The German stream typology

(February 2004)

Typ 18: Sand- and lehmgeprägte Tieflandflüsse

Verteitung in Gewässerkorridoren

Assen über 300 m Breite: lang, lang, sandig. Assen über 300 m Breite: lang, sandig. Dünne Sandbelagung, Litoralbereiche, Grundmoräne, auch in sandigen Bereichen von Flussterrassen.

Übersichtstafel:

Lage (NH) Foto: T. Eise

Morphologie:


Entwässerung: Wasserflächen und Faltenflächen.


Akutvolumen:

Langsamere Einwanderung: 100 bis 1000 l/s EGS

Gesamtvolumen: 6,0 – 1,0%

Stromablauf: vorherrschend lang Fortlauf


Wasserbeschaffenheit:

typisch für mehr oder weniger deutlich karbonatischen Pegel auf.

Elektrische Leitfähigkeit (gelten): 400 – 900 

pH-Wert: 6,5 – 8,0

Durchschnittliche Laufzeit: 6 – 20

Alkalität des Flusses: Maßige bis große Alkalitätsschwankungen im Jahresverlauf, ausgeprägte Eisenansammlung der Eisenenegie.
Introduction

The EU Water Framework Directive (EU-WFD) demands that all assessments of surface waters must base on sound surface water typologies. The ecological status of a surface water body is described, based on the measured deviation from the type-specific reference conditions, which describe the natural or near-natural characteristics of a given water body type. The differentiation of natural surface water body types, for all categories of surface water bodies (streams, lakes, transitional waters and coastal waters) is thus a fundamental step for the implementation of the EU-WFD. The detailed description of typological entities serves to clearly differentiate between types and helps pinpoint their specific abiotic and biotic characteristics. The latter are of utter importance as delimited stream types must be biologically significant.

Also important is that the typological framework includes all sizes of water bodies relevant for the EU-WFD. For streams, these include all bodies of running water with at least 10km² catchment area, covering small, mid-sized, large and very large rivers.

The German Stream Typology

A fundamental draft for the German stream typology was laid out by Schmedtje et al. (2001). This served as a basis for discussion and numerous projects involved in developing stream assessment protocols in accordance with the implementation of the EU-WFD. This draft was developed further in several steps to the present typology. This development incorporated all relevant research projects involved in developing EU-WFD appropriate assessment protocols and was accompanied by the “Working Group of the Federal States on water problems” (LAWA) subcommittee “Biological Stream Assessment and Intercalibration in Accordance with the EU-WFD” (LAWA-Unterausschuss „Biologische Bewertung Fließgewässer und Interkalibrierung nach WRRL“). The German stream typology follows the System B approach as outlined in the EU-WFD. Obligatory and optional descriptors used to delineate German stream types include ecoregion, altitude, geology according to the river landscapes and regions (Briem 2003), stream slope and size.

The German stream typology was first developed following a “top down” approach, based on general, primarily geomorphologic landscapes in Germany and subsequently delimited in more detail, down to different size classes within stream types. Following this a “bottom up” validation of the types based on similarity analyses of large data sets from reference sites, with as little anthropogenic impairment as possible. The expertise from the federal states gained over the last few years in dealing with stream types went into developing the system and describing the stream types. Since this process is not ultimately finished, the typology and the “profiles” should be considered “living documents”, subject to further iteration, which, with the increasing experience in dealing with the stream types will be updated.

At the time of writing, February 2004, a total of 24 stream types have been defined for Germany: Four in the ecoregion Alps and Alpine foothills, eight in the central highlands and eight in the northern German lowlands. Another and four ecoregion independent stream types were delineated which are spread out across several ecoregions. The appendix contains the table of “Biocentically relevant stream types for Germany” and their short names. Four of the types are further broken down into sub types based on longitudinal differentiation.
These are stream types 1, 2, 3, 5 and 22. For technical reasons, the numbering of stream types is not continuous. As a result of further developing the first draft, some types were deleted or merged with others and their numbers are now missing in the list. On the other hand, defining new types in some cases brought on the need for decimals in some types; types defined by a decimal number can either represent a subtype or a completely independent type. The profile header gives clear definitions what the case is in each stream type with a decimal code number. Sub types are not considered in the 24 delimited types; they usually differ finely in their biocoenoses, while the basic morphological types show the same characteristics.

**Map of biocoenotically relevant stream types in Germany**

The stream types and subtypes are cartographically presented on the “Map of biocoenotically relevant stream types in Germany” (as of December 2003) (Pottgiesser et al. 2004). The Profiles are the detailed legend associated with the stream type map. Commissioned by the LAWA, this map depicts the network of all running waters relevant for the EU-WFD (DLM 1000 – Objektbereich Wasser: ATKIS®, DLM 1000; Copyright © Bundesamt für Kartographie und Geodäsie, 2003) and assigns each watercourse its appropriate stream type, as a linear object.

**Purview and objectives of the stream type descriptions in „profiles“**

The given stream type profiles serve to describe and illustrate stream types and create a common communication platform. They offer a contribution to the description of reference conditions, cannot however serve as the sole basis for describing reference conditions for biocoenotic assessment purposes. They also do not replace concrete, detailed reference taxa lists. These will be delivered by commissioned research projects in cooperation with state agencies.

The descriptions of the biocoenoses in the profiles are not complete. They cannot serve the purpose of checklists and should not be used as such. The species listed were rather selected for their specific ecological requirements, which are met by the characteristic habitat conditions found in a particular stream type. Not all species listed occur across the entire distribution of a given stream type. The authors are aware of the zoogeographic restrictions, but consider them subordinate in this context. As in every typology, the profiles describe the ideal, typical situation and cannot meet the demands of intermediate forms or individual conformation. The profiles are not a description of the present status of our watercourses, and must not be mistaken for such.

**Description of profiles and parameter selection:**

The header contains the number (code) of the stream type and the complete name. For stream types, which incorporate delimited sub types (e.g. sub type 1.1 in type 1), a comment is included in the header. The colour in the header refers to the colour by which the type represented in the “Map of biocoenotically relevant stream types in Germany”.

The common or characteristic association of stream types with certain natural physiographic regions is described in the “Distribution of river landscapes and regions in Germany” according to Briem (2003). The nomenclature of river landscapes and region follows Briem (2003).
The short morphological characterisation of each stream type is given as a text and complemented by a photograph as a means of illustration.

The short morphological characterisation and abiotic profile comprise the typical parameter configuration and characteristic stream morphological forms. The brief morphological description is text giving information on channel form, valley type and form, channel substrates, channel profile and incision, and water bodies present in the floodplain. The abiotic profile addresses parameters, which are generally fixed like catchment size (size grouping according to typology system A, EU-WFD) or valley slope, or parameters relevant for biotic colonisation like current flow and channel substrates. The numerical information given in this section, e.g. % valley slope, gives representative margins of values typical for a stream type. These margins are not absolute and are not a disqualification character for any given stream from a stream type. Between closely related stream types, these margins show overlap and intermediate forms.

Physico-chemical water conditions entails is a geological classification according to the EU-WFD (siliceous, calcareous, organic streams). “Organic” streams can form base-rich or base-poor variants (e.g. type 11 and type 12). The selection of chemical and physical water condition descriptors is limited to geogenic and geochemical parameters. In different stream types margins of values may overlap. This underlines the overlap and intermediate forms between some closely related stream types, which are not sharply delimited but rather transitional. Physical and chemical range of values are of exemplary character and not a disqualification character for any given stream from a stream type, especially since present-day water quality often differs greatly from natural, geological conditions.

The characterisation of Flow regime and hydrology includes information on annual patterns of discharge and comments on intermittent periods in surface discharge (summer dry or ephemeral variants)

For those stream types, where a sufficient data base exists, the characterisation of biological quality components – macroinvertebrate community, macrophyte and phytobenthos community, fish community – lists a number of typical species, supplemented by a description of functional groups. As requested by the LAWA, the profiles of the German stream types were to include a short characterisation of the fish fauna, and macrophyte and phytobenthos community structure. With the exception of the phytobenthos communities, this was realised.

The characterisation of biological quality components was kept general on purpose. Future data and more differentiated information are being gathered and evaluated in ongoing research projects and this knowledge will be used to supplement the present characterisations.

Acknowledgements

We wish to thank all members of the LAWA subcommittee “Biological Stream Assessment and Intercalibration in Accordance with the EU-WFD” (LAWA-Unterausschuss „Biologische Bewertung Fließgewässer und Interkalibrierung nach WRRL”) for the fruitful cooperation. Representative for all members, we extend our special thanks to the chairman Dr. Klaus Wendling. The working group “Fischereiliche Gewässerzustandsbewertung” and its chairman Dr. Rainer Berg are thanked for the very helpful and critical revision of fish fauna characterisations. We thank the photographers for allowing us to publish their material, without which the profiles would not be nearly as vivid.
References


Grundlage für die Erarbeitung der wichtigsten biozönotisch relevanten Fließgewässertypen im Sinne
der Wasserrahmenrichtlinie (Typentabelle) (unveröffentl.).

SOMMERHÄUSER, M. & H. SCHUHMACHER (2003): Handbuch der Fließgewässer Norddeutschlands – Typolo-
gie, Bewertung, Management. Atlas für die limnologische Praxis. – ecomed. Landsberg am Lech:
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WOLFF, P. (1999): Vegetation und Ökologie der nährstoffarmen Fließgewässer der Pfalz. - Pollichia-Buch 37:
125 S.
### Biocoenotically relevant stream types for Germany

- **Quality element Makrozoobenthos**

M. Sommerhäuser & T. Pottgiesser (February 2004)

<table>
<thead>
<tr>
<th>Selected river landscapes and regions according to Briem (2003)</th>
<th>biocoenotically type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size class¹ ²</td>
</tr>
<tr>
<td></td>
<td>small river</td>
</tr>
<tr>
<td></td>
<td>mid-sized river</td>
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<tr>
<td></td>
<td>large river</td>
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<td></td>
<td>very large river</td>
</tr>
</tbody>
</table>

#### Ecoregion 4: Alps, altitude > 800 m

Calcareous Alps, Flysch-Alps

<table>
<thead>
<tr>
<th>Alpine foothills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary hills, river terraces, lower river terraces, old moraines</td>
</tr>
<tr>
<td>Pleistocene moraine landscapes</td>
</tr>
<tr>
<td>Floodplains (over 300 m wide)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ecoregion 9 (and 8): Central highlands and Alpine foothills, altitude ca. 200 - 800 m and higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine foothills</td>
</tr>
<tr>
<td>Tertiary hills, river terraces, lower river terraces, old moraines</td>
</tr>
<tr>
<td>Pleistocene moraine landscapes</td>
</tr>
<tr>
<td>Floodplains (over 300 m wide)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Central highlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gneiss, granites, schists, volcanis regions</td>
</tr>
<tr>
<td>Buntsandstein sandstone, sandy deposits</td>
</tr>
<tr>
<td>Loess regions, upper Triassic rocks, middle and lower Jurassic</td>
</tr>
<tr>
<td>Lacustrine limstones, lower and middle Jurassic stones, upper Jurassic limestone, Cretaceous rocks</td>
</tr>
<tr>
<td>Floodplains (over 300 m wide)</td>
</tr>
</tbody>
</table>

#### Ecoregion 14: Central plains, altitude < 200 m

Outwash plains, sandy deposits, ground and terminal moraines                                    |

<table>
<thead>
<tr>
<th>Ecoregion independent stream types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outwash plains, loess regions, floodplains (paludificated)</td>
</tr>
<tr>
<td>Floodplains (over 300 m wide)</td>
</tr>
<tr>
<td>Outwash plains, ground and terminal moraines</td>
</tr>
</tbody>
</table>
Concerning size categories of streams: The short descriptors „small river“, „mid-sized river“, „large river“ and „very large river“ indicate size classes of stream catchments and refer to the size categories of the EU-WFD. Longitudinal biological characteristics of streams do not change in the same way in all stream types as catchment size category increases; therefore, it is noted that these categories serve as an orientation. They are however important concrete parameters for selecting and managing assessment sites in databases.

- **small catchment („small river“):** ca. 10-100 km²
- **mid-sized catchment („mid-sized river“):** ca. >100-1.000 km²
- **large catchment („large river“):** ca. >1.000-10.000 km²
- **very large catchment („very large river“):** ca. >10.000 km²

The stream types listed in the table are not fully differentiated with respect to longitudinal biocoenotic and relevant zoogeographic aspects. This must be taken into consideration when type specific biological reference conditions are defined and described (especially with respect to the biological quality component fish).

Differentiation in sub type 1.1 „Small and mid-sized rivers of the Calcareous Alps“ and sub type 1.2 „Large rivers of the Calcareous Alps“.

Differentiation in sub type 2.1 „Small rivers in the alpine foothills“ and sub type 2.2 „Mid-sized rivers in the alpine foothills“.

Differentiation in sub type 3.1 „Small rivers in the Pleistocene sediments of the alpine foothills“ and sub type 3.2 „Mid-sized rivers in the Pleistocene sediments of the alpine foothills“.

Differentiation of types is still in progress.
Short names of the biocenotically relevant stream types for Germany

T. Pottgiesser & M. Sommerhäuser (February 2004)

Types in the Alps and Alpine foothills
Type 1: Alpine streams
Type 2: Streams in the alpine foothills
Type 3: Streams in the Pleistocene sediments of the alpine foothills
Type 4: Large rivers in the alpine foothills

Types in the central highlands
Type 5: Small coarse substrate dominated siliceous highland rivers
Type 5.1: Small fine substrate dominated siliceous highland rivers
Type 6: Small fine substrate dominated calcareous highland rivers
Type 7: Small coarse substrate dominated calcareous highland rivers
Type 9: Mid-sized fine to coarse substrate dominated siliceous highland rivers
Type 9.1: Mid-sized fine to coarse substrate dominated calcareous highland rivers
Type 9.2: Large highland rivers
Type 10: Very large gravel-dominated rivers

Types in the central plains
Type 14: Small sand-dominated lowland rivers
Type 15: Mid-sized and large sand and loam-dominated lowland rivers
Type 16: Small gravel-dominated lowland rivers
Type 17: Mid-sized and large gravel-dominated lowland rivers
Type 18: Small loess and loam-dominated lowland rivers
Type 20: Very large sand-dominated rivers
Type 22: Marshland streams of the coastal plains
Type 23: Backwater and brackish water influenced Baltic Sea tributaries

Ecoregion independent stream types
Type 11: Small organic substrate-dominated rivers
Type 12: Mid-sized and large organic substrate-dominated rivers
Type 19: Small streams in riverine floodplains
Type 21: Lake outflows

1 Differentiation in sub type 1.1 „Small and mid-sized rivers of the Calcareous Alps“ and sub type 1.2 „Large rivers of the Calcareous Alps“.
2 Differentiation in sub type 2.1 „Small rivers in the alpine foothills“ and sub type 2.2 „Mid-sized rivers in the alpine foothills“.
3 Differentiation in sub type 3.1 „Small rivers in the Pleistocene sediments of the alpine foothills“ and sub type 3.2 „Mid-sized rivers in the Pleistocene sediments of the alpine foothills“.
4 Differentiation of types is still in progress.
### Type 1: Alpine streams
(Sub types 1.1 and 1.2)

**Distribution in river landscapes and regions according to Briem (2003):**

Calcareous Alps, Flysch-Alps, large coarse material floodplains (over 300 m wide)

**Short description of morphology:**

Stream type 1 incorporates calcareous alpine watercourses of various sizes, from small and mid-sized rivers (sub type 1.1) to large rivers (sub type 1.2). Small rivers run straight or sinuous through v-shaped or u-shaped valleys. The large rivers usually flow in braided channels through fluvial deposits in main stem valleys, while mid-sized rivers flow in secondary v-shaped and u-shaped valleys, where fluvial sediments form the valley floor. The dominant substrates in all streams are boulders and cobble (bedload). In some stretches the streambed is cleared of loose substrate and the stream flows over bedrock. Finer substrates are relatively rare.

