Länsstyrelsen Stockholm

RETROUT

River Habitat Survey

Methods for surveying and analysing habitats within and in connection to streams

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Content

1 Preface

This handbook was originally produced in Sweden to meet the demands of hydromorphological classification of watercourses according to the Water Framework Directive. It is to a large extent based on a previously published method of river habitat surveys developed in the 1990-ies in Sweden (Naturvårdsverket 2003) and further developed by the County Administrative Board in Jönköping (Länsstyrelsen i Jönköping 2012). The manual has now been translated into English and abridged to be used in the Interreg Baltic Sea Region project Retrout - Development, promotion and sustainable management of the Baltic Sea Region as a coastal fishing tourism destination. The description of the river habitat survey methodology is however general and can be used as a reference by anyone who wish to use this method.

The theoretical background to the method (chapters 5 and 6 in the Swedish original) is not included in this edition. Information on hydromorphological theory is to be found in the reference list in chapter 4 of this manual and in presentations on the subject that can be found at the Retrout website (www.retrout.org). These presentations were given at a workshop held in Klaipeda 26-28 June 2018.

Of the original five protocols only protocol A – Water biotope, selected parts of protocol A- Optional variables and protocol D – Migration barriers have been translated. The original manual also contains methods for surveying ditches, road passages and more in-depth hydromorphological details. The labelling of protocols and the numbering of all variables have been kept in order to facilitate comparisons with rivers analysed with the complete method.

2 Introduction

The river habitat survey is a method for survey describing the physical conditions within and in connection to streams. In a stream there are a lot of different structures, everything from sand dunes and block accumulations to erosion pools and pools. In common, all these structures are creating different biotopes and are vital for the streams' biological diversity. The structures have been created during many years when the water has sculpted and rearranged the landscape under its course from the spring areas to the sea.

Each stream is unique and have its own prerequisites and its own species. Despite this, there is a common pattern recurring in the streams. If you look at streams all around the world, there are many similarities between them, provided that the streams being compared have the same basic prerequisites, (slope, geology, discharge). The biotopes are not emerging randomly. If a single structure is observed, for example a pool, there is always a logical explanation as to why the water has created a pool in that place. The occurrence of these similarities, as well as the fact that there always is an explanation as to why a certain structure is in a certain location, makes it favourable to carry out inventories of streams, despite their multiple formats.

Through a systematic analysis of structures in and properties of streams it can be understood how the stream functions as a system, and in what ways humans have affected the stream. There are many methods for analysing streams, and the method described in this report is river habitat survey.

In river habitat survey, the streams are divided into different reaches. For each reach, the biotopes, the degree of impact, and the reach's properties are described in a protocol. In addition, there are several optional protocols to be used for inventory of barriers, or for in-depth inventory.

After the river habitat survey, the results can be evaluated in different ways. How different reaches affect each other can be evaluated, for example how a reach with a lot of erosion affects a reach downstream. How common different natural habitats are can also be evaluated, as well as the degree of impact and the hydromorphological status of the stream. The results may be used in many ways and be important keys to everything from intervention planning to environmental considerations.

2.1 Division system

If streams with the same prerequisites when it comes to slope, flow, and geology are compared, similar patterns and structures in the streams will emerge. This means that the streams can be divided into different groups and categories, based on different characteristics. There are many different systems with different levels of detail. One of the division methods entails that the stream is classified after its capacity to transport sediment in relation to how much available sediment there is to transport

The division after transport capacity is a division between streams in so-called "supply limited condition", (limited available sediment or sedimentary limited) and "transport limitation condition". In river habitat survey, these two conditions are treated as two separate groups, and in addition, an extra group, peat streams, has been added. This classification does not really relate to distinctively separate types of streams but should instead be regarded as a gradient ("the supply-limited to transport-limited spectrum"). At one end of the gradient (supply limited condition), there are steep streams with high transport capacity

and low sediment availability, (for example steep bedrock streams), and at the other end (transport limited condition) there are fine-grained flat streams with lower transport capacity and higher sediment availability (for example, meandering alluvial streams). Depending if a reach or a stream primarily is characterised by supply limited or transport limited conditions, in the river habitat survey method they are called SL reach/SL streams, and TL reaches/TL streams (sedimentary limited and transport limited). Streams or reaches in peat are simply called peat streams or peat reaches.

The three groups are defined as follows:

Streams in supply-limited condition (SL streams)

A stream or a reach in supply limited condition is defined as having a sediment transport, independent of the transport capacity. Thus, the sediment transport is dependent on the available sediment.

Streams in transport-limited condition (TL streams)

A stream or a reach in transport limited condition is defined as having a sediment transport in relation to the transport capacity. The sediment availability is high.

Peat streams

Peat streams are flowing over land where the local environment is waterlogged during a major part of the year. Normally, the transport of inorganic material is low.

A pronounced SL stream usually consists of fixed materials that the stream cannot move (flat rocks, boulders), the slope is steep and the access to moveable sediment is low. A TL stream consist largely of materials moved by the stream (sand, gravel, or finer materials), has a lower slope, high access to sediment, and is also considerably self-adjusting, i.e. changes its morphology after the physical prerequisites at the time. Between these types of stream there are those which are in between, for example step-pool streams with a relatively stable morphology, that may change at certain flows.

3 Method

3.1 The basics of the method

The method consists of two different parts, denominated as two different protocols. Of the protocols, the A protocol is compulsory and should always be filled out. The D protocol is filled out if there are barriers. Lists of variables for Protocol A and Protocol D can be found in Appendix 4 and 5

3.2 Equipment

Table 2-1 lists the resources needed for an ordinary river habitat survey. In addition to the resources listed in the table, a database is required for data storage.

Table 2-1. List of resources needed in river habitat survey.

GIS program with tools for height data analysis
Height data
Maps (soil type maps, historic maps, aerial photos, topography map, etc.)
Digital field protocols, and prepared GIS layers
Field computer/smartphone or similar
Folding rule (laser distance meter, if necessary)
Camera
GPS

3.3 Preparatory steps

In advance of the river habitat survey certain preparatory steps are required. Primarily it's the choice of which parts of the method to be included (the protocols, and variables) and which parts of the water system to be mapped.

When choosing which parts of the water system to be included, it is important to include the parts that are important for the hydromorphology. It can be a difficult assessment since how the system works may be unknown prior to the survey. In many cases it may be necessary to map the entire water system, including all tributaries up to the headwaters, to get a picture of how the stream works as a system and to carry out a hydromorphologic analysis. This is particularly important in streams where it can be suspected that the tributaries or the headwaters are important for the system, for example if they contribute a lot of sediment. Under other conditions, foremost in SL streams, it may be less important to work with the entire system. In the river habitat survey method there are no rules for how much of the water system to include, but to get basics fitting the purpose of the study, it is important to consider the limitations carefully.

