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Technical Sheet: Indicator Set 1 Habitat diversity

Indicators:

- 1.1 River bed structures (in accordance with Woolsey et al. 2005, no. 36)
- 1.2 River bank structures (in accordance with Woolsey et al. 2005, no. 45)
- 1.3 Water depth (in accordance with Woolsey et al. 2005, no. 17)
- 1.4 Flow velocity (in accordance with Woolsey et al. 2005, no. 16)
- 1.5 Presence of cover (in accordance with Woolsey et al. 2005, no. 11)
- 1.6 Substrate (in accordance with Woolsey et al. 2005, no. 35 and Hunzinger et al. 2018)

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This Indicator Set forms part of the Swiss STANDARD outcome evaluation and is to be used in conjunction with the practice documentation “Evaluating the outcome of restoration projects – collaborative learning for the future” (FOEN 2019). The indicators included in the Indicator Set derive from various sources (e.g. Woolsey et al. 2005; Modular Stepwise Procedure) and, where appropriate, have been updated or adapted for the practice documentation. An overview of the most important modifications made can be found in Factsheet 7.

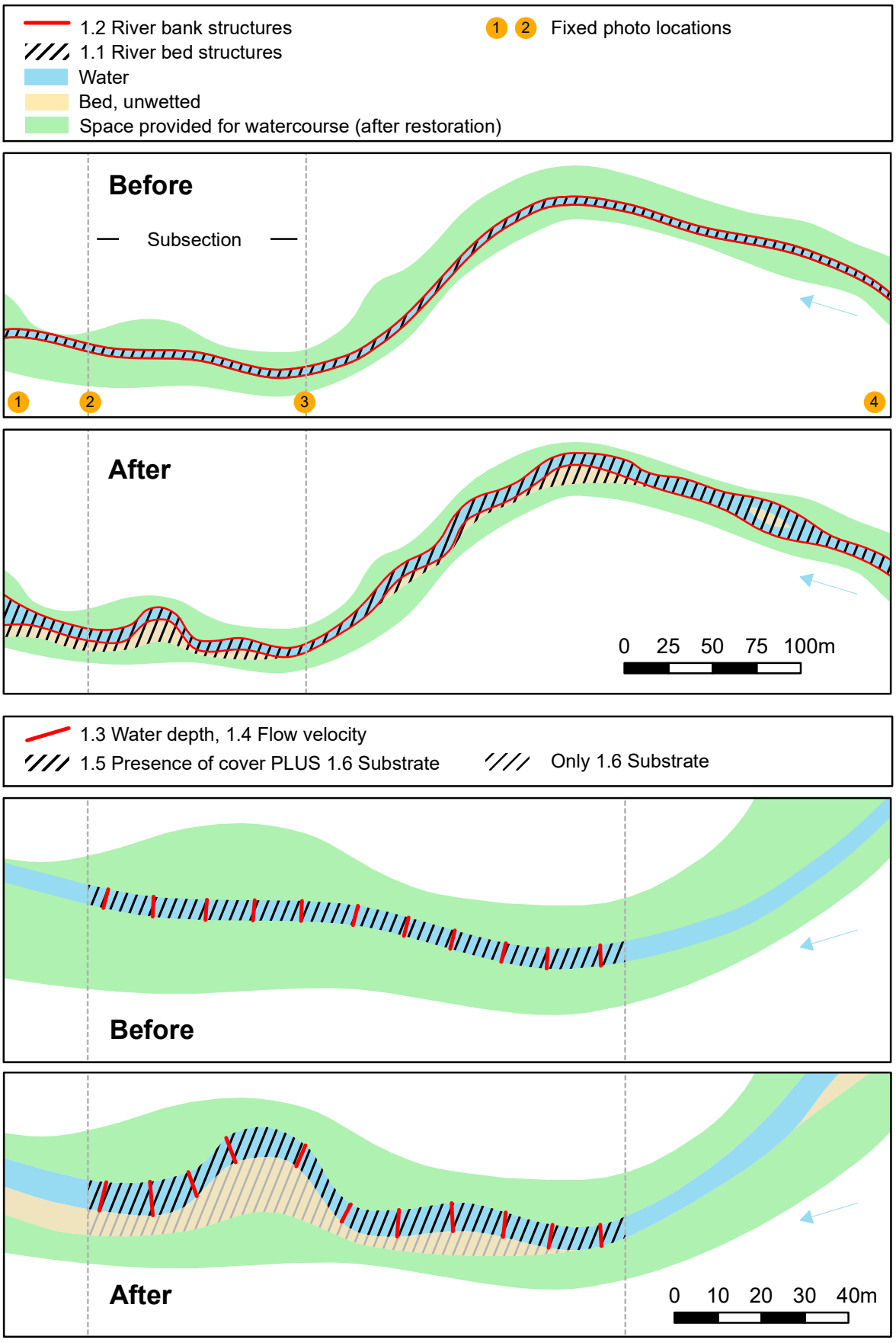
Principle

A river or stream section comprises a diverse mosaic of aquatic and terrestrial habitats. These habitats are shaped by abiotic processes, such as floods or bedload transport, but also by biological activity, such as plant growth or beaver operations. The habitats are used by different types of organisms, depending on the flow velocity, water depth or substrate composition. Indicator Set 1 is used to determine to what extent habitat diversity is altered by a restoration project; it thus provides the basis for the determination and interpretation of the biological indicator sets. Indicator Set 1 covers morphological bed and bank structures, the resultant hydraulic conditions (water depth, flow velocity), and substrate composition and mobility. Some of the indicators are determined along the entire restored section; the others are determined within a selected subsection (see also Factsheet 8 in the practice documentation).