**Abiotic profile:**

<table>
<thead>
<tr>
<th>Size class:</th>
<th>10 - 10,000 km² catchment area</th>
</tr>
</thead>
<tbody>
<tr>
<td>(sub type 1.1 small and mid-sized rivers: 10 - 1,000 km² catchment area)</td>
<td></td>
</tr>
<tr>
<td>(sub type 1.2 large rivers: 1,000 - 10,000 km² catchment area)</td>
<td></td>
</tr>
<tr>
<td>Slope of the valley floor:</td>
<td>6 - 45 ‰</td>
</tr>
<tr>
<td>Flow category:</td>
<td>turbulent</td>
</tr>
<tr>
<td>Channel substrate:</td>
<td>boulders, cobbles, gravel, coarse sand</td>
</tr>
</tbody>
</table>

**Physico-chemical water conditions:**

- Conductivity [µS/cm]: 170 - 460
- pH-value: 7.7 - 8.5
- Alkalinity [°dH]:
- Total hardness [°dH]:

**Flow regime & hydrology:**

Alpine flow regime with severe annual fluctuation and strongly pronounced extreme flow conditions during spates or low-flow periods.
Type 1: Alpine streams
(Sub types 1.1 and 1.2)

Characterisation of the macroinvertebrate community:

**Functional groups:** The benthic macroinvertebrate community is very species-rich. With respect to current, oxygen demand and water temperatures species with very particular demands abound. The prominent substrates (boulders and cobble) are suitable habitat for rheophilic stone-dwelling species, which dominate the benthic macroinvertebrate community. Filter-feeding is the most common functional feeding type. In terms of longitudinal biocoenotic regions, epirhithral species are prevalent, especially in sub type 1.1. Remarkable is the limited number of Crustaceans in the biocoenosis.

**Selection of type-specific species in small and mid-sized rivers (sub type 1.1):**

**Selection of type-specific species in large rivers (sub type 1.1 and sub type 1.2):**

Characterisation of macrophyte and phytobenthos communities:

**Selection of type-specific macrophyte species:** *Chara aspera*, *C. hispida*, *C. intermedia*, *Mentha aquatica* (submers), *Juncus articulatus*, *Myriophyllum alterniflorum*, *Callitriche hamulata*, *Chiloscyphus polyanthos*, *Potamogeton alpinus*, *Ranunculus peltatus*.

**Selection of type-specific diatom species in small and mid-sized rivers (sub type 1.1):** *Achnanthes biasolettiana*, *Cymbella delicatula*, *Cymbella affinis*, *Denticula tenuis*, *Gomphonema angustum*. Trophic status: ultra-oligotroph to oligotroph.

**Selection of type-specific diatom species in large rivers (sub type 1.2):** *Achnanthes biasolettiana*, *Achnanthes minutissima*, *Gomphonema angustum*. Trophic status: ultra-oligotroph to oligo-mesotroph.

Characterisation of the fish fauna:

For the most part, Alpine streams belong to the trout region. Typical inhabitants include the brook trout and bullhead, in mid-sized rivers also grayling. In small rivers, often only brook trout are found. Generally, watercourses with steep slopes only support fish temporarily or not at all.

Comments:

Stream type 1 „Alpine rivers“ is readily distinguished into two subtypes longitudinally, based on the diatom colonisation: Sub type 1.1 „Small and mid-sized rivers of the Calcareous Alps“ and sub type 1.2 „Large rivers of the Calcareous Alps“. For stream assessment purposes longitudinal differentiation of the biocoenoses and/or local particularities should be taken into consideration.

Examples of typical streams

**Macroinvertebrates:** Lindenbach, Ostrach, Tiroler Achen (Bavaria)
**Macrophytes and phytobenthos:** Lauterbach, Isar, Ammer, Inn (Bavaria)

Comparative literature (selection):

T. POTTOESSER & M. SOMMERHAUSER 2004: Profiles of German Stream Types
Type 2: Streams in the alpine foothills
(Sub types 2.1 and 2.2)

Distribution in river landscapes and regions according to Briem (2003):
Tertiary hills, old moraines (ground and terminal moraines) and river terraces, lower river terraces, occasionally in loess regions

Picture:

Kleine Laber (Bavaria). Photograph: Bavarian Water Management Agency (LfW)

Short description of morphology:
Stream type 2 „Streams in the alpine foothills“ comprises both small rivers (sub type 2.1) and mid-sized rivers (sub type 2.2). Characteristic for these stream types is the winding and meandering channel form. Dominant substrates are cobble and depending on catchment geology gravel with varying shares of sand and loam. Cobble and gravel bars with some argyllal and valley peat intrusions are common. Slowly flowing pool sections are disrupted by fast flowing riffles.

Abiotic profile:
Size class: 10 - 1.000 km² catchment area
(Sub type 2.1 small rivers: 10 - 100 km² catchment area)
(Sub type 2.2 mid-sized rivers: 100 - 1.000 km² catchment area)
Slope of the valley floor: > 0,5 ‰
Flow category: slow flowing with fast flowing riffles sections
Channel substrates: cobble, gravel, sand, clay, silt

Physico-chemical water conditions:
(slightly) calcareous or siliceous
Conductivity [µS/cm]: 300 - 400
pH-value: 7,9 - 8,4
Alkalinity [°dH]:
Total hardness [°dH]:

Flow regime & hydrology:
High fluctuations in discharge over the year, with very pronounced extreme discharge events.
Type 2: Streams in the alpine foothills
(Sub types 2.1 and 2.2)

**Characterisation of the macroinvertebrate community:**

**Functional Groups:** The macroinvertebrate community is dominated by rheophilic stone-dwellers. Besides these, species inhabiting the small gravel and sand patches also occur. With respect to abiotic parameters (current velocity, oxygen supply and water temperature) demanding species are prevalent. In sub type 2.1 species of the epirhithral are abundant.

**Selection of type-specific species in small rivers (sub type 2.1):**


**Selection of type-specific species in mid-sized rivers (sub type 2.2):**


**Characterisation of macrophyte and phytobenthos communities:**

**Selection of type-specific macrophyte species:** *Callitriche obtusangula, Hygroamblystegium fluviatile, Brachythecium rivulare, Bryum argenteum, Cratoneuron filicinum, Callitriche hamulata.*

**Selection of type-specific diatom species:** *Achnanthes biasolettiana, Achnanthes minutissima, Cymbella microcephala.*

**Characterisation of the fish fauna:**

Small rivers offer suitable habitat for brook trout, bullhead, minnow and stone loach. Mid-sized rivers generally represent the grayling and barbel regions. In this stream type, gravel-spawning species like grayling, nase, barbel and indifferent species like chub and roach are common. Typical small fish species are schneider and gudgeon. Often the grayling region fauna is not developed. In temporary small rivers of this stream type, the fish fauna can be reduced or absent depending on the extent and length of dry periods.

**Comments:**

Stream type 2 „Streams in the alpine foothills“ comprises two longitudinal sub types: small rivers (sub type 2.1) and mid-sized rivers (sub type 2.2). Longitudinal, biotic differentiation and local particularities should be considered in stream assessment.

**Examples of typical streams**

**Macrophytes and phytobenthos:** Baierzer Rot (Baden-Württemburg), Schrannenbach (Bavaria)

**Comparative literature (selection):**

T. POTGGIESSER & M. SOMMERHÄUSER 2004: Profiles of German Stream Types
Type 3: Streams in the Pleistocene sediments of the alpine foothills
(Sub types 3.1 and 3.2)

Distribution in river landscapes and regions according to Briem (2003):

Pleistocene moraine landscapes (ground and terminal moraines), folding molasses of Alpine piedmont

Picture:

This stream type exhibits meandering to straight channel forms, running through v-shaped valleys, troughs or u-shaped valleys. The predominantly single channels, are generally shallow and wide. Some anabranching or sections with islands occur. Dominant channel substrates are boulders, cobbles and gravel. Streams running through end moraines are more dynamic in flow than those on the base moraine. Stream type 3 comprises both small and mid-sized rivers in the Pleistocene moraines of the Alpine piedmont. Mid-sized rivers (sub type 3.2) are often the middle and lower reaches of lake outflows (Type 21).

Abiotic profile:

Size class: 10 - 1.000 km² catchment area
(sub type 3.1 small rivers: 10 - 100 km² catchment area)
(sub type 3.2 mid-sized rivers: 100 - 1.000 km² catchment area)

Slope of the valley floor: 10 - 40 ‰
Flow category: turbulent
Channel substrates: boulders, cobbles and gravel dominate

Physico-chemical water conditions:

Predominantly calcareous

Conductivity [µS/cm]: 250 - 440
pH-value: 7.8 - 8.5
Alkalinity [°dH]:
Total hardness [°dH]:

Flow regime & hydrology:
Type 3: Streams in the Pleistocene sediments of the alpine foothills

(Sub types 3.1 and 3.2)

Characterisation of the macroinvertebrate community:

Functional groups: The macroinvertebrate community is very species rich: demanding species in respect to abiotic parameters (current velocity, oxygen supply and water temperature) dominate the coenosis. Rheophile, stone-dwelling species are most abundant, while species inhabiting smaller patches with finer sediments are less common. Epirhithral species are particularly frequent in sub type 3.1.

Selection of type-specific species in small rivers (sub type 3.1):

Selection of type-specific species in mid-sized rivers (sub type 3.2):

Characterisation of macrophyte and phytobenthos communities:

Selection of type-specific macrophyte species: Callitriche obtusangula, Hygroamblystegium fluviatile, Brachythecium rivulare, Bryum argenteum, Cratoneuron filicinum, Callitriche hamulata.

Selection of type-specific diatom species: Achnanthes biasolettiana, Amphora pediculus, Gomphonema pumilum, Gomphonema tergestinum, Navicula cryptotenella, Nitzschia fontica.

Characterisation of the fish fauna:
Small rivers offer suitable habitat for brook trout, bullhead, minnow and stone loach. Mid-sized rivers generally represent the grayling region. They typically support gravel spawning species like grayling and nase and more indifferent species like gudgeon or chub. In the temporary variant of the stream type, the fish fauna can be reduced or absent depending on the extent and length of dry periods.

Comments:
Stream type 3 „Rivers in the Pleistocene sediments of the alpine foothills“ comprises two longitudinal sub types: small rivers (sub type 3.1) and mid-sized rivers (sub type 3.2). Longitudinal, biotic differentiation and local particularities should be considered in stream assessment.

Examples of typical streams
Macroinvertebrates: Hardtbach, Rott, Thalkirchner Ache (Bavaria)
Macrophytes and phytoevelobothos: Schlitbach (Bavaria), Obere Argen (Baden-Württemberg)

Comparative literature (selection):
Type 4: Large rivers in the alpine foothills

Distribution in river landscapes and regions according to Briem (2003):

Large coarse material floodplain (over 300 m wide)

Picture:

Inn (Bavaria). Photograph: Bavarian Water Management Agency (LfW)

Short description of morphology:

Large streams with springs in the Alps. Dominant substrates are boulders, cobble, gravel and sand. Average grain size decreases continually downstream and the share of finer substrates increases. Suspended fine material can lead to turbid water during spates or high discharge periods. During floods, the entire channel bed is altered: strong discharge events move enormous amounts of cobbles and boulders despite relatively low stream slopes. The channel form becomes braided with anastomising channels in narrow to wide u-shaped valleys. Lateral erosion occurs, numerous unvegetated islands and cobble bars form. This leads to a highly dynamic, winding, multiple channel river form, with very high structural diversity. Important structures also occur in the floodplain, including standing water bodies and connected temporary or permanent side arms. Besides braided sections, single channel reaches occur.

Abiotic profile:

Size class: 1.000 - 10.000 km² catchment area
Slope of the valley floor: > 2 %
Flow category:
Channel substrates: dominant substrates are cobbles, subordinate are boulders and gravel, while finer substrates occur in smaller shares

Physico-chemical water conditions:
calcareous
Conductivity [µS/cm]: 250 - 350
pH-value: 8.0 - 8.6
Alkalinity [°dH]:
Total hardness [°dH]:

Flow regime & hydrology:
Alpine flow regime with severe fluctuation over the year and strongly pronounced extreme flow conditions during spates or low-flow periods.
Type 4: Large rivers in the alpine foothills

Characterisation of the macroinvertebrate community:

**Functional groups:** The macroinvertebrate community is very diverse: Demanding species in respect to abiotic parameters (current velocity, oxygen supply and water temperature) dominate the coenosis. Rheophile, stone-dwelling species are abundant. Besides these, species inhabiting smaller patches or gravel and sand occur. The share of epirhithral species is low.


Characterisation of macrophyte and phytobenthos communities:

**Selection of type-specific macrophyte species:** *Chara aspera*, *C. hispida*, *C. intermedia*, *Mentha aquatica* (submerged), *Juncus articulatus*, *Myriophyllum alterniflorum*, *Callitriche hamulata*, *Chloscyphys polyanthos*, *Potamogeton alpinus*, *Ranunculus peltatus*.