If a lesser part of a stream is to be mapped, the lower border of the mapped area (i.e. the lower part of reach 1) should not be a TL reach or a peat reach, but instead a controlling section or an SL reach. Otherwise it may be difficult to analyse the morphology since TL reaches and peat reaches are affected by the downstream morphology.

It is possible to carry out the survey all year around, except when land is covered by snow. Often the low flow periods during autumn or spring are good. The advantage is that the stream and its structures are more visible during low flow. If the bank vegetation, leaves, and grass, isn't lush it may be easier to get an overview of the morphology, of any dredging masses and similar compared to periods with lush vegetation. The cooler temperature may be advantageous for work. Periods with high flow are inconvenient for inventory but may be difficult to avoid completely for practical reasons.

3.4 Execution

The description below is foremost for survey with Protocol A and D. Usually, the work commences with a GIS analysis and then the fieldwork is carried out. After the fieldwork, certain complementing information is filled out.

It is not compulsory to begin with the GIS analysis, it can be carried out afterwards, but it will facilitate the work if you have an image of the stream before the fieldwork begins. In certain cases, a complementing GIS analysis is needed after the fieldwork, for example if something in the field showed to be easier to assess from the GIS material.

3.4.1 Preparatory GIS analysis

Below follows a guideline for performing a preparatory GIS analysis before the fieldwork. There are different ways of performing the GIS analysis, depending on the type of stream, the available information, and the expected type of impact.

The primary purpose of the analysis is to increase the speed in the field, facilitate assessment in the field, and facilitate the division into reaches. In addition, the analysis gives information about structures that are impossible to view in the field. The analysis results may be added as notes in a GIS layer, brought into the field.

The analysis should primarily be carried out through aerial photography, height maps, soil type maps, and historic maps. During the analysis, a survey is carried out of controlling sections and hydromorphological base type, assessment of clearing, and possible changes in the erosion and sedimentation processes. Table 2-2 presents variables that may be preliminary assessed before the fieldwork. In addition to these, it is possible to get a good picture of the other variables as well. A precise description of how the analysis is carried out is a technical issue and not described here.

Examples of what is analysed is the soil types in different areas, the slope of different areas, if the stream is unnaturally straight, the occurrence of dredging masses, if the planform is affected (for example meanderings with unnatural curvature), the occurrence of cut-off meanderings, and if controlling sections are cleared out. For example, ditches in the local environment may give information if a clearing was warranted (if there are ditches in the local environment, the stream's closest controlling section downstream is usually lowered).

The analysis may commence with an overview check of aerial photography, soil type maps (preferably with terrain shadowing) and through making a longitudinal profile for the stream channel and the floodplain. Based on these, it is possible to assess the required analyses and a suitable ambition level.

After the first check it may be beneficial to analyse the height maps and soil type maps together. With the right analysis tools, this may give answers to many of the variables in Table 2-2.

The controlling sections are found in connection to this, and through analysis of the profile measuring. Afterwards or in connection to this, the historic maps should be analysed. Based on these materials, it is possible to get a good image of the stream before the assessments are carried out in the field.

The historic maps are valuable materials for showing changes over time. Information about existing and historic use of the land give clues about where it may be cleared and where it may be required to be extra vigilant in the field. For example, it may be warranted to consider agricultural areas downstream extra carefully where it has been motivated to lower controlling sections. The analysis of historic maps requires certain training and competence to use their potential fully. Many old maps are very detailed and, for example, descriptions of the historic usage of flooded areas can give good information of when/if the floodplains were active. How wet the floodplains and other flooded areas are, may also be understood, for example can the occurrence of perpetual or transitional meadows give information about the flooding frequency. An important part is to assess how well the historic maps are representing the real picture. Sometimes the course of the stream has been drawn precisely, but sometimes meanderings are just sketched in, which may depend on the purpose of the map when it was drawn. Other information to be discerned is how the planform has changed over time, the occurrence of different constructions such as ditches, mills, and sawmills. In some cases, small controlling sections may be found. During the analysis of historic maps, it is beneficial to get maps from before the middle of the 19th century since there were huge impacts on streams back then. All maps describing draining give important information about the streams.

Table 2-2. Variables, that may be assessed in part from the GIS analysis in river habitat survey according to Protocol A.

Heading	**Variable**	**Note**
A3 Hydromorphological type, planform	HyMo type	
	Original HyMo type	
	Valley confinement	
	Original confinement	
A10-Cleared/impact	Clearing	
	Culverted	
	Dam	
	Embanked	
	Dry stream	
A12-Flooding areas	Flooding frequency/ground water level	Only a preliminary assessment can be carried out. The main part will be carried out in the field.
	Physical impact on flooding area	
A15-Fluvial processes	Dominant fluvial process	Only a preliminary assessment can be carried out. Most will be carried out in the field.
A19-Controlling sections	Variables according to description under A19	Preliminary assessment and an analysis of were the controlling sections originally were situated.
A20-Knickpoint/Knickzone	Knickpoint/Knickzone	The possibility for knickpoint formation is dependent on the size of the stream.
A21-The floodplain's flooding frequency	Active floodplain	Only preliminary assessment can be carried out. Most will be carried out in the field.
	Recent terrace	

3.4.2 Field survey and supplementary work

After the map analysis it is time to go out in the field. The inventory begins at the lowest point downstream and the stream inventory is carried out upwards. During the inventory, the stream is divided into reaches and then the protocols are filled out according to the descriptions in the following chapters.

In the field, the information is filled out in a suitable digital form. Some parts of the information are inserted into a GIS layer (insertions from Protocol A and D are shown in Table 2-3).

Some adjustments may need to be done after the fieldwork, for example if there are uncertainties regarding an assessment or if an extra check against historic maps or similar is required. Performing a quality assurance is also important, through checking that all information seems reasonable and that everything is filled out, etc. Then, the inventory is finished.

Table 2-3. Variables registered in GIS after survey with Protocol A or D.

Heading	Variable	Note
A2-Local information	Reach no.	Noted as a line object and includes the reach number.
A19-Controlling sections	Unaffected controlling section with stone, boulder, or similar Beaver dam Large woody debris Other unaffected controlling section Weakly cleared controlling section Heavily cleared controlling section Culvert Road passage (not a culvert) Dam Other unnatural damming controlling section Other unnatural controlling section Controlling section with regulation possibility	Noted as a point object and includes information about the type of controlling section with the same denomination as the variables. In some cases, several types must be noted for the same location, then a point object is made for each.
A20-Knickpoint/Knickzone	Knickpoint/Knickzone	Noted as a point object.
D2-Local information	Field number	Noted as a point object and includes the barrier's field number.