This symbol is used to share tips and tricks from users.

Parameters	The following parameters are determined along the entire restored section: • River bed structures: occurrence and area of 9 types of structure • River bank structures: length of bank with different types of profile, composition and slope The following parameters are determined within a selected subsection, in which the biological indicator sets are also determined: • Flow velocity: distribution along at least 10 cross sections • Water depth: distribution and maximum along at least 10 cross sections • Presence of cover: occurrence and area [m^2] of 13 types of cover • Substrate: proportions of substrate area with different types of composition and mobilisability
Applicability	Indicator Set 1 is specified for all projects for which an outcome evaluation is conducted. It is particularly suitable for wadable watercourses, but it can also – with certain adjustments (e.g. measurements performed from a boat) – be used for large watercourses.
Special considerations	The timing of the determination of Set 1 should coincide as closely as possible with the biological surveys. This will permit the direct comparison of abiotic and biotic factors. Types of structure and cover cannot always be unequivocally classified; this task requires experience on the part of the observer. Different observers lacking experience can produce significantly different results. With the surveys described here, other indicators of habitat diversity can also be calculated – e.g. the IAM (Indice d'attractivité morphodynamique; Vonlanthen et al. 2018) or the HMID (Hydromorphologischer Index der Diversität; Gostner & Schleiss 2012).
Survey site	Restored section and subsection (see Fig. 1.1) The surveys extend across the entire width of the river bed, i.e., across the area between the left and right toe of the bank. This area is regularly mobilised during floods and is correspondingly free of perennial vegetation.
Timing	From a methodological perspective, the following points are to be noted: • Favourable discharge conditions, i.e. mean low flow as, for example, in late summer and autumn for low-lying watercourses (Q200–Q300), good transparency • The "before" and "after" surveys should be conducted under comparable discharge conditions. • No surveys directly after intense high flows, i.e. wait until representative structural-morphological conditions have re-established (e.g. macrophyte growth). • If macrophytes are present in the watercourse and they are mown for maintenance purposes, the survey should be conducted before mowing takes place.
Material	• General and detailed maps (e.g. high-resolution orthophoto), measuring tape, measuring rod, flow meter, waders. • Boat (for deeper rivers, to measure water depth and flow velocity)

Figure 1.1: Survey site for the indicators from Indicator Set 1.



Survey

The survey involves two stages: first, the entire restored section is mapped to provide a rough description of the river bed and bank structures; then, a selected subsection is surveyed in more detail (flow velocity, water depth, presence of cover, substrate). The location of the subsection remains unchanged before and after restoration, i.e. the “after” surveys are conducted in the same place (Factsheet 8).

Step	Description	Indicator
Preparation for mapping of the entire restored section	• Preparation of a general map (e.g. detailed site map, map, sketch, recent drone-shot aerial photo) which covers the entire restored section and on which the river bed and bank structures can be marked (minimum scale 1:1000). • For the “after” surveys, the general map may need to be thoroughly revised, or a new one prepared, depending on the extent of changes occurring in the course of the restoration project. For digital mapping, e.g. by means of QField, see tips on page 7	
Mapping of river bed structures (restored section)	• Inspection (on foot) of the entire restored section. Identification of river bed structures (Table 1.1) across the entire bed width (see survey site in the chapter "Principle"), i.e. including the unwetted areas such as open gravel or sand banks (Fig. 1.1). • Marking of the position and extent of river bed structures (area, shape) on the general map. Minimum area of a river bed structure: 3–5 m^2 for large, 1–3 m^2 for medium-sized and 0.5–1 m^2 for small watercourses (half to whole bed width). • For larger watercourses, mapping with the aid of a recent aerial photo will be most efficient. • Temporary structures established for recreational purposes (stone dams or piles, swimming areas) are not taken into account, i.e. what is mapped are the bed structures which would exist without them (generally shallows). • Block ramps are mapped differently depending on their construction type: - Closed block ramps = artificial bed (0). - Structured dissolved block ramp = sequence step (8) – plunge pool (9). Note: Only 1 step and 1 plunge pool are considered in the assessment for the entire restoration section so that the density of structures is not artificially increased. - Unstructured dissolved block ramp = run (5)	1.1
Mapping of river bank structures (restored section)	• In parallel with the mapping of river bed structures: mapping of the shoreline (= boundary between water and land). N.B. The shoreline does not necessarily run directly along the bank toe. The shoreline of side channels or backwaters is to be included. Water bodies that are disconnected from the main channel and are usually temporary are only considered if they are located in the regularly mobilised area of the bed (see survey location in the "Principle" chapter). • Characterisation of river bank structures based on the attributes of profile (= water-land interconnection), composition and slope (Table 1.2), and marking of their position and extent (length) on the general map. Minimum length of a river bank structure: at least 1 m in small, 3 m in medium-sized and 5 m in large watercourses.	1.2
Photo-documentation of the restored section	• Concurrently with the mapping of river bed and bank structures, up- and downstream photographs are taken at each of 4 fixed locations, from one of the two banks (Fig. 1.1). • For purposes of photo-documentation, a drone-shot aerial photograph (orthomosaic) is recommended, but is not a requirement.	