**Selection of type-specific diatom species:** *Achnanthes biaesolettiana*, *Amphora pediculus*, *Cocconeis placentula*, *Cymbella silesiaca*, *Cymbella sinuata*, *Denticula tenuis*, *Gomphonema olivaceum*, *Gomphonema pusillum*, *Gomphonema tergestinum*.

Characterisation of the fish fauna:

Streams with cool water temperatures in summer support grayling region fauna, while warmer streams support a fauna typical for the barbel region. Characteristic are gravel-spawning species like grayling, barbel, and nase. Species endemic to the Danube region like huchen and sandsmelt occur. In the downstream reaches euryoecious species like roach, pike and perch become increasingly important. Among others, abandoned side arms support bream and rudd.

Comments:

Longitudinal, biotic differentiation and local particularities should be considered in stream assessment.

Examples of typical streams:

**Macroinvertebrates:** Lech (Bavaria)

**Macrophytes and phytobenthos:** Lech (Bavaria)

Comparative literature (selection):
**Type 5:** Small coarse substrate dominated siliceous highland rivers

*(incl. Sub type 5.2)*

**Distribution in river landscapes and regions according to Briem (2003):**

Schists, gneiss, granites and similar rocks, volcanic regions

**Picture:**

*Kleine Schmalenau (North Rhine-Westphalia). Photograph: T. Ehlert*

**Short description of morphology:**

Streams of this type run in different valley forms depending on distance to source and the local conditions. Depending on the valley shape – v-shaped valleys, troughs, u-shaped valleys – the stream channel is either straight, sinuous or (slightly) meandering. Beside single channel forms, rivers with numerous secondary channels occur. The channel substrates are dominated by cobbles and boulders, which form numerous and large cobble bars. Locally large boulders and bedrock are found as substrates. The interstitial is well developed. In pools with slow current flow and in slip-off slope regions, finer substrates are found. The channel profile is usually very flat. Characteristic is a regular sequence of riffle and pool sections. Below perpendicular structures (debris dams, alder root bales) deep scour pools form. Specific variants of this type are found in volcanic regions (ub type 5.2), which are best differentiated by the diatom community.

**Abiotic profile:**

- **Size class:** 10 - 100 km² catchment area
- **Slope of the valley floor:** 10 - 50 ‰
- **Flow category:** turbulent and fast flowing current, characteristic sequence of shallow turbulent riffles and deeper pools with calmer flow
- **Channel substrate:** cobbles, rocks and gravel dominate; locally large boulders can dominate, while finer substrates are subordinate

**Physico-chemical water conditions:**

- **Conductivity [µS/cm]:** 50 - 300
- **pH-value:** 6,5 - 8,0
- **Alkalinity ['dH]:** <1 - 6
- **Total hardness ['dH]:** 1 – 10

**Flow regime & hydrology:**

High fluctuations in discharge over the year, with very pronounced extreme discharge events.
Type 5: Small coarse substrate dominated siliceous highland rivers

(incl. Sub type 5.2)

Characterisation of the macroinvertebrate community:

**Functional groups:** The macroinvertebrate community is generally species rich. With respect to abiotic parameters (current velocity, oxygen supply and water temperature) demanding species are prevalent. Inhabitants of the coarse cobble substrates dominate, to a lesser extent, fine sediment inhabitants are found. In terms of feeding types, abundance of grazers and a smaller share of shredders are typical. Biocoenotically, species of the epirhithral and metarhithral regions dominate.

**Selection of type-specific species:** Besides species which predominantly inhabit smaller streams like the stonefly *Perla marginata* and the caddis fly *Philopotamus* spec., typically metarhithral species abound. These include the mayflies *Baetis scambus*, *Ecdyonurus torrentis* and *Epeorus assimilis*, the stoneflies *Perlodes microcephalus* and *Protonemura* spec. as well as various species from the family Chloroperlidae. Typical caddis flies are *Micrasema longulum* und *Sericostoma* spec.. Because the interstitial is well developed, typical inhabitants of this microhabitat like stoneflies of the genus *Leuctra* and beetles from the genus *Esolus* occur.

Characterisation of macrophyte and pyhtobenthos communities:

Higher aquatic plants are generally absent. On stable substrates aquatic moss can develop, like *Scapania undulata*, *Rynchostegium riparioides* or *Fontinalis anipyretica* as well as freshwater red algae of the genus *Lemanea*.

Characterisation of the fish fauna:

Streams of this type usually belong to the upper trout regions and are inhabited by gravel-spawning species like the brook trout and species, which depend on sandy substrates as juveniles like the brook lamprey. The bullhead also occurs. In parts migratory fish like the salmon complement the fauna.

Comments:

This stream type corresponds to the “classic” cobble dominated highland stream. Streams of this type are vulnerable to acidification.

Specific variants of this stream type occur in volcanic regions (Sub type 5.2), which are especially different with respect to the diatom community.

Examples of typical streams

**Macroinvertebrates:** Kleine Schmalenau, Heve, Weiße Wehe (North Rhine-Westphalia), Elbrighäuser Bach (Hesse), Wilde Gutach (Baden-Württemberg)

**Macrophytes and phytobenthos:** Wilde Rodach (Bavaria), Olef, Lörmecke (North Rhine-Westphalia), Sub type 5.2: Lüder, Kerkenbach (Hesse)

Comparative literature (selection):

Type 5.1: Small fine substrate dominated siliceous highland rivers

Distribution in river landscapes and regions according to Briem (2003):

Buntsandstein sandstone, sandy deposits

Picture: Kinzig (Hesse). Photograph: E. Briem

Short description of morphology:

Streams of this type run in different valley forms depending on distance to source and the local conditions. Depending on the valley shape – v-shaped valleys, troughs, u-shaped valleys – the stream channel is either straight, sinuous or meandering. Sand and gravel dominate as substrate, locally cobbles can occur. Bank cliffs and slip-off slopes are often developed. The alternation of pool and riffle sequences occurs over relatively short stretches. The channel profile is flat, locally marginal sand or gravel bars develop. As in the somewhat comparable "lowland sand streams" lateral erosion along banks can lead to eroding bank cliffs.

Abiotic profile:

- Size class: 10 - 100 km² catchment area
- Slope of the valley floor: 4 - 50 ‰
- Flow category: generally calmly flowing current, locally fast and turbulent flow
- Channel substrate: sand and gravel dominate, locally rocks occur; coarse woody debris is the most important hard substrate

Physico-chemical water conditions:

- Conductivity [µS/cm]: 50 - 180
- pH-value: 5,0 - 8,0
- Alkalinity ['°dH']: <1 - 3
- Total hardness ['°dH']: 1 - 5

Flow regime & hydrology:

Discharge is relatively steady.
Type 5.1: Small fine substrate dominated siliceous highland rivers

**Characterisation of the macroinvertebrate community:**

*Functional groups:* Compared with other highland stream types, rather poor macroinvertebrate fauna. Rheophile stone-dwelling species dominate in riffles, while pools and stable sand deposits are colonised by fine substrate inhabitants. Generally the species are cold-adapted or cold-stenothermous, adapted to strong current. Colonisers of aquatic moss are frequent. In contrast to the "classic" highland stream (Type 5: Small coarse substrate dominated siliceous highland rivers), gatherers/collectors and shredders dominate.

*Selection of type-specific species:* Typical species of turbulent riffles are caddis flies of the genera *Micrasema* and *Lype*. The slow flowing, stable sand deposits are rich in detritus and are inhabited by burrowing species like the mayfly *Ephemera danica* or by shallow burrowers like the dragonfly *Cordulegaster boltonii*. Species of the interstitial are completely absent or very rare.

**Characterisation of macrophyte and phytobenthos communities:**

A typical higher plant found in these streams is *Callitriche* spec.. The macrophytes community is dominated by aquatic moss; characteristic for this stream type is the *Scapanietum undulatae* community.

**Characterisation of the fish fauna:**

This stream type supports a rather species poor fish fauna. In highly acidic streams fish are completely absent. Besides brook trout, bullhead and brook lamprey are characteristic species in these streams. As a result of the high share of fine sediments, brook lamprey can reach high abundances.

**Comments:**

The sand dominated streams of this type, resemble sand streams of the lowlands. This stream type has little buffering capacity and is susceptible to acidification.

**Examples of typical streams**

*Macroinvertebrates:* Speyerbach, Wellbach, Schwarzbach (Palatinate Forest, Rhineland-Palatinate), Ilme (Lower Saxony), Seebach (Baden-Württemberg)

*Macrophytes and phytobenthos:* Aubach (Bavaria), Wieslauter (Rhineland-Palatinate)

**Comparative literature (selection):**

Type 6: Small fine substrate dominated calcareous highland rivers

Distribution in river landscapes and regions according to Briem (2003):

Loess regions, upper Triassic rocks, Permian rocks (sandstone, claystone, conglomerate rocks), middle and lower Jurassic (sandstone, claystone and marl)

Picture:


Short description of morphology:

Sinuate to meandering streams, dominated by fine substrate. As a result of erosion in soft sediments, the streams are cut-in and run in entrenched channels often exhibiting undercut banks or eroding cliffs. Channel substrate is dominated by silt, loess, clay or fine sand. Occasional cobbles and boulders and gravel-dominated sections can occur. The palette is completed by organic substrates like coarse woody debris or coarse particulate organic matter, e.g. leaf packs. The muddy, sandy sections are covered by a varying degree of gravel and loess, resulting in a diverse mosaic of fine sediments. Streams of this type are often rich in nutrients and suspended matter. A distinct interstitial zone is usually missing.

Abiotic profile:

Size class: 10 - 100km² catchment area
Slope of the valley floor: 4 - 30 ‰
Flow category: calm to quickly flowing
Channel substrates: loam, clay and sand dominate; gravel, rocks and occasional cobbles or boulders occur.

Physico-chemical water conditions:
calcareous

Conductivity [µS/cm]: 450 - 800
pH-value: 7,0 - 8,5
Alkalinity [°dH]: 8 - 40
Total hardness [°dH]: 10 – 50

Flow regime & hydrology:

Large fluctuations in discharge over the year.
Type 6: Small fine substrate dominated calcareous highland rivers

Characterisation of the macroinvertebrate community:

**Functional groups:** Rheophilic hard substrate dwellers and fine substrate dwellers occur in equal parts. Most species are euryoecious stream species, while specialists are rare. The proportion of fine substrate or macrophyte inhabiting species is high. Many species are biocenotically considered me-tarthirhal. Some species are found, which also occur in lowland streams.

**Selection of type-specific species:** Characteristic for the fine channel sediments is the burrowing mayfly *Ephemera danica*. Other typical inhabitants include the mayfly *Siphlonurus aestivalis*, the caddis fly *Hydropsyche siltalai* and *H. pellucidula*-Gr., and the Snipe fly *Atherix ibis*. Typical is also the frequent occurrence of *Gammarus roeseli*.

Characterisation of macrophyte and phytothecos communities:

Mosses are the most prominent macrophytes, while other water plants play a lesser role or are completely absent. Stable hard substrates, e.g. alder roots and larger rocks are colonised by the mosses *Fontinalis antipyretica* and *Rhynchostegium riparioides*.

Characterisation of the fish fauna:

Characteristic fish are those common in all highland streams: brook trout, bullhead, and brook lamprey. Suitable habitat for ammocoete of brook lamprey, which prefer sandy or muddy substrates with high organic content, is abundant.

Comments: Possible confusion with other stream types: The highland loess-loam streams of this type are morphologically similar to those of the lowland stream type 18 (Loess and loam dominated Lowland streams). Faunistically however, stream type 6 is dominated by highland species, although some species occur, which are also often found in lowland streams.

Examples of typical streams  
**Macroinvertebrates:** Brettach, Rot, Wieslauf (Baden-Württemberg)  
**Macrophytes and phytothecos:** Schweinenaab, Dachsgraben (Bavaria)

Type 7: Small coarse substrate dominated calcareous highland rivers

Distribution in river landscapes and regions according to Briem (2003):
Lacustrine limestone, Lower and Middle Jurassic stones, Upper Jurassic limestone, Cretaceous rocks

Picture: Talgasse (intermittent variant of the type) (North Rhine-Westphalia). Photograph: T. Ehlert

Short description of morphology:
Streams of this type occur in v-shaped valleys, troughs or u-shaped valleys and flow in straight to strongly sinuous channels. The channel substrates are dominated by boulders and cobbles. In calmer sections along the shore, finer sediments like sand and mud are also found. In some streams there are signs of calc-sinter deposits (limestone tuffs on rocks). In single channel beds of the temporary streams, we find conspicuously coarse rocky substrates (flat cobbles and boulders), and after dry periods large amounts of organic matter (fallen leaves, woody debris). The alternation of riffle and pool sections, typical for most highland streams, is often not pronounced in this stream type.