3.5 Protocol A - Water biotope

Protocol A has the most important variables. In section 2.5.1 and forward, all variables are described, and how they are to be filled out. The variables are sorted under different headings (for example A1-Survey) and for clarity the variables are always marked in bold type (see below). The heading is only intended for structuring the protocol. In Appendix 1 there is a short summary of all variables, intended to be uses as a quick reference in the field or to get an overview of the method.

The protocol is divided into three parts. Part 1 must always be filled out. If the reach originally (before human impact) was in TL condition or a peat stream, either Part 2 or Part 2 and 3 are to be filled out as well. The assessment of the parts is based on the original hydromorphological type, as seen in Table 2-4.

Table 2-4. Guideline for choice of which parts of Protocol A to be filled out. The choice is made based on the original hydromorphological type.

Original HyMo type	Part of the A Protocol
A, B	Part 1
C, E, D, F	Part 1, 2 and 3
P	Part 1 and 2

3.5.1 Part 1 - Variables to be filled out for every stream

3.5.1.1 A1 SURVEY

Organisation: The organisation, department, or similar in charge of the survey. Free text, maximum 50 characters.

Inventory personnel: Name of the person/persons carrying out the survey. Free text, maximum 50 characters.

Date: The date when the reach inventory is carried out in the field, in the format "2015-01-01".

3.5.1.2 A2-LOCAL INFORMATION

Main watercourse: Note the river basin, according to national or EU standard. For water courses without their own number, the adjacent are to be noted.

Watercourse: Name and ID number for the stream, according to national or EU standard. If the name is missing in these registers, it is to be taken from a map. Otherwise a local name is to be noted.

Reach no: The streams are divided into reaches, numbered from the lowest and upwards within each stream. The reach number is noted in the protocol and in the GIS layer. The reach demarcation is to be performed in such a manner that the biotope within each reach is as homogeneous as possible.

The main criteria are that the reach demarcation is based on the flow condition, the degree of human impact, changes in the hydromorphological base type, as well as other significant changes. This entails that if a reach consists of an environment with riffles and the biotope transfers to an environment with calmer waters, a reach demarcation is to be done, (examples in Figure 2-1). In the same manner, a change in the physical impact or similar, must always entail a reach demarcation. A heavily cleared reach changing into a part where the stream is not cleared entails a demarcation. Culverts, dams, dry streams, and dammed areas are to be included in the survey and constitute separate reaches. An anabranch area is usually noted as a reach, but in some cases, for example if the character of different anabranches differs, they are to be demarcated as separate reaches. By a lake, a reach demarcation is to be done, but the lake is not to be noted as a separate reach. Table 2-5 shows a summary of the phenomenon always causing reach demarcation. In addition to the factors listed in Table 2-5, other factors may lead to reach demarcation. It can be changes regarding size, depth, bed material, water vegetation, if the changes are significant and affecting the function of the biotope. For hydromorphological types consisting of variations in flow conditions, (foremost Cx reaches), a reach demarcation is usually not done at each change of the flow conditions.

The length of the reach should not be lower than 30 m, since it would entail rather extensive survey work otherwise. In some cases, it can be warranted to demarcate shorter reaches, for example when creating detailed action plans or in shallow streams where the biotope in a short reach can bring a significant impact upstream (for example if the reach is a controlling section). There is no maximum length for the water biotope reaches, since they are naturally limited by changes in the biotope.

There are a few exceptions where the reach demarcation must be performed differently. One case is if there is a mix of different degrees of clearing, distributed over very short reaches. For example, if a reach of 1 km is almost untouched, but there are shorter, cleared reaches here and there. Then they can be consolidated into one complete reach, and the clearing degree set to the one most suitable for the whole, (see description under A10-Cleared/impact). In those cases, it is important to document this under A18-Additional information, and to ensure that the generalisation do not picture it wrongly. In some cases, it is necessary to make similar exceptions if there are a mix of hydromorphological types.

Another exception is when calm water dominates, with shorter riffle reaches here and there. Then the riffle reaches can be noted as a neck, (see A 13-Structural elements), provided that the riffle reach is shorter than 30 m. The purpose is to reduce the need for reach demarcation. If the neck is a controlling section in a shallow stream or in other ways significant for the geomorphology, a reach demarcation may be needed anyway. Sometimes it is practical to note the necks instead of making them into separate reaches, but it is important not to do it in such a way that you miss important information. Shorter inserts, (less than 30 m), with calm waters in reaches with riffles can be denoted as pools. If the calm inserts do not exceed 30 m, they are demarcated as separate reaches.

It is not wrong to make a more detailed reach demarcation than described above, but then the field work could take a long while.

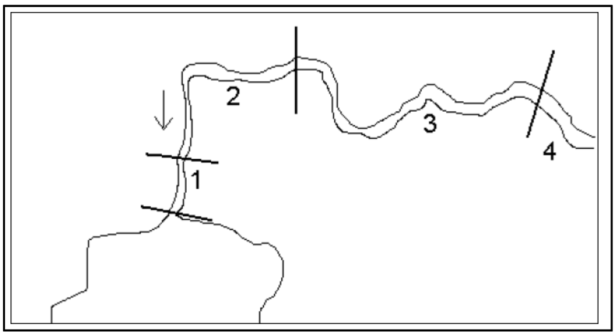

Figure 2-1. The photo shows an example of reach demarcation. The low slope part in the foreground is a reach. Where the flow conditions and the hydromorphological type changes, a new reach is created. To the right the principle for reach demarcation is shown, reach 1 is always the lowest downstream, and from there the reaches are numbered upwards.

Table 2-5. Phenomena, always leading to reach demarcation in river habitat survey, according to Protocol A.

Phenomenon, always leading to reach demarcation
Significant changes in flow conditions
Changes in degree of clearing
Significant changes in channel evolution phase
Culverted reaches
Dams
Dammed areas
Dry streams
Anabranch areas/Anastomosing
Flooding protection
Changes in flooding frequency
Migration barriers
Lakes
Other phenomenon of significance for the biotope

Coordinate system: Note which coordinate system that is used (the same as in the GIS analysis)

Starting coordinate N: Note the N coordinate for the start of the reach according to national standard

Starting coordinate E: Note the E coordinate for the start of the reach according to national standard

Ending coordinate N: Note the N coordinate for the end of the reach according to national standard

Ending coordinate E: Note the E coordinate for the end of the reach according to national standard

Discharge classification: An assessment if the discharge is high, average, or low on a yearly basis is made and noted as Low, Average, or High. The limit for classification as low or average is if the flow represents a value exactly between average low discharge or average discharge, (if the average low discharge is 0.1 m^3/s, and the average discharge is 1 m^3/s, the limit will be 0.55 m^3/s). The limit between average and high is calculated in the same manner.