Preparation for mapping of subsection	• Based on the changes to be expected as a result of restoration, a subsection characteristic of the restoration project is selected (Factsheet 8). • The length of the subsection should be approx. 12 times the width of the river bed after restoration (from left bank toe to right bank toe, including unwetted areas) and should be at least 100 m and at most 200 m (Factsheet 8). • If the restored section is shorter than 100 m, then the entire restored section is studied. • For the subsection, a detailed map is prepared. Depending on the length of the restoration project, the map section or scale may need to be adjusted, compared to the general map.  For digital mapping, e.g. by means of QField, see tips on page 7	
Measurements along cross sections (subsection)	• Surveying of 10–15 cross sections at more or less regular intervals along the subsection, i.e. approx. every 10 m, at right angles to the river axis. Any notable features lying in between (e.g. local channel narrowing) are to be taken into account. The exact position of each cross section is recorded on the detailed map.  It is worth marking out the subsection and the location of the cross sections (e.g. using stakes) before starting the field surveys. The location of the cross sections can thus be recorded on the detailed map in advance. This will also facilitate recording of the available cover and the substrate (indicators 1.5 and 1.6). • Measurement of water depth and flow velocity at (at least) 10 points along the cross section, every 0.2 m to 1 m, at equal intervals. If fewer than 10 points can be measured – due to a low wetted width (< 2 m) – then a larger number of cross sections should be sampled. Overall, measurements should be made at approx. 150–200 points. • Water depth [m]: accurate to cm level, i.e. to 2 decimal places (x.xx m) • Flow velocity [m/s]: at 40% of water depth, i.e. 40% above the river bed. Accurate to cm level, i.e. to 2 decimal places (x.xx m/s). • Measurement of the wetted width. • Determination of the wetted area (= length of the study section x mean wetted width)	1.3, 1.4
Mapping of available cover (subsection)	• Mapping of all types of cover in accordance with Table 1.4. The area of each cover is recorded on the detailed map and assigned to a cover type. • Deciding whether to map or not: Ask yourself whether a fish of 25-30cm length can hide in/under it. If yes -> map. • If cover can be assigned to two or more types, the area is only assigned to the dominant type.	1.5
Mapping of substrate (subsection)	• Characterisation of the substrate, based on its composition and mobilisability (Table 1.3). Exception: Gravel is not naturally mobilized in lake outlets, bog streams and groundwater-fed streams. Accordingly, the survey and assessment of mobilisability can be dispensed with there. However, the composition of the substrate is still surveyed. • Recording of areas with uniform composition and mobilisability on the detailed map. Minimum area for substrate mapping: 3–5 m^2 for large, 1–3 m^2 for medium-sized and 0.5–1 m^2 for small watercourses. • Optionally (necessary for calculation of the IAM), the compactness of the river bed per area of uniform substrate can be qualitatively assessed using the boot test (Schälchli 2002): the effort and force required to loosen the top layer with the foot. Three categories – easy (no to little compaction), medium (moderately packed), high (tightly packed). • In case of sintering: - Composition: If there is no interstitial/pore space, then map as rock (7). If it has interstitial spaces, then as boulders (6).	1.6

- Mobilisability: The bed is no longer mobilisable in the case of sintering, i.e. similar to a cover layer -> no mobilisation (5), regardless of whether texture indicated as rock or blocks.

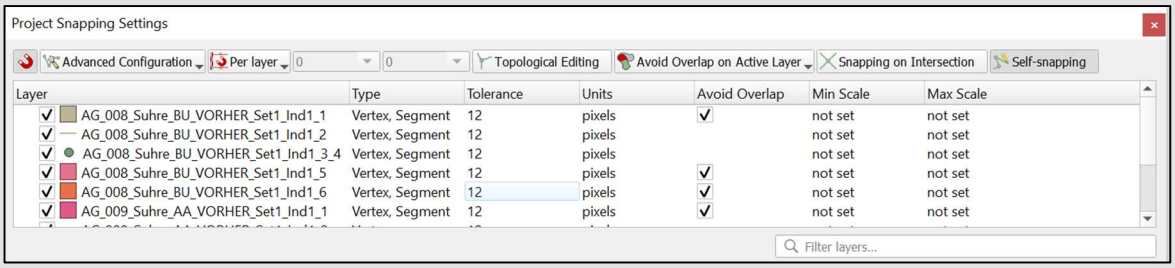
Digitalisation of general and detailed maps (data mapped in the field)	• Digitalisation of the survey data, using GIS, under consideration of the requirements defined in the data model (download under “Hilfsmittel” on the FOEN webpage; there you can also find a GIS sample dataset) • Creation of 2 shapefiles for the restored section (for the file naming scheme, see “Data arising” below): 1. Polygon shapefile for the 9 river bed structures 2. Line shapefile for the river bank structures, with profile, composition and slope • Creation of 3 shapefiles for the subsection 1. Point shapefile for water depth and flow velocity along cross sections 2. Polygon shapefile for the 13 cover types 3. Polygon shapefile for substrate based on composition and mobilisability The following procedure is recommended for digitizing the data mapped in the field: 1. optional: georeferencing drone image. Use of Swisstopo aerial images -> available free of charge since 1.3.21: https://www.swisstopo.admin.ch/de/geodata/images/ortho/swissimage10.html 2. placing of the cross sections. 3. reading in the data for the cross sections (instructions under "Hilfsmittel" on the FOEN website). 4. Draw the shoreline and divide it into sections according to the shoreline structure. In the subsection, orient to cross sections and pay attention to precision. 5. draw the bed surface and divide it into subsections according to the bed structure. The bed area extends beyond the shoreline if benches are present, otherwise shoreline as boundary. 6. drawing the valley path. The length of the valley path is used to determine the average width of the stream bottom (= bed area / length of valley path) and from this the unit length. 7. drawing of shelter offer (subsection). Can project above the shoreline (ex. stone groynes, undercut banks). 8. drawing from substrate (subsection). Extends beyond shoreline if gravel bars are present, otherwise shoreline as boundary. • Requirements for quality of GIS data to be submitted: - All lines must be coupled except at the beginning and end of the section. - There must be no self-intersections or duplicate nodes. - Polygons must contain at least three nodes. - Polygons of the same shapefile must not overlap each other. - Polygons of the bed structure or the substrate must not have any gaps between them. A topology check/ geometry check allows to identify these error sources. In QGIS the *Geometry Checker* plugin can be used for this purpose. https://docs.qgis.org/3.34/en/docs/user_manual/plugins/core_plugins/plugins_geometry_checker.html The following principles and settings are recommended: • Carry out separate geometry checks for each layer • Geometry check rules: - Points: • Topology checks –> Check for Duplicates - Lines: • Geometry validity –> Self-intersections • Geometry validity –> Duplicate nodes • Geometry validity –> Self contacts	

