phytobenthos example (taken from ECOSTAT, 2003).

Intercalibration

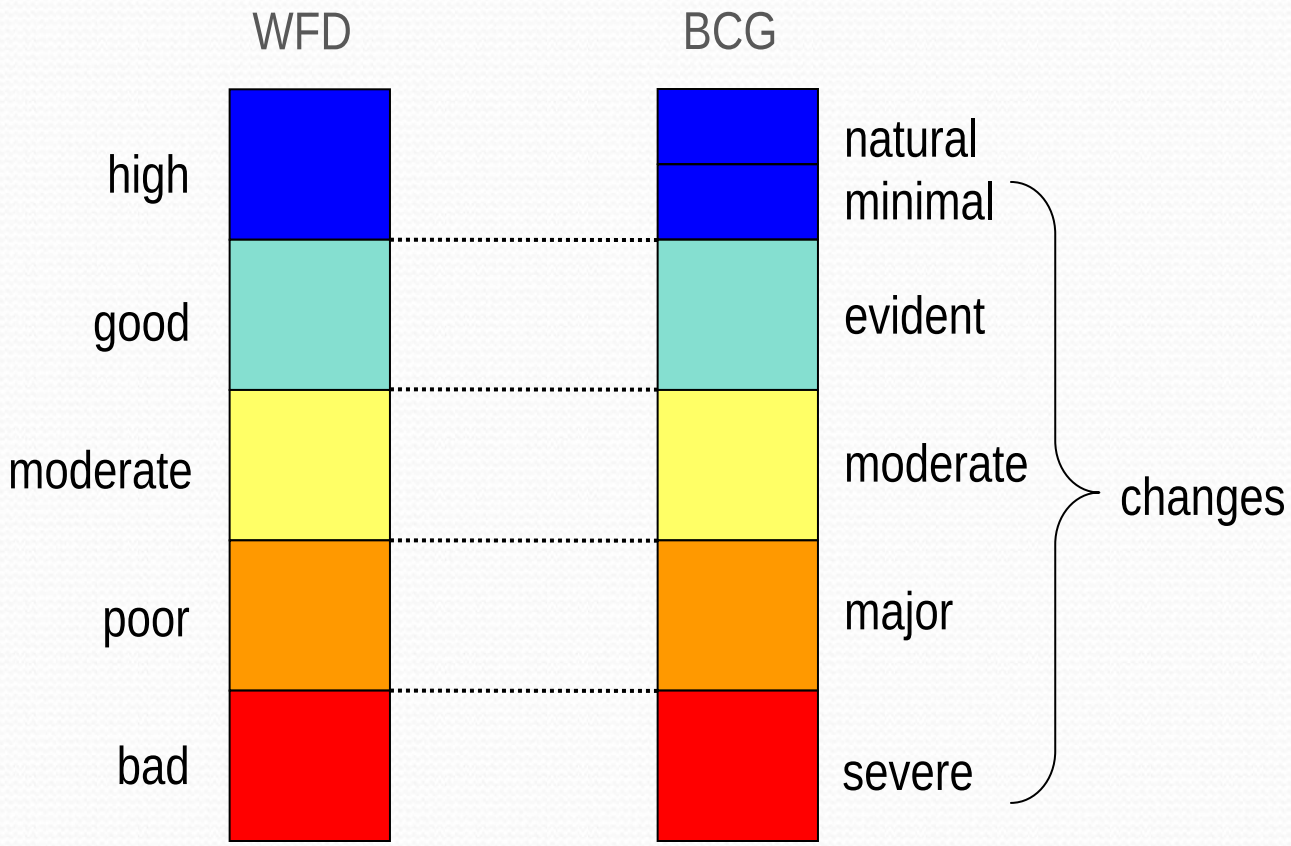
- How can we compare assessment results throughout Europe?
- Or compare them throughout the US?



The importance of a common definition of near-natural reference conditions in intercalibration. If the national assessment methods of two countries refer to different levels of human influence (Δ), the same EQRs represent different levels of impairment