The discharge classification is usually calculated after the inventory, through a national hydrological database (e.g. S-HYPE run by SMHI in Sweden).

For stream reaches in dry channels, switchbacks or similar environments the discharge class is to be assessed from the original discharge of the stream.

Divergent ambition level: If a reach inventory is performed less carefully in the field, this must be noted. State Yes or No in the protocol. This may be the case if a reach has a small deviation in occurring biotopes. The most common example is when a reach consists of a homogeneous ditch with no known controlling sections or other structures that need to be in the inventory are found within the reach. The deviation is to be commented under A18

– Additional information. The purpose of the variable is primarily to save time, but it is only to be used if it will not result in significantly lower quality of the survey.

Photo: State the number code for the photos taken, (for example 001-004). How to number the photos are optional.

3.5.1.3 A3-HYDROMORPHOLOGICAL TYPE, PLANFORM

HyMo type: State the hydromorphologic base type for the reach. If possible, state the subtype as well, if it is the same for the whole reach. In Appendix 3 there is a flowchart of the HyMo types, and Appendix 4 includes a table with the usual characteristics for each type.

It is important to make the right assessment of the base type, since they are very different. If the subtype is assessed wrongly, it is not as serious. Since it's not possible to do overly extensive studies in the field, it is best to assume that the subtype assessment will not always be perfect.

Hydromorphological type is noted as a letter combination according to Table 2-6. If the subtype isn't noted, it is replaced with the letter “x”. If the base type is Steep bedrock streams, and the subtype is Bedrock streams with a slope of more than 10%, the letter combination is Aa, (or Ax if the subtype isn't stated). If the reach is to have an amendment, it is added after the two first letters, (for example AaM or ExK). Possible amendments are shown in Table 2-7. Several amendments can be noted, but in the same sequence as in the table. M and A cannot be combined, neither can LWD and BMC. Thus, possible alternatives are M, MLWD, MBMC, A, ALWD, ABMC, LWD and BMC.

The Zz type is only intended for extremely affected reaches, not fitting for the other types, such as culverted reaches, reaches with deep ponds, and other reaches, lacking almost all stream characteristics. The Zz type is not to be used for heavily affected reach, still with some form of stream environment, such as completely straightened streams.

Table 2-6. Hydromorphological base type and subtype, to be noted in river habitat survey, according to Protocol A.

Base type	Subtype
Z Extremely affected streams	**z** Extremely affected streams
A Steep bedrock streams	**a** Steep bedrock streams with more than 10% slope **b** Steep bedrock streams with less than 10% slope
B Steep bedrock streams with stones and turbulent flow	**c** Cascade streams **s** Step-pool streams **p** Streams with flat beds **l** Streams with boulders and stones with low slope
C Streams with regularly changing flow reaches and pools	**t** Streams with transverse riffle-pool system **r** Riffle-pool streams
D Braided streams	**x** Braided streams
E Alluvial streams	**x** Alluvial streams
F Incised alluvial streams	**x** Incised alluvial streams
P Peat streams	**x** Peat streams

Table 2-7. Amendments to hydromorphologic base type and subtype as well as original type and subtype in river habitat survey according to Protocol A. If the reach consists of e.g. anabranch, the letter "K" is to be added.

Amendments	Denomination	Definition
M	Multichannel stream in boulders/cobbles	Several parallel channels (at least three). Islands between channels are stable and consist of rough materials such as stones and boulders.
A	Anastomosing	Several parallel channels (at least two). Islands between channels consist of active floodplains or peat. If the stream is incised into the sediments due to human impact, the islands may be recent terraces.
LWD	Large Woody debris	Streams where the morphology is formed by large amounts of large woody debris. At least half of the reach drop are at terraces, formed by large woody debris
BMC	Beaver meadow complex	Streams where the morphology at large is due to the occurrence of beaver dams. At least half of the fall drop on the reach is caused by beaver dams.

Original HyMo type: In addition to the present hydromorphological type, the assessed original type and, if possible, the subtype as well is to be noted. To be noted in the same manner as HyMo type. The amendments in Table 2-7 are to be noted as well. If the original type is missing, for example if the reach flows through a drained lake, Missing is to be noted.

Original type is the type before the stream was affected by human activity. Since almost all streams have some kind of impact from human activity, it may be difficult to assess the natural type under certain conditions, especially when choosing amendments.

If there are any doubts, assess the type when the stream <u>last</u> was functional as a natural stream with the typical functions for a stream with the prerequisites in question. In practice, this usually entails a period of around 500-1,000 years. Table 2-8 shows examples.

If the stream is unaffected, the assessment is simple. For heavy impact it can be difficult, and in those cases the assessment is made according to the appearance of the landscape surrounding the stream, the slope, the soil types, the bed and shore fractions, and other information showing the original type. Historic maps, soil maps, and height data may facilitate the assessment significantly.

The most difficult is to decide if LWD or BMC is to be noted. Looking far back, of course the importance of large woody debris and/or beavers have been extensive in almost all streams, except the larger ones. Though these amendments do only have to be used if the impact on the morphology through large woody debris/beavers can be seen in the field, or if there are other ways to get knowledge of a relatively recent impact from these factors. Examples of this is visible reinforcement on the bed by old, large woody debris or if it is known that the stream has been surrounded by natural forest for a very long time. Another way to see that the impact from large woody debris has been huge is to look at the shore banks where erosion has occurred. A lot of large woody debris protruding in the outer curves may entail prior large impact from large woody debris. Another way is to check if the bed substrate is reinforced with large woody debris and if its stability is dependent on this. The assessment is difficult and during analyses of the results from the river habitat survey, the assessment is not to be seen as an exact description of the history.

In many cases the original HyMo-type describes what may be called the reference condition during status assessment and an image of the objective for restoration, but that is not always the case. If a stream has been situated in an open landscape for hundreds of years and its morphology is completely adapted to this, knowing the original HyMo-type is very important to understand how the stream works, but it does not mean that the original type should be the objective for the future.

Table 2-8. Example of how Original HyMo type and HyMo type can be noted during river habitat survey according to Protocol A.