- For polygons:
  - Geometry validity –> Self-intersections
  - Geometry validity –> Duplicate nodes
  - Geometry validity –> Self contacts
  - Geometry validity –> Polygon with less than 3 nodes
  - Geometry properties –> Polygons and multipolygons may not contain any holes
  - Geometry conditions –> Minimal polygon area *0.2 map units squared based on small watercourses*
  - Geometry conditions –> No sliver polygons *maximum thinness 20*
  - Topology checks –> Check for features within other features
  - Topology checks –> Check for overlaps smaller *than 10 map units squared*
  - Topology checks –> Check for gaps smaller than *10 map units squared*

Digital mapping in the field

Prior to fieldwork

- Set snapping settings in the QGIS project
  - Project –> *Snapping Options –> Advanced Configuration*
  - Select the following settings:
    - Enable Snapping
    - Enable Topological Editing
    - Select Avoid Overlap on Active Layer
    - Enable Snapping on Intersection
    - Layers: Check all
    - Type: Vertex and Segment for all layers
    - Tolerance: 12 (default)
    - Units: pixels
    - Check Avoid Overlap for polygons



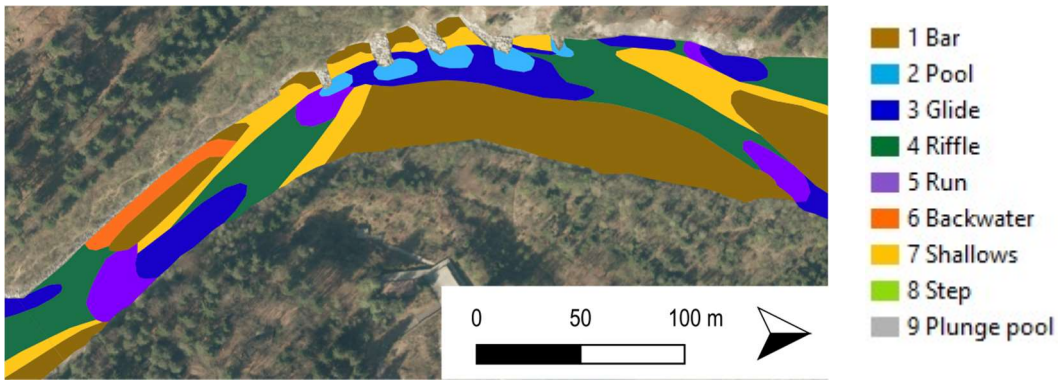
During Fieldwork

- Do NOT use the freehand digitizing feature in QField
- Do not zoom in past the scale 1:100 for drawing
- Note: with the snapping sections selected, it will be possible to draw over existing polygon features in the active layer without creating overlapping features

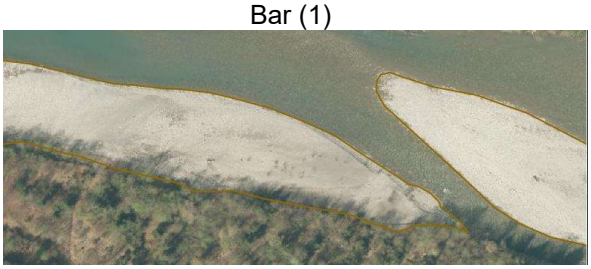
Table 1.1: River bed structures mapped along the restored section for Indicator 1.1, including, by way of example, photos of the Kander (canton of Bern) and of a step-pool sequence (Photos: Flussbau AG).

No.	Structure	Description
1	Bar	Local sediment deposit, not submerged during low-flow conditions, in the middle of the river or along the bank
2	Pool	Local deepening of river bed due to erosion by secondary currents and/or eddies
3	Glide*	Elongated, deep channel section with slow current. Wetted width/depth ratio low (<10–12).
4	Riffle*	Broad, elevated portion of river bed with slow current, with a low gradient. Wetted width/depth ratio higher (>10–12).
5	Run*	Steep channel section with swift current, with a high gradient
6	Backwater	Wetted area with no current during low-flow conditions (“dead end”)
7	Shallows	Low-current zone along the bank or along a gravel bar
8	Step**	Natural or artificial drop followed by a pool. The step begins at the point in the upper waters where flow is accelerated towards the drop and ends where the jet enters the lower waters; here the pool begins.
9	Plunge pool**	Larger depression following a step
0	Artificial bed	Local artificial stabilisation of the river bed, which is not mapped as a step

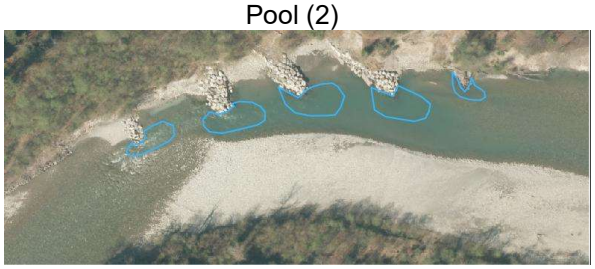
* Glide, riffle and run together form a sequence typical of low-gradient rivers (gradient <3%).
** Step-pool sequences are natural features of steep waters (gradient >1%), which appear as a result of artificial sills, but also in more gently sloping rivers.