Abiotic profile:
Size class: 10 - 100 km² catchment area
Slope of the valley floor: 10 – 50 %
Flow category: calm to quickly flowing current, in parts turbulent
Channel substrate: coarse cobbles and rocks dominate, finer mineral fractions and organic substrates also occur

Physico-chemical water conditions:
calcareous
Conductivity [µS/cm]: 400 - 900
pH-value: 7,5 - 8,5
Alkalinity ['dH]: 6 - 17
Total hardness ['dH]: 8 – 34

Flow regime & hydrology:
Large fluctuation in discharge over the year, with dry, intermittent flow periods possible. Typical for the temporary variant of the type (karst streams) are streamsinks, where surface streams seep away and continue to flow in the limestone aquifer and reappear at the surface in karst springs. Karst springs with high discharge can often form larger streams immediately after surfacing; karst streams are often fed by water of "foreign" regions.
### Type 7: Small coarse substrate dominated calcareous highland rivers

<table>
<thead>
<tr>
<th>Characterisation of the macroinvertebrate community:</th>
<th>Functional groups: Permanently flowing reaches often support high numbers of species and individuals. Rheophilic stone-dwelling species dominate, but strongly decline during intermittent flow periods in the temporary variants of this stream type. Temporary reaches sustain lower numbers of taxa and individuals. Characteristic are species adapted to intermittent flow patterns and those exhibiting strong tolerance of or preferences for high carbonate water concentrations and/or limestone tuff formation on substrates. During flow periods, the fauna of temporary and permanent variants of this stream type differ only minimally.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of type-specific species: Besides many common highland stream taxa, a number of specialised species occur, which are adapted to the intermittent flow in the temporary variant of this stream type. These include the stoneflies <em>Nemoura cinerea</em> and <em>Amphinemura standfussi</em>, the caddis flies <em>Micropterna nycterobia</em>, <em>M. sequax</em> and <em>Plectrocnemia conspersa</em> as well as the black fly <em>Simulium vernum</em>. Typical species calc-sinter reaches with limestone tuffs are the aquatic beetle <em>Riolus subviolaceus</em> and the caddis flies <em>Rhyacophila pubescens</em>, <em>Tinodes unicolor</em> and <em>Melampophylax mucoreus</em>.</td>
<td></td>
</tr>
<tr>
<td>Characterisation of macrophyte and phyto-benthos communities:</td>
<td>Higher aquatic plants are absent. The macrophyte community is composed of aquatic mosses, like <em>Fontinalis antipyretica</em>, <em>Brachythecium rivulare</em> and the calciphile species <em>Cinclidotus fontinaloides</em>.</td>
</tr>
<tr>
<td>Characterisation of the fish fauna:</td>
<td>As in other highland stream types, the fish fauna of this stream type is characterised by the brook trout and bullhead. Brook lamprey is rare but can occur. In the temporary variant of this stream type, the fish fauna can be completely absent depending on recurrence and length of dry periods.</td>
</tr>
<tr>
<td>Comments:</td>
<td>This stream type presents a limestone variant of the typical cobble bed highland stream. For EU-WFD purposes, this stream type comprises permanent and temporary carbonate rich variants, which hardly differ in fauna during the surface discharge periods.</td>
</tr>
</tbody>
</table>
| Examples of typical streams | Macroinvertebrates: Lipbach (Baden-Württemberg)  
Macrophytes and phyto-benthos: Große Lauter (Baden-Württemberg) |
**Type 9:** Mid-sized fine to coarse substrate dominated siliceous highland rivers

**Distribution in river landscapes and regions according to Briem (2003):**

Schist, gneiss, granite and similar rocks, Buntsandstein sandstone, volcanic regions, large floodplain over 300 m wide

**Picture:**

![Orke (Hesse). Photograph: T. Ehler](image)

**Short description of morphology:**

This stream type exhibits different morphological forms, depending on the width of the valley floor, the channel bedload and valley slope. In narrow valleys, the channel is straight or sinuous, with numerous side channels; in wide u-shaped valleys with limited slope, the single stream channel is sinuous to meandering. With increasing valley slope, the channel becomes slightly sinuous to meandering and forms anabranching sections and numerous side channels.

In general, cobbles and rocks dominate the channel substrates. Gravel is less frequent and forms pronounced bars. Fine sediments like sand and loam are found in the calmer flow sections along shore and between large rocks. The channel profile is usually very shallow and wide. There is a typical alternation of riffle and pool sequences. Pronounced gravel and cobble bars with a distinct, well developed interstitial are typical for streams of this type.

**Abiotic profile:**

<table>
<thead>
<tr>
<th>Size class:</th>
<th>100 - 1,000 km² catchment area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope of the valley floor:</td>
<td>2 - 6 ‰</td>
</tr>
<tr>
<td>Flow category:</td>
<td>predominantly fast to turbulent currents, with high current diversity.</td>
</tr>
<tr>
<td>Channel substrates:</td>
<td>cobbles and boulders dominate with high amounts of gravel mixed in; to a lesser degree sand and loam deposits in slowly flowing areas</td>
</tr>
</tbody>
</table>

**Physico-chemical water conditions:**

- **Conductivity [µS/cm]:** 75 - 350
- **pH-value:** 7.0 - 8.0
- **Alkalinity [*°dH]:** 1 - 6
- **Total hardness [*°dH]:** 6 - 10

**Flow regime & hydrology:**

Large fluctuations in discharge over the year, with pronounced individual events of extreme discharges.
### Type 9: Mid-sized fine to coarse substrate dominated siliceous highland rivers

#### Characterisation of the macroinvertebrate community:

**Functional groups:** As a result of high habitat diversity, the macroinvertebrate community is very diverse. On stable rocks and boulders of turbulent riffle sections, rheophile species with high oxygen demands dominate. The sandy and muddy deposits in calm sections between large rocks, in side channels or along shore are colonised by species preferring fine sediments. In this river type, species typical for smaller and cooler streams are frequently found.

**Selection of type-specific species:** Characteristic species for the well-oxygenated, turbulent cobble bars are e.g. the mayflies *Baetis lutheri* and *Ecdyonurus insignis* or the caddis fly *Micrasema setiferum*. Numerous moss tufts on rocks are inhabited by the water beetle *Hydraena* spec. In the gravel and sand deposits large mussels like *Unio crassus* and *Margaritifera margaritifera* are found. Otherwise typical species include the mayfly *Ecdyonurus dispar*, stoneflies of the genus *Leuctra*, the true bug *Esolus parallelepipedus* and the caddis flies *Allogamus auricollis* and *Brachycentrus maculatus*.

#### Characterisation of macrophyte and phytobenthos communities:

Compared to other highland stream types, this stream type is relatively rich in macrophytes. Numerous water mosses (e.g. *Scapania undulata*, *Rhynchosostegium riparioides*, *Fontinalis antipyretica*, *Fontinalis squamosa*, *Chiloscyphus polyanthos*, *Hygroamblystegium fluviatile*, *Jungermannia exsertifolia*, *Racomitrium aciculare*, *Schistidium rivulare*, *Marsupella emarginata*) and higher plants like *Ranunculus fluitans*, *R. peltatus*, *R. penicillatus*, *Callitriche platycarpa*, *C. stagnalis* and *Myriophyllum alterniflorum* occur.

#### Characterisation of the fish fauna:

Streams of this type generally support fish typical for the grayling region. Besides the character species of this region, brook trout are also found frequently. So are populations of the rheophile, gravel-spawning stream cyprinids like nase and dace. In the Danube region the huchen occurs. Side channels and backwaters also allow for indifferent species and even lenitic species to find suitable habitat. In some cases anadromous fish like salmon can occur.

**Comments:** This stream type represents the „classic“ highland river, dominated by coarse substrates, fast currents, with regularly alternating riffle and pool sequences. This dynamic stream type is characterised by expansive lateral channel movement and formation of numerous side channels.

Because of their siliceous character „mid-sized fine substrate dominated highland rivers“ are included in this stream type, although the higher amount of fine sediments, especially in Buntsandstein sandstone streams, results in biocenotic differences. The somewhat species poorer fauna – analogous to stream type 5.1 – typically lacks interstitial species. That is also why the fish fauna does not include typical gravel-spawning species. On the other hand, brook lamprey are abundant.

#### Examples of typical streams

- **Macroinvertebrates:** Eder, Orke (Hesse), Prüm (Rhineland-Palatinate), Wutach (Baden-Württemberg), Sieg (North Rhine-Westphalia)
- **Makrophyten- und Phytobenthos:** Fulda (Hesse), Zschopau (Saxony)

### Comparative literature (selection):


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T. POTGIESSER & M. SOMMERHÄUSER 2004: Profiles of German Stream Types
**Type 9.1:** Mid-sized fine to coarse substrate dominated calcareous highland rivers

**Distribution in river landscapes and regions according to Briem (2003):**

Lacustrine limestone, Lower and Middle Jurassic rocks, other limestones, loess regions, Upper Triassic rocks, Cretaceous rocks, large floodplains (over 300 m wide)

**Picture:**

![Image of a river](attachment:image.png)

*Werre (North Rhine-Westphalia). Photograph: T. Pottgiesser*

**Short description of morphology:**

In u-shaped valleys, these sinuating to meandering rivers generally flow in a single channel. However, with increasing slope, they can develop a tendency to form side channels. Riffles and pools alternate regularly. Most channel bars are narrow, the profile is shallow and only moderately incised. Steep, unvegetated eroding banks are common. Substrate diversity is principally very high: depending on catchment conditions, the channel substrates are dominated by cobbles, rocks or gravel. Sand can be mixed in as fine sediment, and can reach high shares in permanent streams. The streams are very dynamic, and subject to expansive and very fast lateral channel movements. Occasionally, this stream also occurs as an intermittent variant.

**Abiotic profile:**

- **Size class:** 100 - 1,000 km² catchment area
- **Slope of the valley floor:** 0.7 - 4.0 %
- **Flow category:** predominantly fast flowing, partially turbulent current; longer calmly flowing sections occur
- **Channel substrates:** depending on catchment conditions, cobbles and rocks or gravel dominate

**Physico-chemical water conditions:**

- **Conductivity [µS/cm]:** 450 - 800
- **pH-value:** 7.5 - 8.5
- **Alkalinity [°dH]:** 8 - 14
- **Total hardness [°dH]:** 11 – 25

**Flow regime & hydrology:**

High fluctuations in discharge over the year.
**Type 9.1:** Mid-sized fine to coarse substrate dominated calcareous highland rivers

<table>
<thead>
<tr>
<th>Characterisation of the macroinvertebrate community:</th>
<th><strong>Functional groups:</strong> Rheophile, hard substrate inhabiting species dominate the coenosis. Colonisers of detritus-rich, stable sand deposits also occur. The macroinvertebrate community also includes calciphilic species and specialists adapted to intermittent flow with dry periods.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Selection of type-specific species:</strong> This stream type is inhabited by rheophilic hard substrate dwellers like the mayfly <em>Caenis macrura</em>, the caddis fly <em>Silo piceus</em> and the Snipe fly <em>Atherix ibis</em>. Expansive sand deposits with high detritus loads are colonised by large mussels like <em>Unio crassus</em> and the caddis fly <em>Sericostoma schneideri</em>. The caddis fly <em>Lasiocephala basalis</em>, is more or less restricted to coarse woody debris.</td>
<td></td>
</tr>
<tr>
<td>Characterisation of macrophyte and phyto benthos communities:</td>
<td>Typical are pondweeds like <em>Potamogeton lucens, P. perfoliatus, P. alpinus</em> and <em>P. gramineus</em>. In calmer sections close to shore <em>Sparganium emersum, Sagittaria sagittifolia, Nuphar lutea</em> as well as <em>Potamogeton natans</em> occur.</td>
</tr>
<tr>
<td>Characterisation of the fish fauna:</td>
<td>In streams of this type the typical fish fauna of the grayling region is developed with rheophilic, gravel-spawning species like grayling and nase. In streams dominated by fine substrates, species like gudgeon, stone loach and river lamprey can be abundant. The well developed mosaic of different currents and connected or abandoned side arms provide suitable habitat for numerous floodplain species. Migrating fish like salmon, occur from time to time.</td>
</tr>
<tr>
<td>Comments:</td>
<td>The water of larger „karst rivers“ appears blue in colour.</td>
</tr>
<tr>
<td>Examples of typical streams</td>
<td><strong>Macroinvertebrates:</strong> Bära, Jagst, Wutach (Baden-Württemberg), Bega (North Rhine-Westphalia)</td>
</tr>
<tr>
<td>Comparative literature (selection):</td>
<td><strong>Macrophytes and phytobenthos:</strong> Aufsess, Main (Bavaria)</td>
</tr>
</tbody>
</table>
Type 9.2: Large highland rivers

Distribution in river landscapes and regions according to Briem (2003):

Picture:

Ruhr (North Rhine-Westphalia). Photograph: U. Koenzen

Short description of morphology:
Depending on slope and bedload transport, the rivers can flow in sinuate to meandering single channels, or develop numerous side channels and form braided reaches. While in narrow valley sections, the floodplain is small or absent, but can be very expansive and up to several hundred metres wide in open valleys. Habitat diversity is high. Channel substrates are dominated by boulder, cobbles and gravel. Deposits of finer sediments like sand and loam can be expansive in areas with reduced current. Large unvegetated gravel and cobble bars are characteristic for streams of this type. The channel profile is shallow; riffle and rapid sections alternate regularly with pools. Streams of this type are very dynamic and subject to expansive lateral channel movements.

Abiotic profile:

Size class: 1.000 - 10.000 km² catchment area
Slope of the valley floor: ~ 3 ‰
Flow category: predominantly fast flowing current, interrupted by slower sections
Channel substrates: boulders and cobbles dominate, some expansive fine substrate deposits of sand and mud

Physico-chemical water conditions:

Conductivity [µS/cm]: 300 - 600
pH-value: 7,0 - 8,5
Alkalinity [°dH]: 4 -10
Total hardness [°dH]: 5 –13

Flow regime & hydrology:
High fluctuations in discharge over the year, with very pronounced extreme discharge events.
<table>
<thead>
<tr>
<th>Characterisation of the macroinvertebrate community:</th>
<th>Functional groups: As a result of habitat diversity, the coenosis is species rich, with many potamal species and rithral species, which are flushed in from tributaries. Eurythermic species occur.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of type-specific species: These include the snails <em>Theodoxus fluviatilis</em> and <em>Bithynia tentaculata</em>, the mayflies <em>Baetis vardarensis</em>, <em>Oligoneuriella rhenana</em> and <em>Potamanthus luteus</em>, the stoneflies <em>Brachyptera braueri</em> and <em>Perla burmeisteriana</em>, the dragonfly <em>Onychogomphus forcipatus</em>, the water bug <em>Aphelocheirus aestivalis</em>, the beetle <em>Stenelmis canaliculata</em> and the caddis fly <em>Hydropsyche bulgaromanorum</em>.</td>
<td></td>
</tr>
</tbody>
</table>

| Characterisation of macrophyte and phytobenthos communities: | Especially frequent is the water crowfoot community with *Ranunculus fluitans*, *R. peltatus*, *R. penicillatus*, accompanied by large pondweeds. Other species include *Callitriche platycarpa* and *C. stagnalis* as well as the aquatic mosses *Scapania undulata*, *Fontinalis antipyretica*, *Chiloscyphus polyanthos*, *Hygroamblystegium fluviatile*, *Jungermannia exsertifolia*, *Racomitrium aciculare*, *Schistidium rivulare*, *Marsupella emarginata* and *Rhynchostegium riparioides*. |

| Characterisation of the fish fauna: | As a result of its high habitat diversity, the stream type supports a rich fauna, typical for the barbel region. Characteristic are gravel-spawning species like barbel and nase and other rheophilic river cyprinids, as well as some species, which are indifferent to current flow. The generally well-developed extensive floodplains support lenitic species. Migratory fish like salmon, sea lamprey, allis shad, and twaite shad spawn in this stream type or use it as a migratory route to reach spawning grounds in tributaries. In the large Danube tributaries, species endemic to the region like huchen and sandsmelt are also common. |

| Comments: |  |
| Examples of typical streams | **Macroinvertebrates:** Ruhr (North Rhine-Westphalia), Fulda (Hesse), Jagst (Baden-Württemberg) |
| **Macrophytes and phytobenthos:** Danube (Bavaria) |
### Type 10: Very large gravel-dominated rivers

**Distribution in river landscapes and regions according to Briem (2003):**
Large floodplains (over 300 m wide), lower river terraces

**Picture:**
![Elbe at Rathen (Saxony) Photograph: F. Schöll](image)

**Short description of morphology:**
Sinuate to meandering river reaches in both narrow, in parts canyon-like, and wide valleys. In open valleys, wide floodplains prone to inundation are common. Locally, depending on the valley slope and river bedload, anabranching and braided sections may develop. The river type shows a shallow bed profile, where fords, islands or bars and side branches are characteristic. The dominant channel substrates are coarse gravel and cobbles; intermittent finer sediments, i.e. mixtures of sand and fine gravel, are found. Under natural conditions this river type carries lots of coarse woody debris. This usually consists of large logs or fallen trees, which remain stable despite the strong current. Large pieces of coarse woody debris in the main and side channels can lead to accumulated debris dams of smaller pieces of woody debris and other organic matter.