Scenario	HyMo type	Original HyMo type
Bx stream cleared 800 years ago where multichannel streams have been cut off.	Bx	BxM
Bx stream where gravel and sand gathered by very old large woody debris. It is known that the forest continuity has lasted for a long time, but recently the alluvial forest has been felled and a large part of the large woody debris there has been cleared. It is assessed that the finer substrate there is a rest of the more frequent large woody debris from older times.	Bx	BxLWD
Bx streams in ice age river material, dug up to a ditch 200 years ago and assessed as a previous Bp stream. Before the digging the forest, continuity lasted for several hundred years and the forest was probably a riparian forest.	Bx	BpLWD
Cr stream in an open landscape. The shores show remains of very old large woody debris and large parts of the bed is reinforced with more or less decomposed logs.	Cr	CrLWD
Ex stream in an open landscape. No traces of large woody debris in shore banks or bed substrate. The stream has probably been open for more than 500 years.	Ex	Ex
Ex stream becoming incised. The stream is assessed to have been situated in an open landscape for a long time	Fx	Ex
Anastomosing Ex stream in the 19th century, at present reformed to a deep ditch.	Fx	ExA
Peat stream, but due to physical impact the sedimentary transport is high, and the stream works more like an Ex stream with, e.g. evolution of secondary floodplains.	Ex	Px
Ex stream that was situated in a forest landscape 800 years ago. The landscape was then opened up. The morphology mainly reflects the open landscape.	Ex	Ex
Ex stream in a forest landscape 800 years ago, that was open until around 1900 when new forest started to grow. The morphology primarily reflects conditions created by the alluvial forest where most of the energy loss is due to thresholds caused by log jams.	ExLWD	Ex
Ex stream having had forest continuity except during a 200-year period when the landscape was open. New forest has been established in the last 100 years. There are traces left of the former forest landscape, among other things bifurcations caused by log jams and the channels are partly anastomosing. The morphology reflects the open as well as the enclosed landscape. Most of the energy loss is at thresholds in connection to log jams.	ExLWD	ExLWD
Bp stream, dammed by remains from a small mill pond. Dammed since the 13th century. The shores and the original flooding areas are wet and peat forming but standing just slightly under the surface of the water.	Px	Bp

Valley confinement: The valley confinement is noted as a letter combination (Vh, Vm, or Vl, Table 2-9). The assessment concerns active flooding areas (floodplain, mire, marsh, and other areas around the stream which are flooded at least every ten years). The assessment concerns the current situations, which entails that incised streams and other watercourses becoming more lowered and enclosed than before may have a higher confinement than before the impact. The fact that the assessment is made of the present appearance is important when compared to other methods, since there are methods where the calculations includes terraces that are not flooded. Since the original confinement is assessed (see below), the inventory results may be compared to other methods.

The assessment is based on Confinement degree and Confinement index (see, for example, Rinaldi et al, 2012). These are estimated in the field and then the confinement, corresponding to the values in Table 2-10 is noted. Confinement Degree describes the amount of the stream banks that are not in contact with the active flooding area, but instead is in direct contact with the valley slopes or older terraces. The total length of the stream's both sides is calculated. Confinement Index is the quotient between the active flooding area and the channel width. The active flooding area's width is the total flooding area (including the width of the channel). If the width of the flooding area varies, an average is used in the calculation.

Table 2-9. Alternatives for the variable Valley confinement and Original confinement at river habitat survey according to Protocol A. The assessment is based on Confinement Degree (CD), and Confinement Index (CI). To correspond to each confinement the conditions for CD as well as CI must be fulfilled. For streams with several parallel channels, the values inside the parentheses are to be used, (5 replaced by 2).

Confinement	CD	CI
Vh High confinement	>90%	
Vh High confinement	10-90%	≤ 1.5
Vm Moderate confinement	10-90%	>1.5
Vm Moderate confinement	<10%	≤ 5 (2)
Vl Low confinement	<10%	> 5 (2)

Original confinement: Noted in the same manner as Valley confinement but concerns the original confinement. Original means before the stream was affected by human activity. The assessment is usually performed at the same time as the assessment of the original hydromorphological type, since the original type is connected to a certain confinement. To be noted as Missing if the original condition is unknown, for example if the reach flows through a drained lake.

Planform: The appearance of the stream's course/planform is noted, according to Table 2-10. The assessment concerns the current appearance. It is not necessary to measure the sinuosity, it is sufficient to make a visual assessment in the field, or from a map. If the reach is short, the assessment is to be made for a longer reach, (the assessed reach must be at least 20 times the channel width).

Branched channel is similar to multichannel streams and anastomosing and can be noted under hydromorphological type but is to be seen as a less strict definition. A branched channel may, for example, emerge in environments where bifurcations are easily created, such as environments with unusually large boulders or with ample amounts of large woody debris.

Table 2-10. Alternatives to choose for the Planform variable in river habitat survey with Protocol A.

Planform	Description
A Straight to weakly curving channel	The channel is very straight or weakly sinus shaped. Sinuosity: 1-1.05.
B Winding or weakly meandering channel	The stream is winding irregularly or meandering regularly. Sinuosity: 1.05-1.3.
C Meandering channel	The channel is meandering. Sinuosity: >1.3.
D Branched channel	There are at least two channels along the major part of the reach.
E Braided river	There are several channels, separated by moving middle banks.

3.5.1.4 A4-LENGHT, WIDTH, DEPTH

Length: The length of the reach is stated in metres. Usually this is calculated via GIS, but sometimes it is necessary to pace out or measure shorter reaches in the field.

Width average: The average width of the reach in normal low discharge is stated in metres (one decimal). If the low discharge isn't normal, an assessment of the level is made.

The width is measured or estimated in the field. It is recommended that the width is measured in at least five (preferably ten) representative sections within the reach, since the deviations usually are large in estimates.

Width minimum: The smallest width of the reach during normal low discharge is noted in metres (one decimal) in the same way as the average width.

Width maximum: The largest width of the reach during normal low discharge is noted in metres (one decimal) in the same way as the average width.

Water depth, average: The average depth of the reach during the visit is noted in metres (two decimals). The depth is measured or estimated in the field. It is recommended to measure the depth at several points since large deviations often occur in estimations.

Water depth, maximum: The largest depth of the reach during the visit is noted in metres (two decimals). The depth is measured or estimated in the field.

Area: The reach area is calculated as the average width, times the length, and noted in square metres.

3.5.1.5 A5-BED SUBSTRATE

The coverage ratio of different bed substrate is noted as classes, according to Table 2-11. The classes are the same as flow condition, water vegetation, and shadowing.

The assessment is to be made for the substrate types in Table 2-12. Each substrate type is a variable. The dominating substrate is noted as class 3. This is valid even if the dominant type does not cover more than 50%.

Table 2-11. Classification in assessment of the coverage of different types of bed substrate, flow condition, vegetation, and shadowing in river habitat survey according to Protocol A.