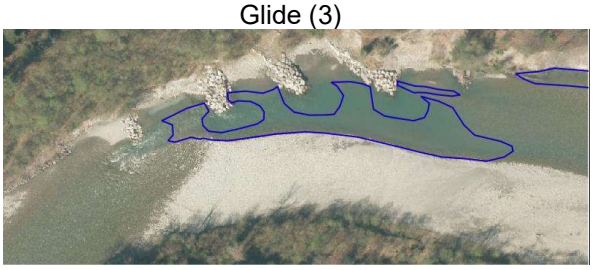
Bar (1)



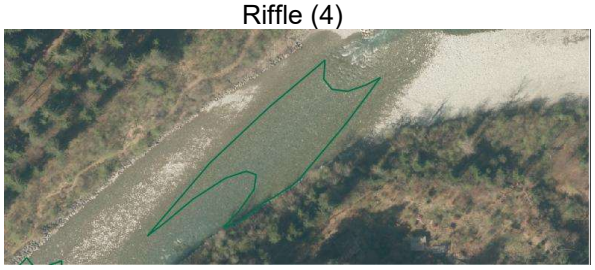
Pool (2)



Glide (3)

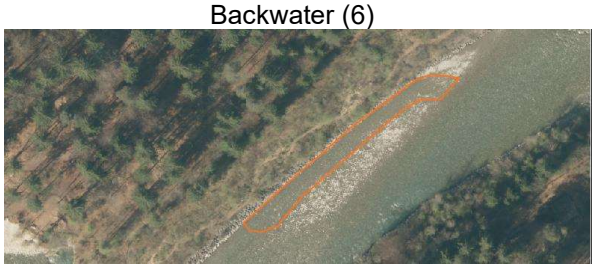


Riffle (4)

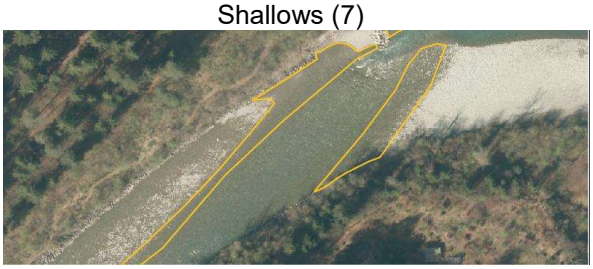


Run (5)

Backwater (6)



Shallows (7)



Step (8) – Plunge pool (9)

Table 1.2: Three attributes of river bank structures which are mapped for Indicator 1.2 along the restored section. The photos illustrate the various qualities for profile, composition and slope (Photos: Flussbau AG).

Attribute	No.	Quality
Profile	1	Linear
	2	Convex: cape, the bank projects into the water
	3	Concave: bay, the water extends into the bank
Composition	1	Permeable embankment (rough banks), e.g. bioengineering, loosely packed natural stones, wood
	2	Impermeable embankment (smooth banks), e.g. tightly packed natural stones, wall, concrete grid
	3	Unconsolidated material (including grass)
	4	Root systems
	5	Rock
Slope	1	Gentle (≤ 1:2)
	2	Steep (> 1:2)

Permeable embankment, steep

Impermeable embankment, steep

Rock, steep

Impermeable embankment, steep, linear

Convex

Concave

Unconsolidated material, gentle

Unconsolidated material, steep

Root systems, steep

Unconsolidated material, steep

Table 1.3: The two attributes of the substrate (Indicator 1.6). The attribute “mobilisability” corresponds to the parameter “substrate type” in the enforcement aid for reactivation of bedload transport (Hunzinger et al. 2018; photos Flussbau AG).

Attribute	No.	Quality	
Composition	1	Silt/fine sediment	<0.2 mm
	2	Sand	0.2–2 mm
	3	Gravel	2–16 mm
	4	Stones	16–64 mm
	5	Large stones	64–250 mm
	6	Boulders	>250 mm
	7	Rock	impermeable
	8	Organic material	e.g. grasses, reeds, roots, branches, woody debris
	9	Artificial substrate	e.g. engineered bed
Mobilisability	1	Deposits of suspended particles	Sand, silt
	2	Fine bedload	Finer-grained portions of regularly transported bedload (*)
	3	Coarse bedload	Coarser portions of regularly transported bedload (*)
	4	Bed material mixed with bedload	Bedload grains are deposited between the large grains of bed material (*)
	5	Coarse bed material	Large grains of bed material predominate, often arranged in an imbricated structure (*)

(*) Do not be deceived by the grain sizes in the photos below - the grain sizes for mobilisability vary depending on the water body and must be determined accordingly on a water body-specific basis.

Suspended particle deposits

Fine bedload

Coarse bedload

Bed material mixed with bedload

Coarse bed material

Table 1.4: Types of cover mapped in the subsection for Indicator 1.5.