**Abiotic profile:**
- **Size class:** > 10,000 km² catchment area
- **Slope of the valley floor:** 2 - 0.2 ‰
- **Flow category:** in narrow valleys quick, even current; in wide valleys and branching or braided sections currents are locally varied
- **Channel substrates:** cobbles, coarse gravel and in small quantities, mixtures of sand and gravel

**Physico-chemical water conditions:**
- **Conductivity [µS/cm]:** 350 - 500
- **pH-value:** 7.0 - 8.5
- **Alkalinity [°dH]:** 4 - 10
- **Total hardness [°dH]:**

**Flow regime & hydrology:**
Alpine influenced flow regime e.g. in the upper and middle Rhein sections; other rivers of this type show a pluvial flow regime, e.g. upper Donau or the upper Elbe.
### Type 10: Very large gravel-dominated rivers

#### Characterisation of the macroinvertebrate community:

**Functional groups:** Occurrence of epipotamal to rhithral species, which are in part transported into the main river from tributaries. Due to this effect and high habitat diversity, there is a very diverse community, especially in branching or braided sections. Grazers dominate the community, which also hosts many detritus and sediment feeders. Stone dwelling species are most abundant, few fine sediment inhabitants occur as well.

**Selection of type-specific species:** Predominant are specifically potoamal species. Noteworthy are large mussels (bivalves) like *Pseudanodonta complanata*, *Unio pictorum* and *Anodonta anatina*, the mayflies *Heptagenia flava*, *Ephoron virgo* and *Potamanthus luteus*, the dragonflies *Gomphus vulgatissimus* and *Onychogomphus forcipatus*, the stoneflies *Perla burmeisteriana* and *Isogenus nubecula*, the water bug *Aphelocheirus aestivalis* and a rich caddis fly fauna including e.g. *Polycentropus flavomaculatus*, *Cheumatopsyche lepida*, *Hydropsyche contubernalis*, *H. exocellata*, *H. incognita*, *Hydropsyche bulgaromanorum*, *Brachycentrus subnubilus*, *Ecnomus tenellus*, *Mystacides azurea*, *Oecetis testacea*.

#### Characterisation of macrophyte and benthos communities:

**Selection of type-specific aquatic bryophytes:** *Fontinalis antipyretica* and less common *Cinclidotus riparius* and *Leptodictyum riparium.*

**Selection of type-specific macrophyte species:** *Potamogeton nodosus*, *P. perfoliatus*, *P. pectinatus*, *R. fluitans*, *Myriophyllum spicatum*, *M. verticillatum*, *Elodea canadensis*, *Hippuris vulgaris*, *Ceratophyllum demersum*.

#### Characterisation of the fish fauna:

Due to the high habitat diversity, the fish fauna is rich in both species and individuals, with typical representatives of the barbel and bream regions. Besides the typical species of the main channel, numerous species occur, which preferably inhabit the slow-flowing waters along shore or standing side arms and other floodplain water bodies. Characteristic are anadromous fish, e.g. Atlantic salmon and salmon trout in the Rhein. In the Danube catchment several typical species occur which do not inhabit the Rhine system (e.g. huchen, stripe ruffe, zingel und sandsmelt). In earlier times, the Black Sea sturgeon was common in the Danube.

#### Comments:

Previously the stream type was insect dominated, while today, species invasion has shifted community dominance toward other invertebrate groups.

For the entire length of the Rhine and Danube systems, specific typologies for the various stream sections have been compiled (IKSR 2004, IICPDR 2003).

#### Examples of typical streams

**Makroinvertebrates:** upper Danube, upper Elbe

**Macrophytes and phytobenthos:** Danube (in Bavaria)

#### Comparative literature (selection):

**Type 11:** Small, organic substrate-dominated rivers

**Distribution in river landscapes and regions according to Briem (2003):**

**Ecoregion independent stream type.** Old and young moraine landscapes (ground and terminal moraines); outwash plains and sandy deposits; river terraces (including lower river terraces); mires; occasionally in upper reaches of streams in basement and overlying mountains; large floodplains of the alpine foot hills (over 300m wide).

**Picture:**

![Stollbach (North Rhine-Westphalia). Photograph: M. Sommerh"auser](image)

**Short description of morphology:**

Sinuate channel form in a clearly defined u-shaped valley, with a tendency to form multiple channels (anabranches) and side channels. The very shallow channel is barely cut in. The substrates can be composed completely of organic matter (peat, wood, coarse and fine detritus). Streams are rich in macrophytes. Humic substances often colour the water brown (“black water streams”). The water level at medium discharge is just below ground level throughout much of the year. The minimal entrenchment allows for a strong connectivity between river and floodplain; at elevated water levels the entire floodplain is inundated. Especially in young moraine landscapes, higher levels of mineral substrate can occur in the channel. Over short stretches the bed can be purely mineral.

**Abiotic profile:**

- Size class: 10 - 100 km² catchment area
- Slope of the valley floor: 2 - 15 ‰
- Flow category: regular alternation between calmly flowing stretches with more turbulent flow behind coarse woody debris accumulations or root barriers.
- Channel substrates: predominantly organic substrates (peat, fallen leaves, coarse woody debris, macrophytes); mineral substrates (sand and gravel) are subordinate.

**Physico-chemical water conditions:**

Organic streams; depending on catchment geology, physical and chemical characteristics exhibit different ranges for base-rich or base-poor variants.

<table>
<thead>
<tr>
<th>Conductivity [µS/cm]</th>
<th>base-poor</th>
<th>base-rich</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>350 - 500</td>
<td>350 - 800</td>
</tr>
<tr>
<td>pH-value:</td>
<td>6,5 - 7,5</td>
<td>7,5 - 8,0</td>
</tr>
<tr>
<td>Alkalinity [°dH]:</td>
<td>3 - 6</td>
<td>~ 16</td>
</tr>
<tr>
<td>Total hardness [°dH]:</td>
<td>6 - 11</td>
<td>~ 25</td>
</tr>
</tbody>
</table>

**Flow regime & hydrology:**

Medium to high seasonal fluctuation in discharge; summer drying is common in small streams.

T. PUTZIESSER & M. SOMMERH"AUSER 2004: Profiles of German Stream Types
Type 11: Small, organic substrate-dominated rivers

Characterisation of the macroinvertebrate community:

Functional groups: Typical for this stream type is the dominance of plant dwelling species, which colonise floating macrophytes, aquatic moss, and flooded grass in high densities. Sediment and detritus feeders collect food in fine organic channel substrates and between dense macrophyte stands. The proximity to springs and the usually small size of streams is reflected in the high portion of hypocrenal and rhithral species. Besides these, lenitic species are also common.

Selection of type-specific species: These include the caddis flies Oligostomis reticulata, Trichostegia minor, Hydatophylax infumatus and Micropterna lateralis as well as the black fly Simulium urbanum. Accompanying species include dragonflies and stoneflies (Cordulegaster boltoni, Aeshna cyanea, Pyrrhosoma nymphula, Leuctra nigra, Nemoura spec.).

Interesting is the disappearance of many species and taxa in base-poor variants due to dystrophic and carbonate-poor habitat conditions. These include Gammarids (except Niphargus spec.), mayflies, many molluscs and Turbellaria.

In base-rich variants, less extreme abiotic conditions allow for a more diverse biocoenosis. Besides demanding species like the caddis fly Sericostoma personatum, euryoecious species can be abundant.

Characterisation of macrophyte and phytobenthos communities:

Older moraines: species, which can form large stands like Potamogeton polygonifolius, Isolepis fluitans, Scapania undulate are common; numerous species of Sphagnum spec. also occur.

Younger moraines: submerged macrophytes are largely absent; locally there are flooded stands of reed; in amphibious zones swamp forest species, reeds and sedge swamp and spring species occur.

Characterisation of the fish fauna:

The ecoregion independent distribution of the stream type is reflected in the fish fauna. A generally valid description of the fish fauna is not possible. In base-poor variants of the stream type a stable community with belica (Leucaspius delineatus) and nine-spine stickleback (Pungitius pungitius) is supported. Other species largely absent.

Comments:

Typical for this stream type are humic substances, which often colour the water brown.

Possible confusion with other stream types: Confusion with other stream types is unlikely in near-natural conditions. Strongly degraded organic streams can resemble small sand-dominated lowland rivers. In contrast to stream type 19 (streams in riverine floodplains), type 14 streams have a clearly discernible valley form and a steeper stream slope. Organic streams are also “independent” from other larger streams into which they flow, and are not hydrologically influenced by them. Faunistically, type 11 streams are characterised by stream and riparian species, while in type 19, streams are dominated by lenitic species.

Notice: The description of this stream type may be supplemented with results from currently running research projects.

Examples of typical streams

Macroinvertebrates: Stollbach (North Rhine-Westphalia)
Macrophytes and phytobenthos: Wümme (Lower Saxony), Schaagbach (Lower Saxony)

Comparative literature (selection):

Type 12: Mid-sized and large organic substrate-dominated rivers

**Distribution in river landscapes and regions according to Briem (2003):**

**Ecoregion independent stream type.** Large floodplains (over 300 m wide) with valley peat, bogs, mainly organic material; outwash plains and sandy deposits, lower river terraces, old river terraces

**Picture:**

![Stepenitz (Brandenburg). Photograph: C. Feld](image)

**Short description of morphology:**

Organic rivers typically meander or flow in anastomising channels in u-shapes valleys with many side channels. The transition to the floodplain is often gradual. The floodplain and river bed are dominated by organic substrates (peat, fallen leaves, macrophytes, etc.). Some mineral substrates can occur, particularly sand and gravel. Pure organic streams are rather rare. More common are partially organic forms with mineral riverbeds, which run through valley bogs or peat floodplains. The minimal entrenchment allows for a strong connectivity between river and floodplain. In the floodplain numerous drainage channels, detached side arms and backwaters of varying age are common.

**Abiotic profile:**

- **Size class:** 100 - 10,000 km² catchment area
- **Slope of the valley floor:** < 0,5 - 1,5‰
- **Flow category:** predominantly slow flowing current, partially turbulent
- **Channel substrates:** organic substrates dominate (peat, fallen leaves, macrophytes), while mineral substrates are subordinate (sand, gravel)

**Physico-chemical water conditions:**

Organic streams; depending on catchment geology, physical and chemical characteristics exhibit different ranges for base-rich or base-poor variants.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>base-poor</th>
<th>base-rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity [µS/cm]</td>
<td>350 - 500</td>
<td>550 - 800</td>
</tr>
<tr>
<td>pH-value</td>
<td>6,5 - 7,5</td>
<td>7,0 - 8,0</td>
</tr>
<tr>
<td>Alkalinity [<em>°dH</em>]</td>
<td>3 - 6</td>
<td>8 - 14</td>
</tr>
<tr>
<td>Total hardness [<em>°dH</em>]</td>
<td>6 - 11</td>
<td>11 - &gt;20</td>
</tr>
</tbody>
</table>

**Flow regime & hydrology:**

Medium to high fluctuation in discharge over the year.
### Type 12: Mid-sized and large organic substrate-dominated rivers

#### Characterisation of the macroinvertebrate community:

**Functional groups:** The macroinvertebrate community is rich in both species and individuals. Dominant are lenitic species of slowly flowing reaches and standing waters. True running water species play a subordinate role and are restricted to shallow lotic regions. Besides species, which inhabit permanent water bodies, numerous species adapted to intermittent flow are also found and inhabit the periodically dry floodplain drainages and abandoned side arms.

**Selection of type-specific species:** These include the mayfly *Leptophlebia vespertina*, which colonised macrophytes, the mayfly *Caenis robusta*, the sponge inhabiting caddis fly *Ceraclea nigronervosa* as well as the caddis flies *Ceraclea senilis*, *Limnephilus nigriceps*, *L. stigma*, *Oligotricha striata* and *Phryganea grandis*.

#### Characterisation of macrophyte and pycno- benthos communities:

The aquatic vegetation is characterised by occurrence of large pondweeds like *Potamogeton lucens*, *P. perfoliatus*, *P. alpinus* and *P. gramineus* and the growth-form rich community of *Sparganium emersum*, which includes *Sagittaria sagittifolia* and *Nuphar lutea*.

Young moraines: The macrophyte community is well developed: stream margins have flooded reeds, usually lined with plants of the Nymphaeion albae-community, duckweed and frog-bit communities. The central riverbed supports submerged species of the Myriophyllid and pondweed communities.

#### Characterisation of the fish fauna:

As a result of the strong connectivity between stream and floodplain, the fish fauna supports mainly macrophyte-spawning standing water body species, which are promoted by the numerous side arms and abandoned channels. Typical are species well adapted to conditions of valley bogs, like Crucian carp. Besides these, few rheophile fish species occur. Gravel-spawning species of lotic and summer-cool reaches, like salmonids, play a minor role and occur only locally.

#### Comments:

Typical for this stream type are humic substances, which colour the water brown.

**Possible confusion with other stream types:** Compared with streams of type 19 (Small streams of riverine floodplains), type 12 streams have a clearly discernible valley form and a steeper stream slope. They are also “independent” from the main stem, rivers into which they flow, and are not influenced by them hydrologically. Biocoenotically, stream type 12 is characterised by running water and floodplain species, whereas stream type 19 supports large numbers of standing water body species.

**Notice:** The description of this stream type may be supplemented with results from currently running research projects.