Class	Coverage
0	Missing or insignificant presence
1	<5% coverage
2	5-50% coverage
3	>50% coverage

Table 2-12. Description of bed substrate variables assessed in river habitat survey, according to Protocol A.

Variable	Size range/description	Denomination
4,000	4,000 mm	Flat rock
200	200-4,000 mm	Boulder
63	63-200 mm	Stones/cobble
2	2-63 mm	Gravel
0.063	0.063-2 mm	Sand
0.002	0.002-0.063 mm (2-6,3 µm)	Silt
<0.002	<0.002 mm (<2 µm)	Clay
Fine detritus	More or less decomposed organic material	
Coarse detritus	Leaves, branches, logs, or similar wood not decomposed	
Artificial materials	Artificial materials are for example crushed stone, concrete, bricks	

The assessment of the coverage ratio can be performed visually, but it is recommended for some form of measurement to be done as well, especially if the hydromorphological base type is uncertain. For dammed areas, deep reaches or if the water is turbid the assessment may be difficult. Since the assessment can be made visually, it is important to consider that there is a significant error margin when evaluating the results.

3.5.1.6 A6-WATER VEGETATION

The total coverage ratio of the water vegetation in the reach and the coverage ratio for different types of plants are noted in a four-degree scale according to Table 2-11. The coverage of the different types is to reflect the overall coverage in the reach, not the coverage within the area covered by vegetation.

All occurring types of vegetation are to be noted, even if they only occur in a limited part of the reach. The possibility to assess the variables depend on the season. Freshwater sponges are also to be included in the assessment, although they are not plants. In addition to the coverage ratio, examples of species are to be noted.

The following variables are assessed:

Coverage in total: The water vegetation's total coverage ratio in the reach.

Rooted or amphibious emerging plants: Examples of species: common reed, rush.

Floating plants: Examples of species: yellow water-lily, floating pondweed.

Free-floating plants: Examples of species: duck weed, frogbit, common bladderwort.

Submerged broad-leaved plants: Examples of species: perfoliate pondweed, shining pondweed.

Submerged myriophyllum plants: Examples of species: water-milfoil.

Rosette plants: Examples of species: water lobelia.

Fontinalis or similar species: The assessment concerns water moss, (the *Fontinalis* species), or other moss species with similar living conditions.

Other moss species: The assessment concerns moss species, (not the *Fontinalis* species), living in the stream channel.

Philamentous algae (e.g. *Cladophora*): Philamentous algae is to be noted if there are a significant number, usually indicating some kind of impact. Otherwise, these algae do not need to be noted.

Other periphyton algae: Some form of growth is always present and other Periphyton algae is only to be noted if there are something above the usual, such as species in the *Nostoc* family or there are substantial amounts of any species. Extra interesting findings, such as *Nostoc* is to be commented. The growth is to be substantial and noted visually, not just felt with the fingers.

Fresh-water sponges: Occurrence of fresh-water sponges (*Spongilla*/*Euphyditia*) are noted according to the same classification as the vegetation, (although it's not a plant).

Example of species: Examples of species or families are noted as free text (maximum 255 characters), if the person performing the survey assess that they can make a relevant determination of species. In other cases, the field may be empty. To note the species followed by a question mark is also possible, (e.g. Bladderwort?).

3.5.1.7 A7-DISCHARGE CONDITIONS

The coverage ratio for different discharge conditions are to be noted according to the scale in Table 2-11. The assessment is performed for the four variables below and concerns the conditions during the field inventory. The assessment is made from the appearance and turbulence of the water. The dominating flow type is noted as Class 3. This is valid even if the dominant type does not cover more than 50%. Examples are shown in Figure 2-2.

Calm water: The flow condition is characterised by water with minor turbulence. The gradient is low and usually the depth is larger in reaches dominated by calm water. In some places there may be eddies, but not to such extent as in weakly flowing water.

Glide: Weakly flowing water moves slowly and have some turbulence in the form of eddies. No waves on the surface, riffles if the stream is shallow. The bed is usually relatively smooth but can consists of coarse material if the gradient is low.

Run/Riffle: The water is significantly more turbulent than weakly flowing water. The flow speed is relatively high, but standing waves, breaking the surface are not present. The gradient is usually higher than for weakly flowing water. The Froude number is lower than 1 (=subcritical). The sound level is relatively low, with gurgling or clucking sounds.

Rapid: The water flows relatively fast downstream and extensive turbulence occurs with breaking waves forming white-water. The sound level is relatively high. The Froude number is more than 1 (=supercritical).

Calm water	3
Glide	0
Riffle	0
Rapid	0

Calm water	2
Glide	3
Riffle	0
Rapid	0

Calm water	0
Glide	3
Riffle	2
Rapid	0

Calm water	0
Glide	2
Riffle	3
Rapid	0

Calm water	0
Glide	2
Riffle	3
Rapid	0

Calm water	0
Glide	1
Riffle	2
Rapid	3

Figure 2-2. Photos, functioning as guidance in assessment of discharge conditions during river habitat survey according to Protocol A. Note that the discharge condition is to be assessed for the conditions during the visit. The dominating flow condition for the reach in the second photo would probably be assessed as calm water if the inventory was performed during low discharge.

3.5.1.8 A8-SHADOWING

Shadowing: How large amount of the stream surface is shadowed is assessed according to the scale in Table 2-11. The shadowing varies during the day and year; thus, the assessment is to be made from the estimated shadowing at 13.00 at summer solstice, in full sunlight. The shadowing does not have to come from trees, it can be from grass, slopes (small creeks), or other structures.

3.5.1.9 A9-LARGE WOODY DEBRIS

Large woody debris (number): The occurrence of large woody debris in the reach is noted as a number. Large woody debris are pieces of wood in the form of trunk wood or branches with a diameter of more than 0.1 metres and a length of more than 1 metre.

To be included, the wood must be located along the stream 's edges, in the water or across the water. The wood may occur above the surface, if it is within the edges of the stream, (it may not be to the right or left of the stream's edges).

All dead trees and tree residue is to be counted, independent of decomposition phase. Buildings and material, (for example planks and piers) are not to be noted, but free logs are, (for example logging timber). Dead trees on root, hanging over the stream are to be counted.

Assessment if the wood is large enough can be made visually, but it is recommended to measure the length and diameter from time to time to check that the assessment is correct.

Large woody debris (number/100 m): Calculated by dividing the value of "Large woody debris (number)" with the length of the reach, multiplied with 100 (calculated after the field work). To be noted with one decimal.

3.5.1.10 A10-CLEARED/IMPACT

The variables below are to be assessed for each reach. Several types of impact can be combined, for example culverting and the clearing class 3, which is a usual combination since a stream often is straightened for culverting. Dam and dammed are also counted together as a rule, for the area closest to the damming. Though it is important not to calculate impact on the reach twice when evaluating, which is a common mistake with large amounts of data.