No.	Cover type
1	Submerged stones or boulders
2	Non-submerged stones or boulders (also areas behind rocks)
3	Small organic particles (mobile, e.g. small branches, collections of leaves, grass)
4	Medium-sized organic particles (relatively immobile, e.g. fine roots, bryophytes 5–20 cm in diameter)
5	Large branches in the water, large roots (from trees standing along the waterside)
6	Tree trunks (lying)
7	Tree stumps or intact root plates (lying)
8	Overhanging vegetation (dead or living, up to a maximum of 50 cm above the water surface)
9	Undercut banks
10	Submerged plants, floating plants
11	Overhanging grass / reeds
12	Turbulent water zones
13	Pools (various pool types are combined)

Evaluation

The evaluation approaches given below are based on those found in the original publications for the indicators (Woolsey et al. 2005; Hunzinger et al. 2018). They serve as a guide and will be revised in the coming years on the basis of the experience accumulated in the STANDARD and EXTENDED outcome evaluations. An evaluation file can be found on the FOEN website under "Hilfsmittel". In it, various steps of the evaluation and assessment of the data are explained and automated.

Indicator	Description
1.1 River bed structures	To be determined are the number of structures per structure type and the total number of structures per unit length (e.g. 2 pools, 1 bar, 1 glide). To do so, the restored section is divided into subreaches, each one a unit length long (= unit length section). If the restoration section is longer than an integer multiple of the unit length, a residual section remains that is also evaluated. A structure is counted if it does not adjoin another structure of the same type within a unit length section. Structure type 0 (artificial bed) is excluded from the calculations, i.e. not counted. If a structure extends across the boundary between two unit length sections, it must be decided on a case-by-case basis whether the structure is counted in both sections or only in the section in which the larger part of the structure is located. Criteria to be considered for the decision are, for example, the size of the smaller part of the structure or the influence on the evaluation (representativeness of the evaluation for the unit length section). Defined as “unit length” is a length 12 times the width of the river bed (from left bank toe to right bank toe, including unwetted areas). This corresponds to the mean wavelength of alternate bars or meanders. The evaluation classes and the conversion to dimensionless normalised values are as follows for each unit length section and for the remaining section:

Evaluation classes	Normalised values
Only one structure type present	0
The structure type glide dominates. Other structure types occur with isolated, spatially isolated structures.	0.25
4 or more structure types are present with a density of 4-8 structures per unit length. If the structure type glide dominates, the structures of the remaining structure types locally form a diverse pattern.	0.5
All structure types of a glide-riffle-run or a natural or near-natural step-pool sequence present with a density of 8-11 structures of this sequence per unit length.	0.75
All structure types of a glide-riffle-run or a natural or near-natural step-pool sequence present with a density of 12 structures or more of this sequence per unit length	1

For the evaluation at the level of the restored section, the evaluations from the unit length sections are averaged weighted according to their length. This results in a value between 0 and 1.

1.2 River bank structures	For the evaluation, two parameters are calculated – one for the proportion of the shoreline with linear embankment (linear embankment parameter A_{Emb}) and one for the proportion of the shoreline lacking linear embankment (structural elements parameter $A_{Structure}$). Analogous to the procedure in indicator 1.1, the evaluation for both parameters is carried out at the level of the unit length sections and subsequent formation of the weighted average (see description of the evaluation of indicator 1.1):

- **Linear embankment parameter (A_{Emb}):**
  Shoreline linear, with embankment (structure types 111, 112, 121, 122)
  -> Profile = linear
  -> Composition = permeable or impermeable embankment

$$A_{Emb} = \frac{1}{2}\left(1 - \frac{L_{Impermeable\ embankment\ linear} + 0.5\ L_{Permeable\ embankment\ linear}}{L_{Bank}}\right)$$

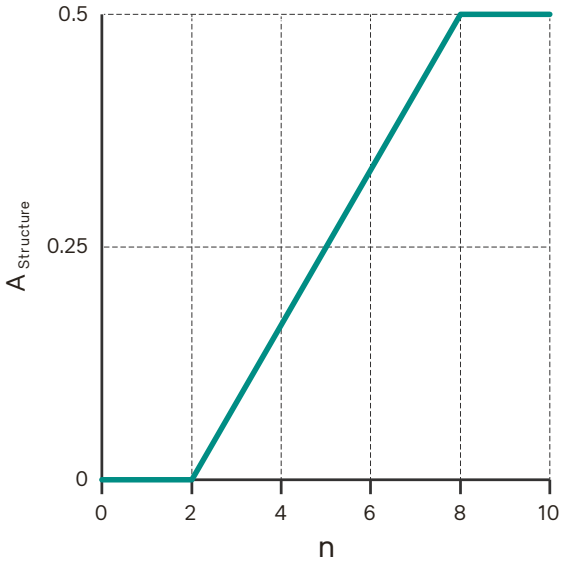
  Normalised values resulting for A_{Emb} are between 0 (smooth/ impermeable embankment on both sides) and 0.5 (no linear embankments).

- **Structural elements parameter ($A_{Structure}$):**
  Shoreline lacking embankments -> Composition = unconsolidated material, root systems, rock
  AND shoreline convex or concave with embankment -> Composition = permeable or impermeable embankment

  For the shoreline lacking linear embankment (i.e. for all structure types EXCEPT 111, 112, 121 and 122), the number of structure types present per unit length is determined (n). The structure types arise from the combination of the three attributes of river bank structures. The definition of “unit length” is given in the section on the evaluation of Indicator 1.1. The values n are normalised as shown in Figure 1.2.

n	$A_{Structure}$
< 2	0
2 ≤ n ≤ 8	$(n-2) * (\frac{1}{12})$
> 8	0.5

Figure 1.2: Calculation of the structural elements parameter ($A_{Structure}$) based on the number of structure types per unit length (n).