#### Examples of typical streams

**Macroinvertebrates:** Schwalm (Lower Saxony)

#### Comparative literature (selection):

LUA NRW (2001) „Organisch geprägter Fluss des Tieflandes“
**Type 14: Small sand-dominated lowland rivers**

**Distribution in river landscapes and regions according to Briem (2003):**
Outwash plains, sandy deposits, ground moraines; also in sandy regions of lower and older river terraces

**Picture:**
![Rotbach (North Rhine-Westphalia). Photograph: M. Sommerhäuser](image)

**Short description of morphology:**
Strongly meandering channel in a shallow trough or wide u-shaped valley. The river is more stretched when it is groundwater influenced. Besides the dominating sandy substrates, gravel can form small but well-established patches (gravel bars); locally marl and clay occur. Important secondary habitat structures include coarse woody debris, alder roots, macrophytes and fallen leaves. These organic substrates are however subordinate. The generally shallow profile exhibits deep furrows and scoured pools behind debris dams. Slip-off slopes and stable bank cliffs are well established. Eroding bank cliffs and slightly undercut banks occur. Valley bogs and fens can occur in the floodplain.

**Abiotic profile:**
- **Size class:** 10 - 100 km² catchment
- **Slope of the valley floor:** 2 - 7 %
- **Flow category:**
  - long stretches of calm flow alternate with short turbulent sections around wood and root barriers;
  - reversed flow in scoured pools.
- **Channel substrates:**
  - a variety of sandy fractions dominate, often supplemented by fine and coarse gravel, some clay and marl. In the young moraines erratic cobbles or boulders occur; organic substrates; when valley bogs and fens occur in the floodplain, peat bars can occur along river banks.

**Physico-chemical water conditions:**
The type occurs in siliceous (older moraines) and calcareous (calcareous older moraines and younger moraines) variants.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Siliceous</th>
<th>Calcareous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity [µS/cm]</td>
<td>&lt; 350</td>
<td>350 - 650</td>
</tr>
<tr>
<td>pH-value</td>
<td>6,0 - 7,5</td>
<td>7,0 - 8,2</td>
</tr>
<tr>
<td>Alkalinity [<em>°dH</em>]</td>
<td>1 - 5</td>
<td>5 - 11</td>
</tr>
<tr>
<td>Total hardness [<em>°dH</em>]</td>
<td>3 – 8</td>
<td>8 - 15</td>
</tr>
</tbody>
</table>

**Flow regime & hydrology:**
Medium to high fluctuations in discharge over the year when streams are surface water fed, low fluctuations in groundwater influenced streams.
Type 14: Small sand-dominated lowland rivers

Characterisation of the macroinvertebrate community:

**Functional groups:** Besides supporting few species of the fine substrates, near-natural sand streams with gravel bars and high amounts of coarse woody debris are inhabited by hard substrate dwellers and colonisers of secondary substrates like woody debris and macrophytes. Based on the high levels of fallen leaves and woody debris, shredders are abundant in near-natural streams. Grazers feeding on small cobbles and gravel supplement the fauna. The gap system in sandy sediments supports detritus and sediment feeders, which eat fine particulate organic matter. Besides species of quickly and slowly flowing water, we find limited numbers of lenitic species. In groundwater influenced variants a higher proportion of crenal and cold-adapted species occur.

**Selection of type-specific species:** Typical are only few true sand inhabiting species like the burrowing may fly *Ephemera danica* and the stone fly *Isoptena serricornis*. More characteristic are inhabitants of secondary habitat structures like woody debris, fallen leaves and gravel bars, which are extremely important in the otherwise poorly structured sand streams. These include the caddis flies *Lasiocephala basalis*, various *Potamophylax*-species, *Sericostoma personatum* and *Notodobia ciliaris*. Common species, which occur in the local gravel bars include the caddis flies *Goera pilosa*, *Hydropsyche saxonica* and *Micropterna sequax*. A typical stonefly is *Taeniopteryx nebulosa*, a species dependent on near-natural banks and riparian structures.

Characterisation of macrophyte and phytobenthos communities:

Characteristic macrophytes include *Berula erecta*, *Nasturtium officinale* and *Callitriche platycarpa* and *C. stagnalis*. The *Berula erecta*-community is limited to smaller streams (up to 5 m width).

Young moraines: macrophytes are absent or sparse. The occurring coenosis is composed mainly of elements from reed communities, Myriophyllid and pondweed communities; plants with floating leaves occur locally. Amphibious zones are sparsely colonised, with insular reed patches. When peat occurs along the banks, some spring species may occur.

Characterisation of the fish fauna:

Besides species, which prefer sandy substrates to spawn, phytophilic species like nine-spined sticklebacks are found in stands of submerged macrophytes. Species, which depend on the gravel bars for spawning can also occur (sandy-gravel streams with cool water temperatures in summer, are considered the "trout streams of the lowlands"). Typical are stone loach, which is dependent on coarse woody debris, and gudgeon. Also typical are brook lamprey and ammocoete, which inhabit sandy substrates.

Comments:

**Possible confusion with other stream types:** In the lowlands confusion is possible with degraded organic streams with a sandy riverbed. Gravel-dominated streams exhibit much higher proportions of gravel and a more sinuate than meandering channel form and typically stable undercut banks. Sometimes degraded gravel streams can resemble sand streams if the gravel fraction is removed, but host different channel form and valley slope.

**Notice:** Pure sand streams with riffle marks are often artefacts of human influence and products of centuries of continued removal of woody debris and leaves and consequently down cutting. A "typical" sand stream can have local gravel bars.

Examples of typical streams

- **Macroinvertebrates:** Angelbach (Lower Saxony), Eltingmühlenbach, Furlbach (North Rhine-Westphalia), Osterau (Schleswig-Holstein)
- **Macrophytes and phytobenthos:** Wehrau (Schleswig-Holstein)

Comparative literature (selection):

Type 15: Mid-sized and large sand and loam-dominated low-land rivers

**Distribution in river landscapes and regions according to Briem (2003):**

Large floodplains (over 300 m wide), outwash plains, sandy deposits, loess regions, ground moraines, also in sandy regions of river terraces.

**Picture:**

![Lippe (North Rhine-Westphalia). Photograph: T. Ehlert](image)

**Short description of morphology:**

Sinuate to meandering streams in shallow troughs or wide u-shaped valleys. Besides the dominant sand and loam fractions, gravel is an important substrate, which can form gravel banks; clay and marl are common and can aggregate into flat slabs. Important habitat structures include natural secondary substrates like woody debris, alder roots, macrophytes and fallen leaves.

The channel profile is flat with pronounced slip-offs and stable bank cliffs. In the floodplain numerous drainage channels, detached side arms and backwaters of varying age are common. Valley bogs and fens can form. Streams with higher amounts of loam are naturally incised well below the floodplain level and have a trench-like profile. Disconnected side channels are rare.

**Abiotic profile:**

- **Size class:** 100 - 10,000 km² catchment area
- **Slope of the valley floor:** 0.2 - 2 ‰
- **Flow category:** predominantly calm current flow
- **Channel substrates:** dominated by sands of varying grain size, or loam; often supplemented by gravel, in parts by clay and marl.

**Physico-chemical water conditions:**

- **Conductivity [µS/cm]:** 400 - 850
- **pH-value:** 7.0 - 8.5
- **Alkalinity [*°dH]:** 6 - 17
- **Total hardness [*°dH]:** 8 – 23

**Flow regime & hydrology:**

Medium to high fluctuation in discharge over the year, with pronounced extreme discharge events.
Type 15: Mid-sized and large sand and loam-dominated lowland rivers

Characterisation of the macroinvertebrate community:

**Functional groups:** The invertebrate community is relatively diverse, although only few specialised species colonise this stream type. These are predominantly inhabitants of lenitic areas with detritus-rich deposits and burrowing species (substrate specialists). The natural hard substrate, coarse woody debris and macrophytes host the most species-rich and abundant communities. Especially rheophile species occur here.

**Selection of type-specific species:** These include only few colonisers of the sandy substrates like the burrowing mayfly *Ephemera danica* or the stonefly *Isoptena serricornis*. Burrowed in the stable detritus rich shore regions, the mussel *Unio pictorum*, the dragonfly *Gomphus vulgarissimus* and the stonefly *Taeiniopteryx nebulosa* occur. Coarse woody debris presents the most important hard substrates in this stream type: the mayfly *Heptagenia flava* and the caddis flies of the genus *Lype* are restricted to this habitat. Other typical mayflies are *Caenis pseudorivulorum*, *Paraleptophlebia cincta* and *Brachycercus harisella*. A number of species typical for large rivers like the mussel *Unio crassus*, the snail *Viviparus viviparus*, the true beetles *Haliplus fluviatilis* and *Brychius elevatus* and the dragonfly *Ophiogomphus Ceciliana* occur.

Characterisation of macrophyte and pythtobenthos communities:

Large pondweeds like *Potamogeton lucens*, *P. perfoliatus*, *P. alpinus* and *P. gramineus* are common macrophytes, which characterise the stream type together with the growth-form rich community of *Sparganium emersum*. More loam-dominated streams are characterised by *Callitriche platycarpa* and *Callitriche stagnalis*.

Young moraines: Here the macrophyte community is spatially highly structured: in erosion zones, macrophytes are missing; otherwise they form banks or meadow-like expanses. The species community is characterised by reeds, pondweed and stream weed community. In slower flowing regions, *Nymphaeion albae* and *Lemnetea minoris* communities occur; in amphibious regions marginal reed and sedge communities.

Characterisation of the fish fauna:

This stream type is characterised by a species rich fish fauna with many rheophile cyprinids like dace, chub, gudgeon. The typical species, especially of larger rivers is the burbot. Many species are dependent on the presence of larger quantities of coarse woody debris, like stone loach, which is more abundant in mid-sized rivers. Besides species of the main channel, many abandoned channels host a number of typical species, like spined loach, which occurs in muddy deposits of bank bays and floodplain channels. The more loam-dominated rivers are usually less specious: trout and other species dependent on high oxygen levels are absent, because suitable spawning habitats are missing and the fine particle load inhibits breathing. Due to the natural entrenchment, species from floodplain water bodies are subordinate.

Comments:

This stream type is the most common and widespread stream type in the northern German lowlands and comes closest to matching the typical perception of the "classic lowland river".

Examples of typical streams:

*Makrozoobenthos:* Lippe (North Rhine-Westphalia), Schaaie, Sude, Alte Elde (Mecklenburg-West Pomerania), Ems, Hunte, Ortze (Lower Saxony), Treene (Schleswig-Holstein), Rhin (Brandenburg)

Comparative literature (selection):

LUA NRW (2001) „Sandgeprägter Fluss des Tieflandes“
**Type 16: Small gravel-dominated lowland rivers**

Distribution in river landscapes and regions according to Briem (2003):

Ground and terminal moraines of young and older moraine landscapes and older river terraces.

**Picture:**

*Kirchweddelbek (Schleswig-Holstein). Photograph: U. Holm*

**Short description of morphology:**

Dependent on valley slope slightly sinuate to meandering channels, with relatively steep stream slope. Quickly flowing streams in v-shaped valleys, troughs or u-shaped valleys. Shallow lotic sections (riffles) alternate with short, deeper channel reaches (pools). There is no channel incision due to stable channel substrates, but there is strong lateral erosion, which causes pronounced, partially deep undercut banks. Slipp-off slopes and bank cliffs are undistinguished. Beside the perceivably dominant gravel fraction, various proportions of sand and loam occur. Especially in young moraine landscapes, erratic cobbles and boulders are washed from the riverbanks and supplement other channel substrates. This is the most dynamic stream type in the lowlands.

**Abiotic profile:**

- **Size class:** 10 - 100 km² catchment size
- **Slope of the valley floor:** 3 - 25 (50) ‰
- **Flow category:** longer, shallow riffle sections, regularly alternating with short pool stretches
- **Channel substrates:** dominated by gravel and cobbles with a varied portion of sand; dependent on regional variation loam can occur; in late Pleistocene landscapes erratic moraine rocks are common

**Physico-chemical water conditions:**

Type occurs in siliceous and calcareous variants

<table>
<thead>
<tr>
<th>Conductivity [µS/cm]</th>
<th>siliceous</th>
<th>calcareous</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-value:</td>
<td>6,0 - 7,5</td>
<td>7,0 - 8,2</td>
</tr>
<tr>
<td>Alkalinity [°dH]:</td>
<td>1 - 5</td>
<td>5 - 20</td>
</tr>
<tr>
<td>Total hardness [°dH]:</td>
<td>3 - 8</td>
<td>8 - 28</td>
</tr>
</tbody>
</table>

**Flow regime & hydrology:**

Low to high discharge fluctuations over the year; small rivers sometimes have intermittent flow with dry periods in summer.
**Type 16:** Small gravel-dominated lowland rivers

**Characterisation of the macroinvertebrate community:**

**Functional groups:** Since this type is mainly developed in small rivers, species typical for rhithral (and crenal) regions are characteristic. The regularly occurring riffle sections with dynamic flow result in a dominance of rheophilic species. High share of hard substrates (gravel, cobbles) promote dominance of stone-dwelling species and colonisers of epilithic aquatic moss.

**Selection of type-specific species:** Species adapted to strong currents and high oxygen levels like the mayflies *Electrochironia ujhelyii*, *Heptagenia sulphurea* and *Rhithrogena semicolorata*, and the caddis flies *Rhyacophila fasciata*, *Agapetus fuscipes*, *Potamophyloides nigricornis*, *Silo pallipes* and *Silo nigricornis* occur. Examples of accompanying species include *Dugesia gonoecephala*, *Ancylus fluviatilis*, *Amphinemura standfussi*, *Leuctra digitata*, *L. hippopus* and *L. nigra*, *Capnia bifrons*, *Elmis aenea*, *Limnius volckmari*, *Hydropsyche saxonica* and *Sericostoma personatum.*

**Characterisation of macrophyte and benthos communities:**

Species, which attach to stable streambed substrates, like the moss *Fontinalis antipyretica*, the freshwater red algae *Hildenbrandia rivularis* or the narrow-leaved water parsnip *Berula erecta* dominate. The *Berula erecta* community is restricted to smaller rivers (< 5 m width). Watercress (*Nasturtium officinale*) is also common.

Young moraines: macrophytes are generally rare; locally flooded or emerging stands occur with streams reeds or pondweed; moss and freshwater algae often colonise hard substrates; amphibious zones are poorly vegetated, with some insular patches of reeds or sedges.

**Characterisation of the fish fauna:**

Gravel-dominated lowland rivers are characterised by gravel substrates and a large number of microhabitats (sandy-muddy stretches, quickly flowing and calm reaches, accumulations of coarse woody debris). Typical for this stream type is a diverse fish fauna: besides gravel-spawning and phytophilic species, fish with a preference for sandy substrates occur. Typical small fish include the stone loach, a species dependent on the presence of coarse woody debris. Also characteristic is brook lamprey, whose ammocoetes colonise sandy substrates.