Culverted stream reaches, dams, dammed areas, and clearing class 3 can usually be detected on a map in advance, before the field work.

Clearing: The clearing ratio of the stream is to be noted as one of the alternatives in Table 2-13. In river habitat survey, clearing entails that substrate has been removed from the stream, manually or by machine, that the bed structure is homogenised, or that the stream has been restructured in another manner. Clearing of large woody debris is not included in the river habitat survey method, but naturally this is a type of impact as well. A guideline for assessment of clearing is shown in Figure 2-3 – Figure 2-6.

It can be difficult to assess the amount of clearing for a stream. It may be difficult to find completely uncleared reaches, and before the survey begins it is good to try to learn the important characteristics to look for. Things to look for are how the transition between shore and stream appears, if there are loose stones or boulders on the shore, if the hydromorphological units of the hydromorphological type are there or missing, or if the curve length of meanderings are larger than expected.

Table 2-13. Classification for assessment of the clearing ratio in river habitat survey according to Protocol A.

Class	Description
0	The reach is not cleared
1	The reach is carefully cleared. The changes in the reach are so small that the ecological function is maintained.
2	The reach is heavily cleared. The reach is clearly changed, and the original ecological function is/may be expected to be severely disturbed.
3	The reach is redug and/or straightened. The water course is changed and the ecological function in the reach is/may be expected to be severely disturbed or completely eradicated. In many cases the clearing can be seen in an aerial photo.

Culverted: Marked as Yes in the protocol if the stream runs through a culvert. Otherwise noted as No. This do not concern short reaches, such as culverts, but when motivated it is possible to make a culvert a separate reach.

Filling: Marked as Yes in the protocol if the shore and/or the stream is filled out with infill or similar, otherwise noted as No. May also be noted for heavily cleared streams if the cleared masses are on the shore, functioning as infill.

Flooding protection: Flooding protection is noted if the shores in full or partially consist of embankments or similar to stop flooding during high water. Can be noted as Yes or No.

Dam: Marked as Yes in the Protocol if the reach consists of an artificial dam, otherwise noted as No. Artificial dams are dammed areas where the water surface is considerably larger (if the water surface has not increased significantly by the damming, Yes is only noted for the Dammed variable). Dug dams are counted, no matter whether the surface is dammed or not.

Dammed: Marked as Yes for reaches upstream from a dam (a dammed area), where the gradient of the reach is changed to a flatter gradient. Otherwise noted as No. Does not concern reaches, dammed by beavers.

Tributary cut-off: Occurrence of a tributary cut-off: is marked as Yes or No. It may, for example be cut-off tributaries, due to log driving. It the stream originally lacked tributaries, No is marked.

Dry stream: If the reach consists of a dry stream, Yes is noted in the protocol. A dry stream is a reach, drained all year or parts of the year due to the water being led away by human activity. The channelling of the water may be for hydroelectric power stations or similar. At hydroelectric power stations the dry stream is usually the channel in parallel with the power station. A dry stream is to be noted, even if there is minimal tapping into the channel.

A dry stream is not to be noted for reaches situated downstream constructions, such as stream reaches downstream from hydroelectric power stations with zero tapping.

Regulated discharge: Marked as Yes if the discharge is regulated somewhere upstream. To be counted as regulated, at least 15% of the discharge must have a significant regulation. For example, if only the water from a small tributary is regulated and the branch consists of less than 15% of the discharge, it is not to be counted. No is also noted if you are sure that it is isn't regulated. May also be noted as Do not know, or Not assessed.

Figure 2-3. Photos, functioning as guidelines in assessment of the clearing ratio during river habitat survey, according to Protocol A. The photos show examples of uncleared reaches.

Figure 2-4. Photos, functioning as guidance in assessment of clearing ratio during river habitat survey, according to Protocol A. The photos show examples of clearing class 1. In the photo to the left, a few boulders have been cleared from the channel. In the photo to the right, some solitary boulders are removed from a riffle reach.

Figure 2-5. Photos, functioning as guidance in assessment of the clearing ratio during river habitat survey, according to Protocol A. The photos show examples of clearing class 2. In all except the last photo, boulders have been cleared from the stream and placed beside it. The last photo depicts a special case. There, the stream has been restructured to a ditch, but the ditch is not completely straight, and the floodplain remains, quite intact. The stream is redug, so it could be classified as clearing class 3, but since certain characteristics remain, Class 2 may be noted for this environment.

Figure 2-6. Photos, functioning as guidance in assessment of the clearing ratio during river habitat survey, according to Protocol A. The photos show examples of clearing class 3. In the last photo, the stream was redug a very long time ago, but it still was assessed as justified to set it as Class 3.

3.5.1.11 A11-UPSTREAM IMPACT

Upstream impact: If any impact (e.g. clearing or a dam) is noted under A10-Cleared/impact, and it is of importance for the morphology in one or more reaches situated upstream, it must be noted as Yes, otherwise No. The purpose of the variable is to facilitate finding casual links in evaluation of the river habitat survey. The variable is primarily of importance where flat reaches occur. A typical example is if a reach is cleared in such a manner that the bed is lowered. If the reach upstream is affected by the lowering, it must be noted.

The note is made for the reach where the intervention is, for example is there is a damming, Yes is noted for Impact upstream, but only for the reach where the intervention is. In many cases it is important to note Yes for several reaches after each other, for example if several reaches are lowered without a controlling section between them, since there are interventions on each of these reaches. If the reach in question ends at a lake outlet and any intervention will impact the lake levels, Yes is to be noted as well.

Figure 2-7 shows an example of using the variable. In the example the variable is shown in common with the Knickpoint/Knickzone variable and the variable Heavily cleared controlling section.

Figure 2-7. Example showing how the variables Upstream impact, Heavily cleared controlling section, and Knickpoint can be used. The water flows to the right in the picture, and the reach demarcation is shown as a red line. In reach 1 there is a heavily cleared controlling section, which entails that an erosion process has begun in reach 2, (head cut erosion). The controlling section is marked as a point object and noted in the protocol. Since impact within reach 1 is of importance for the morphology in reach 2, Upstream impact is to be noted as well. In reach 2 there is a knickpoint showing how far the erosion impact has reached. The knickpoint is also noted as a point object, as well as in the protocol. The variables intend to facilitate the evaluation of the river habitat survey, and in this example the possibility is shown that the clearing of the controlling section caused erosion in reach 2, but also that the erosion has not affected the complete distance since the knickpoint still is close to the controlling section.