1.3 Water depth	To evaluate the distribution of maximum flow depth, the coefficient of variation of maximum water depth is calculated:

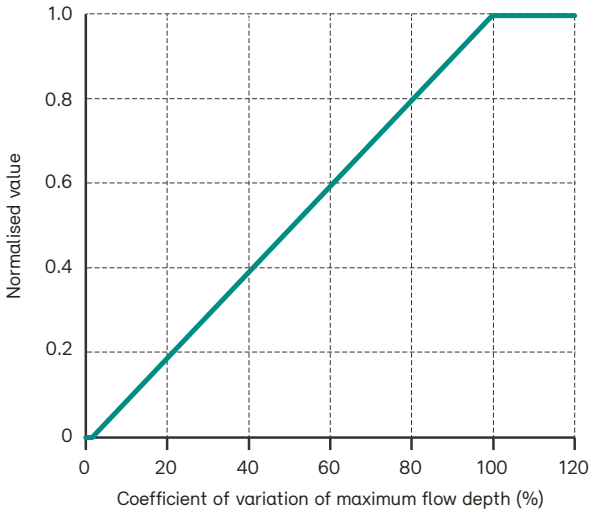
$$VC_{max.\ water\ depth} = \frac{\sigma_{max.\ water\ depth}}{\mu_{max.\ water\ dept}} x\ 100\ [\%]$$

$\sigma_{max.\ water\ dept}$ = Standard deviation of maximum water depths measured

$\mu_{max.\ water\ depth}$ = Mean of maximum water depths measured

For normalisation, a coefficient of variation of 0% corresponds to a value of 0, and a coefficient of variation of ≥100% corresponds to a value of 1, with the value function being linear in between (Figure 1.3).

Figure 1.3: Normalisation of results for Indicator 1.3 Water depth



1.4 Flow velocity	To evaluate the distribution of flow velocity, the coefficient of variation is calculated; in the formula, equal account is taken of all the flow velocities measured:

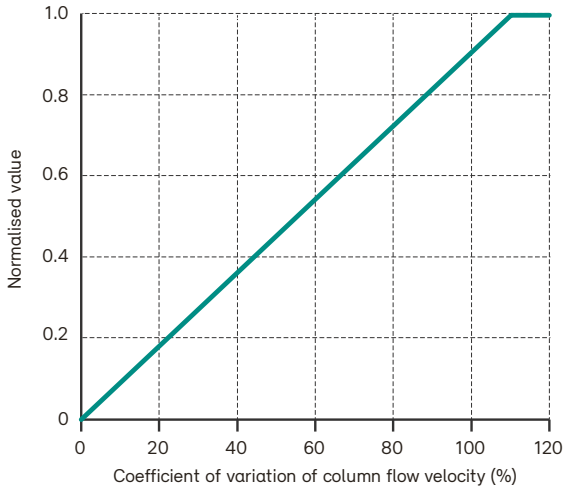
$$VC_{Flow\ velocity} = \frac{\sigma_{Flow\ velocity}}{\mu_{Flow\ velocity}} x\ 100\ [\%]$$

$\sigma_{Flow\ velocity}$ = Standard deviation of flow velocities measured

$\mu_{Flow\ velocity}$ = Mean of flow velocities measured

For normalisation, a coefficient of variation of 0% corresponds to a value of 0, and a coefficient of variation of ≥110% corresponds to a value of 1, with the value function being linear in between (Figure 1.4).

Figure 1.4: Normalisation of results for Indicator 1.4 Flow velocity



1.5 Presence of cover	The total area is calculated for each of the 13 cover types. Available cover is then determined for the entire wetted area (= “currently available cover” for the time point Before or After1 or After2).

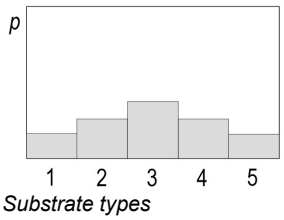
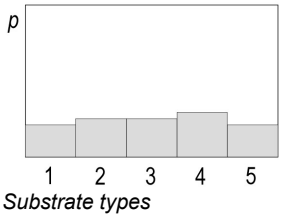
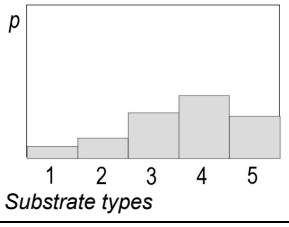
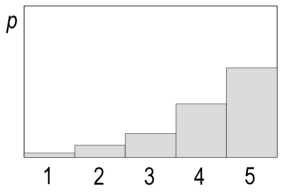
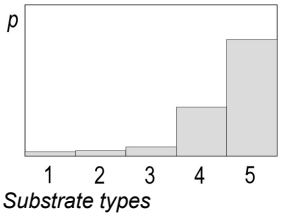
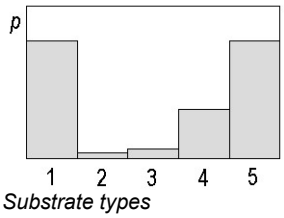
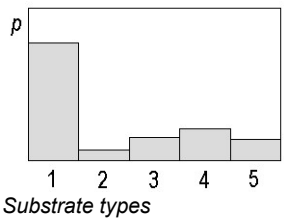
An estimation is then made of watercourse type-specific cover availability (reference condition). This step is currently based on expert knowledge (consideration of river type, knowledge of reference watercourses, possibly with the aid of known reference reaches of the watercourse).
Lastly, currently available cover is compared with watercourse type-specific cover availability.

$$\text{Proportion of reference condition [\%]} = \frac{\text{Currently available cover [\%]}}{\text{River type} - \text{specific cover availability [\%]}}\ x\ 100$$

This proportion describes closeness to the reference condition and can be evaluated or normalised using the following matrix. Here, deviation from reference conditions is evaluated (i.e. 100% minus proportion of reference condition [%]). Accordingly, not every increase in available cover automatically counts as an improvement.