**Comments:**

An especially characteristic and the most dynamic stream type in the lowlands, which in reaches resembles highland streams. In the stream type presented here, numerous variants of gravel-dominated lowland streams as they have been described at the ecoregion scale for the “Northern German Lowlands” or in state typologies have been summarised (see comparative literature).

**Possible confusion with other stream types:** In the lowlands, this stream is possibly confused with degraded sand-dominated lowland streams, where the gravel substrates have appeared as a result of erosion. Sand-dominated streams have a much higher portion of sand in channel substrates and show a much more meandering channel form with typical slip-off slopes and stable cliff banks. In small streams, the slope of the valley floor is less steep and the regular alternation between riffles and pools is poorly developed.

**Examples of typical streams**

**Macroinvertebrates:** Kirchweddelbek, Krempel Au (Schleswig-Holstein), Steinbach (North Rhine-Westphalia), Klasbach, Bäche in der Kühlung (Mecklenburg-West Pomerania), Lachte, Weesener Bach, Wümme (Lower Saxony)

**Type 17: Mid-sized and large gravel-dominated lowland rivers**

**Distribution in river landscapes and regions according to Briem (2003):**

Large floodplains (over 300 m wide); old river terraces; old moraines; terminal moraines of younger moraine landscapes

**Picture:**

*Ilmenau (Lower-Saxony). Photograph: L. Meyer*

**Short description of morphology:**

Sinuate to strongly meandering, dynamic mid-sized to large streams in wide shallow u-shaped valleys. Beside the usually well-rounded gravel fraction, cobbles and sand occur. Fraction sorting is common: gravel bars occur in stronger current regions, sand bars in calm sections. Beside side bars, mid-channel gravel bars and development of scour pools along eroding meander banks are common. The channel profile is shallow, but eroding bank cliffs can form. In the floodplain, old meanders are transformed into numerous backwaters and abandoned side channels, with varying degrees of silting up.

In respect to substrate and current conditions, streams passing terminal moraine gorges of the young moraine landscapes belong to this stream type.

**Abiotic profile:**

- **Size class:** 100 - 10,000 km² catchment area
- **Slope of the valley floor:** 0.5 - 1.5 %
- **Flow category:** fast to turbulent current, slow flowing stretches
- **Channel substrates:** well-rounded gravel fractions of varying grain size dominate, sand accounts for comparable portions of channel substrates, cobbles are subordinate

**Physico-chemical water conditions:**

The stream type occur as a siliceous and a calcareous variant

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Siliceous</th>
<th>Calcareous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity [µS/cm]</td>
<td>~ 450</td>
<td>500 - 800</td>
</tr>
<tr>
<td>pH-value</td>
<td>~ 7.5</td>
<td>7.5 - 8.5</td>
</tr>
<tr>
<td>Alkalinity [°dH]</td>
<td>~ 6</td>
<td>8 - 10</td>
</tr>
<tr>
<td>Total hardness [°dH]</td>
<td>~ 8</td>
<td>12 - 18</td>
</tr>
</tbody>
</table>

**Flow regime & hydrology:**

Medium to high discharge fluctuations over the year.
**Type 17: Mid-sized and large gravel-dominated lowland rivers**

### Characterisation of the macroinvertebrate community:

**Functional groups:** Species rich invertebrate community with rheophile hard substrate dwellers inhabiting stable gravel reaches; also sand-dwelling species in stable, detritus-rich sandy deposits. Species typical for the meatarhithral to epipotamal region dominate. In transition zones from the highlands to lowlands, numerous highland river species occur.

**Selection of type-specific species:** Characteristic species for gravel bars with fast current are the water bug *Aphelocheirus aestivalis*, and the caddis flies *Rhyacophila* spec., *Hydropsyche* spec. and *Cheumatopsyche lepida* (terminal moraine gorges). In slower, calmer currents, finer substrates are inhabited by the mussel *Unio pictorum* or the dragonfly *Gomphus vulgatissimus*. Accompanying species include *Ancylus fluviatilis* and *Theodoxus fluviatilis*, *Serratella ignita*, *Elmis aenea* and species of the genus *Potamophylax* spec.. Typical river species like the mussel *Unio crassus*, and the beetles *Haliplus fluviatilis* and *Brychius elevatus* occur.

### Characterisation of macrophyte and phytotobenthos communities:

Beside large pondweeds like *Potamogeton lucens*, *P. perfoliatus*, *P. alpinus* and *P. gramineus*, the bur reed (*Sparganium emersum*) community with numerous growth forms occurs. *Sagittaria sagittifolia* and *Nuphar lutea* are typical.

Young moraines: macrophyte colonisation varies. Eroding zones are usually not colonised, otherwise there are marginal to wide spread stands of different macrophyte communities dominated by typical stream species and stream reeds; subordinate are elements of pondweed and floating plant communities. Hard substrates are often colonised by moss (e.g. *Fontinalis*) or freshwater algae (e.g. *Hildenbrandia rivularis*); amphibious zones are poorly vegetated or support insular or marginal reeds and sedge communities.

### Characterisation of the fish fauna:

The fish fauna is diverse and dominated by gravel-spawning species. Due to the varied currents and depth variance species of calm stretches occur beside the rheophile species of the main channel. Calm stretches are found in back waters or disconnected side channels. Most species spawn in the gravel substrates, but species, which spawn on sand or between macrophytes can occur.

### Comments:

This stream type incorporates very dynamic streams passing terminal moraine gorges. These are short river stretches limited to young moraine landscapes near former glacier margins. They flow through shallow troughs or u-shaped valley. In terminal moraine gorges, the stream channel is straight to sinuate, the current velocities and hydraulic forces are generally high, dominant substrates are gravel, cobbles and boulders. Coarse woody debris, cobbles bars and island formation are common.

In terminal moraine gorges, the macroinvertebrate community can include many potamtal species, if lakes are passed in the course of the river (see Type 21).

### Examples of typical streams

- **Macronvertebrates:** Rur (Netherlands), Terminal moraine gorges of Nebel and Warnow (Mecklenburg-West Pomerania), Trave (Schleswig-Holstein), Ilmenau, Meiße, Seeve (Lower Saxony)
- **Macrophytes and phytotobenthos:** Warnow (Mecklenburg-West Pomerania)

### Comparative literature (selection):

- LUA NRW (2001) „Kiesgeprägter Fluss des Tieflandes“

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T. POTTGEISSER & M. SOMMERHÄUSER 2004: Profiles of German Stream Types
**Type 18: Small loess and loam-dominated lowland rivers**

**Distribution in river landscapes and regions according to Briem (2003):**

Loess regions, ground moraines

**Short description of morphology:**

In irregular curves, the river runs sinuous to meandering in a u-shaped valley. Very striking stream type. The loess and loam-dominated lowland stream is naturally the deepest cut-in stream type. The virtually vertical banks are undercut along eroding margins, but are stable because of the high bonding capacity of the loess fraction. On the streambed, the fine material is continuously removed and remains suspended in the current, often giving the streams a milky white colour (white water streams). The fine clastic substrate tends to form loam aggregates. In marl regions of the catchment, marl can be incorporated in the aggregates. The often flat aggregates replace hard substrates in the channel and supplement the dominating fine fractions. This stream type is characteristic for the loess region, but is also found as loam-rich variants in regions of the ground moraines. The steep, deeply cut-in channel profile, and the development of impermeable silt and clay horizons in the channel bed and floodplain are comparable to those of loess-dominated streams. However, this variant often also shows patches of deposited or incorporated gravel. The milky white turbidity common of loess streams is rare in loam-dominated variant.

**Abiotic profile:**

- **Size class:** 10 - 100 km² catchment area
- **Slope of the valley floor:** 2 - 12 ‰
- **Flow category:** even flow pattern; aggregate “hard substrate” occur, alternation of deep, slowly flowing sections and shallow quickly flowing reaches, similar to coarse material streams
- **Channel substrates:** silt and clay fractions dominate, limited organic proportions, often loam aggregates, marl rocks, gravel

**Physico-chemical water conditions:**

- **Conductivity [μS/cm]:** 450 - 750
- **pH-value:** 7.0 - 8.2
- **Alkalinity [°dH]:** 10 - 20
- **Total hardness [°dH]:** 14 - 28

**Flow regime & hydrology:**

Little to high fluctuations in discharge over the year; small streams have a tendency to intermittent surface discharge (summer dry).
**Type 18: Small loess and loam-dominated lowland rivers**

**Characterisation of the macroinvertebrate community:**

**Functional groups:** Depending on stream size, different shares of individual rhithral groups occur. Hard loam aggregates offer alternative “hard” substrates for gravel and stone-dwelling species. In fine sediments inhabitants of sand and mud habitats are common. The high load of fine suspended mineral material in the water column is unfavourable for many demanding species. Species diversity is low.

**Selection of type-specific species:** *Siphlonurus spec.*, *Metreletus balcanicus* (in intermittent, summer dry streams), otherwise comparable communities to those of gravel-dominated streams, due to carbonate richness and formation of loam aggregates as alternatives for hard substrates.

**Characterisation of macrophyte and phytobenthos communities:**

As a result of permanent turbidity, the aquatic vegetation is sparse. Plants with floating leaves like the pondweed *Potamogeton pectinatus* are supported as a result of their growth form.

**Characterisation of the fish fauna:**

The very specific habitat conditions do not support a very diverse or abundant fish fauna. The stream type specific turbidity and lacking substrates suitable for spawning, usually limit the occurrence of demanding species like trout, which require high oxygen saturation levels and gravel beds. Typical are species, which spawn among macrophytes, however these only occur in low abundances. Often these streams are only inhabited by sticklebacks.

**Comments:**

As a result of the deeply incised stream channel, the highly bonding steep banks and the turbid water, the stream type is very distinct. In the present landscape the stream type is rarely found in near-natural conditions, because the soils where it occurs are very rich and subject to intensive agricultural use. Only in some forested regions do small, near-natural streams remain.

**Examples of typical streams**

- **Macroinvertebrates:** Hövenbach (intermittent, summer dry) (North Rhine-Westphalia), Ahse (North Rhine-Westphalia), Eschbach, Holtorfer Bach, Siede (Lower Saxony)
- **Macrophytes and phytobenthos:** Ahse (North Rhine-Westphalia)

**Comparative literature (selection):**

**Type 19: Small streams in riverine floodplains**

**Distribution in river landscapes and regions according to Briem (2003):**

- **Ecoregion independent stream type.** Large floodplains (over 300 m wide), Lower river terraces

**Picture:**

*Hellbach (Schleswig-Holstein). Photograph: J. Stuhr*

**Short description of morphology:**

Streams with very low slope, running in winding to meandering, in parts multiple channels, through floodplains of main stem rivers, which hydrologically influences these tributaries. A valley form is not discernible. The very shallow, hardly cut-in channels have stable banks. Channel substrates vary from organic material to fine or coarse mineral fractions depending on the original fluvial deposits (often sand and loam, less common are gravel or loess). The water is often turbid as a result of high loads of suspended material, and streams rich in organics are often coloured brown by humic substances. Characteristic is an alternation of running water sections with standing water pools, as well as shaded and well-lighted reaches where macrophytes and reeds are abundant. At high discharges, the entire floodplain is inundated, often for longer periods of time. Water flow in river terrace tributaries is backed up, when the main stem river is experiencing high discharges.

In young moraines, reaches above lakes can be categorised into this stream type.

**Abiotic profile:**

| Size class: | 10 - 300 km² catchment area |
| Slope of the valley floor: | < 2 ‰ |
| Flow category: | alternation of stretches with barely evident current and clearly flowing stretches; rarely turbulent. |

**Channel substrates:**

besides organic substrates (macrophytes, woody debris, peat), deposits of the river terrace or the further extending catchment make up the channel substrates

**Physico-chemical water conditions:**

No generally parameter ranges can be given, because they are dependent on the geological-pedological conditions in the river terraces or the further extending catchment.

**Flow regime & hydrology:**

Low to high discharge fluctuations over the year, depending on the hydrology of the main stem river.
**Type 19: Small streams in riverine floodplains**

**Characterisation of the macroinvertebrate community:**

*Functional groups:* The characteristic combination of slowly flowing reaches and lentic stretches leads to a high amount of both species common to slow flowing reaches and standing water taxa. Hyporhithral and epipotamal species dominate, supplemented by numerous litoral species. Abundant macrophyte growth promotes high shares of plant colonisers. Other taxa include inhabitants of fine and hard substrates (under near-natural conditions mainly coarse woody debris). The fine, partially organic sediments, support sediment and detritus feeders, which make up the most abundant functional feeding group. Mainly euryoecious and eurythermic species.


**Characterisation of macrophyte and phtobenthos communities:**

The stream type is characterised by a rich macrophyte community, which can cover the vast expanses of the channel bed, due to favourable insolation conditions. The occurring species are often not running water specialists, but rather species, which also occur in standing water bodies. They include *Potamogeton natans*, *Myriophyllum spicatum* or *Nuphar lutea*.

**Characterisation of the fish fauna:**

The high current and substrate diversity support a very species rich and abundant fish fauna. Species common in running and standing waters, as well as those indifferent to current flow occur. So do species, which prefer mineral spawning substrates, or spawn among macrophytes. Besides fish species, which prefer small streams, species of larger water bodies also occur. The gravel-dominated sections of this stream type are colonised by trout and bullhead, while Crucian carp, roach and pike inhabit slow flowing reaches with high shares of organic matter or long and extensively inundated floodplains. Generally, species composition is influenced by the fish fauna of the main stem river.

**Comments:**

In contrast to other lowland stream types, Type 19 is not defined by the dominant channel substrates! Characteristic for this stream type is the plain floodplain setting, with no discernible valley shape, and the hydrologic influence by the main stem river, into which type 19 streams flow. Lacking shade and extensive reed stands are not artefacts, but are characteristic for this stream type. When bogs or valley peat occur in the catchment, humic substances often colour the water brown. Near natural streams of this stream type are hard to find, as a result of intensive landuse. Most streams of this type have been straightened, channelised and impounded.

*Possible confusion with other stream types:* Compared with stream types 11 and 12 (small and mid-sized to large organic rivers), streams of this type do not have a discernible valley form and have much lower stream slope. It is not a hydrologically independent stream type, but is much rather controlled by the discharge behaviour of the main stem river, into which or through the floodplain of which it flows (back flow). Biocenotically, the stream type supports high numbers of standing water body species, while type 11 and 12 are characterised by running water and floodplain species. The stream type only comprises small rivers up to 300m² catchment area. Periodically or permanently connected backwaters and old channels of the large rivers do not belong to stream type 19, but are rather categorised as stream type 15 or 20.