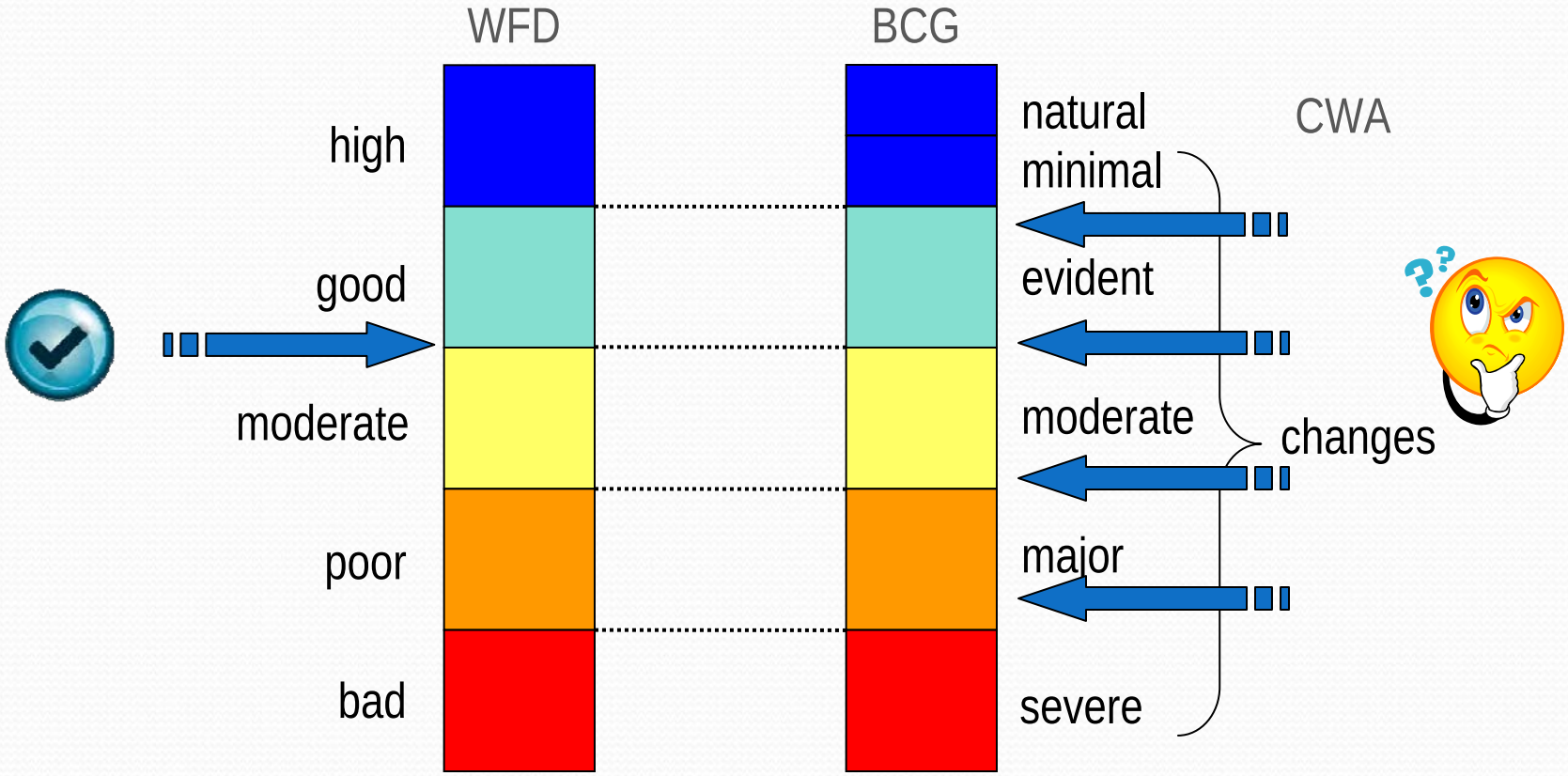
From the “Implementation Strategy for the Water Framework Directive (2000/60/EC)”

Translation of WFD EQC into BCG Tiers



Tentative translation of WFD ecological quality states into BCG tiers.

What about reference conditions and thresholds?



Reference condition and acceptable change is clear for the WFD….
What is reference condition and acceptable change for the CWA?

The BCG shows us this gap in understanding and decision making….

Departure from reference conditions

The expected condition to which current conditions are compared:

- "minimally disturbed condition" (MDC)
- "least disturbed condition" (LDC); and
- "best achievable condition" (BAC)



See *Stoddard et al. Ecological Applications, 16(4), 2006, pp. 1267–1276*

Lessons to be learned from the WFD….

- Biology is required (4 BQEs)
- Well defined reference conditions
- Ecological quality ratios and departure from reference
- Intercalibration is necessary
- Typology beyond ecoregions
- BCG is critical for transparency and communication
- Simple is good

Reference condition challenges from the WFD and BCG

- Clearly defining the goals and reference condition
  - (where along the gradient?)
- Characterizing the reference condition
- Proper classification and typology
- Selecting a decision threshold
  - (%tile of reference)
- Incorporating measurement error appropriately
- Required number of reference sites

Thank you for your attention !

Contact

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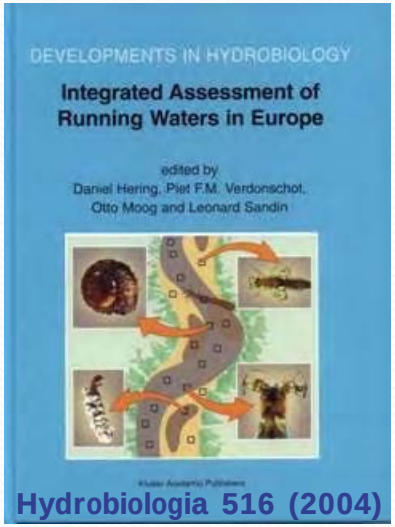
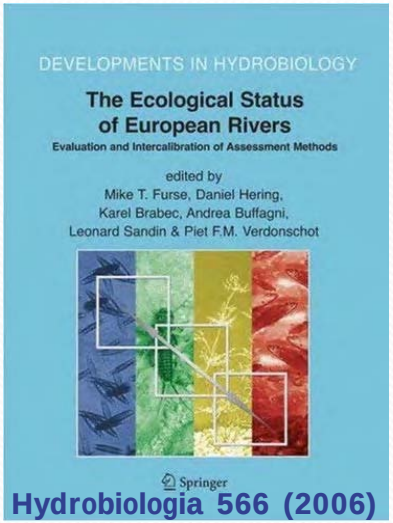
Read more:

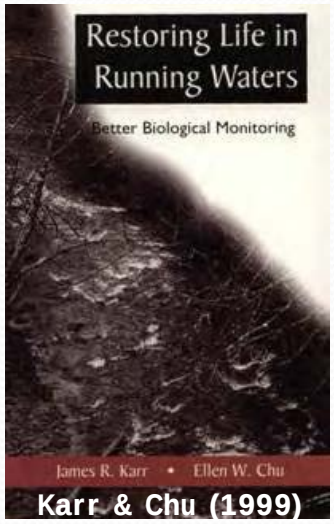
Limnologica 34(4) (2004)



Hydrobiologia 516 (2004)



Hydrobiologia 566 (2006)



Karr & Chu (1999)

www.fliessgewaesserbewertung.de