	Evaluation scores				
	0	**0.25**	**0.5**	**0.75**	**1**
Deviation from reference condition (%)	Very strong deviation (>80%)	Strong deviation (50–80%)	Marked deviation (30–50%)	Slight deviation (10–30%)	No deviation (<10%)

1.6 Substrate	The attribute “mobilisability” is evaluated using the method described for the parameter “substrate type” in the enforcement aid for reactivation of bedload transport. The normalised value for the outcome evaluation (between 0 and 1) is apparent from the following list. “Substrate type” corresponds to the attribute of mobilisability defined in Indicator Set 1. For the attribute “Composition”, no evaluation method is currently available. It does, however, represent an important variable for the sampling and interpretation of the biological indicators.

1	Bedload deposits predominate. No or limited areas of coarse, armored bed material. Rather limited fine sediments.	
0.75	Balanced distribution of all classes.	
0.5	Mostly coarse substrate mixed with bedload. Some areas with bedload deposits.	
0.25	Mainly coarse and armored bed material, partly mixed with bedload. No areas with bedload deposits.	
0	Mainly coarse and armored bed material, locally also mixed with bedload.	
0	Predominantly coarse and armored bed material, with vaste fine sediment deposits. (-> This distribution is found, for example, in residual flow reaches where the flood discharge recedes unnaturally fast or which are influenced by reservoir flushing).	
0	Gravel bed covered with fine sediment deposits. (-> This distribution is found, for example, in shallow reaches of small streams with intensively farmed catchment areas or at the root of a dam).	

Time required

Table 1.5: Summary of time required in person-hours for the determination and evaluation of Indicator Set 1. General items (e.g. travel time) are not taken into account. A rough cost estimate can be found in Table 2.1 of Factsheet 2.

Step	Specialists		Assistants	
	Persons	Time per person (h)	Persons	Time per person (h)
Preparation of field surveys (excl. drone flights)	1	2		
Field mapping of river bed and bank structures, per km	1	5–10		
Digitalisation of river bed and bank structures, per km			1	5–8
Survey of subsection	1	5–10	1–2	5–10
Data processing for subsection			1	8–16
Evaluation	1	4–8		
Total person-hours	16–30		18–44	

Notes: -

Further information

Data arising	• Data entry form Indicator Set 1: KT_ProCode_ERHEBUNG_Set1_V#.xls • Shapefiles, under consideration of the requirements defined in the data model (download under “Hilfsmittel” on the FOEN webpage) • River bed structures as polygon shapefile: KT_ProCode_ERHEBUNG_Set1_Ind1_1.shp • River bank structures as line shapefile: KT_ProCode_ERHEBUNG_Set1_Ind1_2.shp • Water depth and flow velocity along cross sections as point shapefile: KT_ProCode_ERHEBUNG_Set1_Ind1_3_4.shp • Cover types as polygon shapefile: KT_ProCode_ERHEBUNG_Set1_Ind1_5.shp • Substrate as polygon shapefile: KT_ProCode_ERHEBUNG_Set1_Ind1_6.shp • Photos from 4 fixed photo locations: KT_ProCode_ERHEBUNG_Set1_1up.jpeg; KT_ProCode_ERHEBUNG_Set1_1down jpeg; KT_ProCode_ERHEBUNG_Set1_2up.jpeg; KT_ProCode_ERHEBUNG_Set1_2down jpeg; KT_ProCode_ERHEBUNG_Set1_3up.jpeg; KT_ProCode_ERHEBUNG_Set1_3down jpeg; KT_ProCode_ERHEBUNG_Set1_4up.jpeg; KT_ProCode_ERHEBUNG_Set1_4down.jpeg» • If available, aerial (drone-shot) photograph documenting the restored section: KT_ProCode_ERHEBUNG_Set1_air.jpeg Elements of the file naming scheme (see Factsheet 5): • KT = two-capital-letter cantonal abbreviation (e.g. BE) • ProCode = project code • ERHEBUNG = survey time point, i.e. VORHER (= before), NACHHER1 (= after 1), NACHHER2 (= after 2), or VERTIEFT (= EXTENDED) • V# = version number of the data entry form
Attachments	The field protocol, data entry form and other tools (e.g. evaluation file, geodata model, GIS example dataset) can be downloaded at: https://www.bafu.admin.ch/wirkungskontrolle-revit

List of modifications

Relevant changes are marked in green.

Date (mm/yy)	Version	Change	Responsibility
1/2023	1.05	Digitalisation of the data: Description of the step-by-step procedure	Eawag
1/2023	1.05	Addition of tips and tricks for the survey (marked with the symbol)	Eawag
1/2023	1.05	Various minor details (e.g. clarity of wording adjusted, mention of evaluation file and GIS sample data set)	Eawag
1/2023	1.05	Survey location: specification of the term ‘river bed’	Eawag
1/2023	1.05	Indicator 1.1: • Survey/evaluation: specification of handling of block ramps.	Eawag
1/2023	1.05	Indicator 1.2: • Survey: specify handling of disconnected water bodies.	Eawag
1/2023	1.05	Indicator 1.6: • Survey: specification of handling of sintering • Survey/evaluation of mobilisability: specification of procedure in bog streams, lake outlets and groundwater-fed streams • Evaluation of mobilisability: addition of two more distributions of substrate types to the listing.	Eawag
3/2024	1.06	Tips for geometry checks in QGIS	Eawag
3/2024	1.06	Tips for digital mapping in QField	Eawag