*Notice:* The description of this stream type may be supplemented with results from currently running research projects.

**Examples of typical streams**

Macroinvertebrates: Hellbach (Schleswig-Holstein), Seege (Lower-Saxony)

**Comparative literature (selection):**


T. POTGIETER & M. SOMMERHAUSER 2004: Profiles of German Stream Types
Type 20: Very large sand-dominated rivers

Distribution in river landscapes and regions according to Briem (2003):

Large floodplains (over 300m wide)

Picture:

Lower Rhine (North Rhine-Westphalia). Photograph: G. Friedrich

Short description of morphology:

These rivers flow in single sinuate to meandering channels or anabranching multiple channels in very shallow lower river terraces (usually in glacial valleys). Besides the dominant sandy and gravel substrates, clay and organic material occur. Under natural conditions this river type carries lots of coarse woody debris. This usually consists of large logs or fallen trees, which remain stable despite the strong current. Large pieces of coarse woody debris in the main and side channels, can lead to a build up of debris dams of smaller pieces of woody debris and other organic matter. Characteristic is expansive lateral channel migration and furcation. Natural channel structures include bars, islands, scoured pools and deep furrows. The profile is predominantly shallow and wide; often fords can develop.

Abiotic profile:

Size class: > 10,000 km² catchment size
Slope of the valley floor: ca. 0,07 - 1,0 ‰
Flow category: predominantly slow flowing current, with some quicker flowing reaches
Channel substrates: predominantly sand and gravel of varying grain size

Physico-chemical water conditions:

calcareous

Conductivity [µS/cm]: 500 - 850
pH-value: 8,0 – 8,5
Alkalinity ['dH']:
Total hardness ['dH']:

Flow regime & hydrology:
**Type 20:** Very large sand-dominated rivers

**Characterisation of the macroinvertebrate community:**

**Functional Groups:** This stream type supports a species rich community. Characteristic are large numbers of stenotopic, potamal species from various insect groups, which often develop abundant populations. The macroinvertebrate community is dominated by species of stable sand and gravel deposits. Typical are pelophile and psammophile insect species. Stone-dwelling organisms are rare and as a result of its gravel-dominated streambed more or less restricted to the Lower Rhine.

**Selection of type-specific species:** Some of the characteristic species of the detritus-rich, stable sand and mud deposits, include the mayflies *Ephemera vulgata*, *Ephoron virgo* and *Palingenia longicauda*, the dragonflies *Gomphus vulgatissimus* and *G. flavipes*, and the caddis fly *Molanna angustata*. Stone-dwelling species are the mayflies *Baetis fuscatus* and *Caenis horaria*, and the stonefly *Isogenus nubecula*.

**Characterisation of macrophyte and pycnhtobenthos communities:**

The typical species for the very large lowland rivers is the pondweed *Potamogeton nodosus*. Together with other floating leave species like *Potamogeton natans*, *Nuphar lutea* or *Sagittaria sagittifolia*, it forms the characteristic macrophytes communities along the river margin. These vegetation units represent the natural plant community of potamal lowland rivers.

**Characterisation of the fish fauna:**

Very large sand-dominated rivers are species-rich and support species of the bream and barbel regions, which can have a variety of different habitat requirements. Dominant species are typical river fish species with low habitat demands like bream, white bream, roach, perch, bleak. Typical for the fish community of the long middle reaches of this stream type are rheophilic species with large action radii (orfe, vimba bream and barbel).

Many water bodies in the floodplain are an essential habitat for typical lenitic species (e.g. tench, Crucian carp, carping, weather loach, belica and others). Local migratory movements between the main channel and floodplain water bodies are frequent. While some anadromous migrating fish travel to these river reaches to spawn (sea lamprey, river lamprey, houting), other migrating species use it as a corridor to their spawning grounds further upstream (e.g. salmon and sea trout). The fish community is complemented by numerous species from the tributaries.

**Comments:**

The stream type comprises several stream-section specific types. Presumably there are zoogeographical differences between several streams belonging to this stream type, like the Rhine, Elbe and Weser. For the entire Rhine (Alpine Rhine to delta) specific typologies for the various stream sections have been compiled (IKSR 2004).

**Examples of typical streams**

- Makroinvertebrates: Rhine (Lower Rhine section, North Rhine-Westphalia), Elbe (Lower Saxony), Oder

**Comparative literature (selection):**


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**T. POTTGIESER & M. SOMMERHAUSER 2004: Profiles of German Stream Types**
Type 21: Lake outflows

Distribution in river landscapes and regions according to Briem (2003):

Ecoregion independent stream type. Ground and terminal moraines of the young moraine landscapes

Picture:

Unterer Schierenseebach (Schleswig-Holstein), Photograph: M. Brunke

Short description of morphology:

Stream reaches below lakes are typical elements of the waterway networks of young moraine landscapes. These are small and mid-sized rivers, which only occur below lake outflows. The stretches are usually quite wide and often connect a series of lakes (interlacustrine stretches). The channel bed usually has gravel with high shares of sand in the main flow line. The channel bed is poorly structured with little coarse woody debris, large shoreline bays often contain pure mud. If eroding banks are developed, the substrates here are usually loam or sand. Based on macroinvertebrate coenoses, lenitic and lotic lake outflows can be differentiated. The stretches are often relatively open and have a reed margin, in the slowly flowing reaches, floating leaf plants occur.

Abiotic profile:

Size class: 10 - 1.000 km² catchment area
Slope of the valley floor:
Flow category: with slow (lenitic outflows) or quick (lotic outflows) currents; directly below the outflow currents are stronger than further downstream
Channel substrates: dependent on the regional and local geological and pedological situation; tendency to high levels of detritus and fine sediments

Physico-chemical water conditions:

Dependent on the water chemistry and nutrient conditions of the lake; tendency to eutrophic and calcareous situations (except in peat or bog rivers).

Conductivity [µS/cm]: 500 - 600
pH-value: 7,0 - 8,2
Alkalinity [*dH]: 10 - 20
Total hardness [*dH]: 12 - 28

Flow regime & hydrology:

Regulated discharge regime, with little fluctuation
Type 21: Lake outflows

Characterisation of the macroinvertebrate community:

**Functional groups:** Because of specific water conditions (nutrient load and temperature regime are regulated by the lake), species adapted to higher temperatures, fluctuating oxygen concentrations and a higher nutrient load are promoted in the outflow fauna. Distinct is the high abundance of filter feeders (large mussels, filter-feeding caddis flies, black flies) and detritus feeders. There is a high share of potamal and litoral species.

**Selection of type-specific species:** Among the species typical for lake outflows are the caddis flies *Neureclipsis bimaculata*, *Athripsodes cinereus*, *A. bilineatus* and *Anabolia* sp., the mayfly *Centroptilum luteolum* and various mussels like *Anodonta anatina* and *Unio pictorum*. Characteristic for lotic outflows are the water bug *Aphelocheirus aestivalis* and the caddis fly *Hydropsyche angustipennis*. The alder fly *Sialis lutaria* and the caddis flies *Athripsodes aterrimus* and *Molanna angustata* are typical species of lenitic outflows.

Characterisation of macrophyte and pythobenthos communities:

Macrophytes are largely absent from narrow, shaded outflows. Otherwise macrophytes are well developed along river margins or over wide expanses. *Nymphaeion albae*, myriophyllid and pondweed communities occur. Often species of the frog-bit and Lemneta minoris communities are present. Amphibious zones are usually colonised by various reed and sedge communities.

Characterisation of the fish fauna:

The fish fauna is highly variable and shows the transitional position between lake and river. Outflows are used differently and locally as a microhabitat by a variety of lake species. A generally valid description of the fish fauna is not possible. In contrast to optically similar streams of other stream types, in lake outflows the high summer temperatures and the presence of plankton as a food source are very important.

Comments:

The stream type is limited to the young moraine landscapes of the northern highlands and alpine foothills. The type cannot be confused with any of the others. Lake outflows can show very different morphological characteristics. The influence of the lake on nutrient and material cycling and thermal regime are significant for the biocoenosis. A description of the many different variants is not feasible.

**Notice:** The description of this stream type may be supplemented with results from currently running research projects.

Examples of typical streams

**Macroinvertebrates:** Lower and Upper Schierenseebach (Schleswig-Holstein)

Comparative literature (selection):

T. POTGIESSER & M. SOMMERHÄUSER 2004: Profiles of German Stream Types
## Type 22: Marshland streams of the coastal plains

**Distribution in river landscapes and regions according to Briem (2003):**

Marshland of the coastal plains and adjoining ground moraines of the older moraine landscapes.

**Picture:**

![Stream on Süderoog (Schleswig-Holstein). Photograph: LANUSH](image)

**Short description of morphology:**

The streams run in expansive meanders. The u-shaped channel profile has flat shores, which partially extend into mud flats. The channel bed shows little relief. The Substrates are usually clay, silt and mud. Some peat intrusions can occur. Overall substrate and current diversity are low. The riparian vegetation is dependent on the salt content of the water and tidal influence; while tidal reeds dominate in brackish water regions, woody riparian vegetation occurs in freshwater regions.

**Abiotic profile:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size class</td>
<td>10 - &gt; 10.000 km² catchment area (Elbe and Weser &gt; 10.000 km² catchment area)</td>
</tr>
<tr>
<td>Slope of the valley floor</td>
<td>&lt; 0.1 %/00</td>
</tr>
<tr>
<td>Flow category</td>
<td>dependent on tidal influence, bidirectional flow and backwater stagnation; typical is the reversal of water flow direction due to tidal influence</td>
</tr>
<tr>
<td>Channel substrates</td>
<td>dependent on the regional and local geological and pedological situation; tendency to high levels of detritus and fine sediments</td>
</tr>
</tbody>
</table>

**Physico-chemical water conditions:**

(Will be supplemented)

- **Conductivity [µS/cm]:**
- **pH-value:**
- **Alkalinity [°dH]:**
- **Total hardness [°dH]:**

**Flow regime & hydrology:**

Open marshland streams are tidal influenced.
# Type 22: Marshland streams of the coastal plains

| Characterisation of the macroinvertebrate community: | (will be supplemented) |
| Characterisation of macrophyte and pyhtobenthos communities: | (will be supplemented) |
| Characterisation of the fish fauna: | The fish fauna of the marshland streams varies greatly dependent on salt content (freshwater or marine influence) and tidal influence. Depending on the dominant conditions fish of the bream and/or ruffle region are found. Composition of the fauna can be determined by seasonally migrating species, especially with respect to abundance. |
| Comments: | Notice: Not yet completed studies in Lower Saxony and Schleswig-Holstein have shown that despite strong anthropogenic alterations, the marshland streams are not homogenous with respect to their biocoenoses. There are differences depending on stream size, salt concentration and catchment conditions. At present the following variants have been delimited: * Very large marshland rivers (22.3) (only Elbe and Weser), * Marshland streams with catchments in ground moraines of young and old moraine landscapes (22.2) and * Marshland streams with catchments almost completely inside the marshes, which flow directly into the North Sea or lower reaches of large rivers (22.1). |
| Examples of typical streams | Godel on Föhr (Schleswig-Holstein), Jümme (Lower Saxony) |
Type 23: Backwater and brackish water influenced Baltic Sea tributaries

Distribution in river landscapes and regions according to Briem (2003):
Young moraine landscapes: ground moraines

Picture:

Hellbach (Mecklenburg-West Pomerania). Photograph: H. Schuhmacher

Short description of morphology:
This stream type is found in the flat coastal plains of the Baltic Sea. The streams flow into slightly brackish, coastal waters, which are often separated from the Baltic Sea by a barrier beach and are silted up to a varying degree. As long as the barrier beach formation is not completed, there is an open connection to the Baltic Sea (e.g. in the “Bodden” waters along the Baltic Sea coast of Mecklenburg-West Pomerania). In the naturally backwater influenced region the mineral substrates of the river channel beds lie much lower than the present water mark of the Baltic Sea (9 m in the lower reaches of the Recknitz). In these regions, organic deposits from natural sedimentation cover the mineral substrates and fill the channel to its present bottom. In smaller streams channel substrates contain humic sand and sand bars and deep pools can form. As a result of backwater and brackish water influence, organic mud is the dominant substrate. This mud causes strong oxygen consumption.

Abiotic profile:

<table>
<thead>
<tr>
<th>Size class:</th>
<th>10 - 1.000 km² catchment area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope of the valley floor:</td>
<td>&lt; 0,5 °/00</td>
</tr>
<tr>
<td>Flow category:</td>
<td>very slowly flowing to standing water (backwater influence); reversal of flow direction is natural</td>
</tr>
<tr>
<td>Channel substrates:</td>
<td>dependent on the regional and local geological and pedological situation; tendency to high levels of detritus and fine sediments</td>
</tr>
</tbody>
</table>

Physico-chemical water conditions:

Conductivity [S/cm]:
pH-value:
Alkalinity [°dH]:
Total hardness [°dH]:

Flow regime & hydrology:
Hydrology is dependent on Baltic Sea water levels (backwater influence).
**Type 23:** Backwater and brackish water influenced Baltic Sea tributaries

| Characterisation of the macroinvertebrate community: | **Functional Groups:** The macroinvertebrate community is characterised by species from the marine and freshwater communities with a tolerance for brackish water. True brackish water species also occur. |
| Characterisation of macrophyte and pyhtobenthos communities: | **Selection of type-specific species:** Typical species are the caddis fly *Limnephilus affinis*, the true flies *Chironomus aprinus* and *C. salinarius* as well as the crustaceans *Gammarus tigrinus* and *G. zaddachi*. |
| Characterisation of the fish fauna: | The macrophyte communities give evidence for higher salt concentrations. Submerged plants include the tassel pondweed (*Ruppia cirrhosa*), brackish water forms of the pondweed *Potamogeton pectinatus* and horned pondweed (*Zanichellia palustris ssp. pedicellata*). |
| | The fish fauna can be very diverse, although usually only a few euryecious species like bass, roach and rudd dominate. Seasonally, migrating fish can occur in higher abundances, when the upper reaches of the catchment provide suitable habitat for gravel-spawning species like river lamprey and sea trout. |
| Comments: | Morphologically, this meandering stream type resembles the streams of riverine floodplains. A major difference is the backwater influence during high water levels of the Baltic Sea. |
| Notice: | The description of this stream type may be supplemented with results from currently running research projects. |
| Examples of typical streams | Hellbach (Mecklenburg-West Pomerania) |