3.5.1.12 A12-FLOODING AREAS

Flooding frequency/ground water level: The variable is assessed for all reaches were moderate or low confinement have been noted for the variable Original confinement. The variable describes if there is human influence leading to reduced flooding frequency and reduced ground water level at flooding areas on the sides. The purpose of the variable is to complement the basics for the reaches where Part 2 and Part 3 are not filled out, (for example B reaches without flooding areas). Note that even if it a reduced level isn't noted, it does not entail that the water level is unchanged, it can still be raised due to damming.

Since the assessment is made for many different hydromorphological types, precise class boundaries cannot be defined. Instead, a guideline description of three type cases has been made, (Table 2-14). These type cases are based on the assumption that there is a floodplain, a flooding area of peat or another type of flooding area. In assessments, the most suitable type case is to be chosen for the reach. The choice of type case is foremost based on the original type of flooding area, not just on the hydromorphological type. For example, there may be a floodplain, peat areas, or other areas along B reaches.

For streams with floodplains, the assessment is based on the incision ratio, and the method is described in more detail under the variable Incision ratio (section 2.5.3.1).

For peat streams an assessment is made of how much the water level is lowered compared to the original condition. The assessment is to be made for a conceived average discharge. The method for the variable Changed base level in total (section 2.5.2.1) may be used as a part of the assessment, but it is also necessary to weigh in other influences leading to a lowered level, such as clearings and canals.

For streams where the flooding area is not a floodplain or peat, the assessment is based on the clearing of the stream. The basis is that the more cleared a stream is, the lower the water level is. In practice a stream may very well be cleared without a lowering of the level, and the values in the table are not to be interpreted rigidly.

The assessment is to be based on physical impact, noted in the field, but also any changes in shore vegetation, (for example a change from a sedge meadow to a dominance of mead worth can be used to support the assessment). Water regulation is not to be included if the reach is situated in a dry stream. Examples are shown in Figure 2-8.

Table 2-14. Classification in assessment of impact leading to a reduced flooding frequency or a reduced ground water level in river habitat survey, according to Protocol A.

Class	Description	Typical incision ratio for reaches with floodplain	Typical water level reduction for peat reaches	Typical clearing class for reaches with other flooding areas
0	No reduction	1	0	0
1	Moderately reduced flooding frequency/Moderately reduced ground water level	1-1-1.2	0-0.2 m	1
2	Severely reduced flooding frequency/Severely reduced ground water level	1.3-1.7	0.2-0.7 m	2
3	Severely reduced flooding frequency/Severely reduced ground water level	>1.7	>0.7 m	3

Figure 2-8. Example of how the variable Flooding frequency/ground water level should be assessed. At the top, to the left: flat stream bed (Bp) surrounded by a flooding area of organic material above ice-age river material. The stream is not cleared, and the flooding frequency is normal, (Class 0). At the top, to the right: Example of a Bx reach, heavily cleared and surrounded by a flooding area. The flooding frequency and the ground water level are reduced due to the clearing, and the assessment is Class 2. At the bottom: Peat reach where the Flooding frequency/ground water level should be assessed as Class 2. In this case, the assessment is based on a controlling section downstream from the wetland being lowered around 50 cm, and the previous environment where sedge dominated, has been replaces by grass, alder, and birch, and other species, less adapted to flooding.

Physical impact on flooding area: The variable is assessed for all reaches were moderate or low confinement have been noted for the variable Original confinement. The assessment is made for the original flooding area, (peat land, floodplain, and other flooding areas). The physical impact is assessed on a four-degree scale, (Table 2-15), according to the same principle as the assessment under A10-Cleared/impact. Impact can consist of filling of oxbow lakes, draining, and similar. Physical impact on flooding area is difficult to assess, especially if it concerns large floodplain areas, since they may have been affected for hundreds of years, and successively. If no visible impact is noted in the field, and if no obvious impact is visible in the preparatory GIS analysis, Class 0 is noted.

Table 2-15. Classification for assessment of physical impact on flooding areas during river habitat survey, according to Protocol A.

Class	Description
0	Natural, unaffected conditions, or no obvious impact.
1	Moderate impact. Impact may consist of small ditches, e.g.
2	Severe impact. The floodplain is visibly changed, and the original ecological or hydromorphological function is/may be expected to be severely disturbed. Impact may consist of severe drainage, filling of hollows, and similar.
3	Very severe impact. The original ecological or hydromorphological function is/may be expected to be severely disturbed. Impact may consist of filling, presence of buildings, and similar.

3.5.1.13 A13-STRUCTURAL ELEMENTS

The structural elements are various elements occurring along the streams and is to be seen as a complement to the other variables. If any/some of the structural elements below are found in the reach they are to be noted. Reaches with many boulders, meandering stream reaches in the agricultural landscape, tributary, lake reaches, and subterranean reaches, are noted as either Yes or No. The Other variable is noted as free text (maximum 255 characters). Other is noted as a number.

Inflowing streams: Note the number of inflowing streams to the reach. To be counted they must have water flowing for a major part of the year.

Neck: If the water is dominated by calm water, shorter reaches with streaming water may be noted as necks, if the stream reach is shorter than 30 m. The purpose is to reduce the need for reach demarcation. If the neck is a controlling section in a shallow stream or in other ways significant for the geomorphology, reach demarcation may be needed anyway.

Sometimes it is practical to note the necks instead of making them into separate reaches, but it is important not to do it in such a way that you miss important information.

Pool: Shorter inserts, (less than 30 m), with calm waters in reaches with riffle can be denoted as pools. The purpose is to reduce the need for reach demarcation. If the calm inserts exceed 30 m, they are demarcated as separate reaches.

Lake outlet: Defined as the location of the lake's outlet.

Lake inlet: Defined as the area where a stream discharges into a lake.

Confluence: Defined as the area where two streams flow together. This do not concern smaller confluences. The river basins in both streams are each to be larger than 20 km^2 to be counted as a confluence.

Oxbow lake: Oxbow lakes are old bends in a meandering stream, cut off when the stream changed to a completely new course. They may have hydrological contact with the stream, but sometimes are completely isolated. In some cases, most visible in the field, but in some fields, they will show up better in GIS analysis.

Delta: A low, flat area of land, formed at the stream outlet into the lake. Built up by the sediments, transported by the stream to the lake. Usually formed where a large stream flows into a lake. The stream is often branched or meandering through the delta landscape. The area between the stream channels consist of very shallow depressions with wetland areas. Usually the delta sedimentation consists of a mixture of sand, gravel, and fine inorganic materials, alternating with organic material. To be noted, the area must exceed one hectare.

Brink/steep sandy bank/slide scars: Steep shore section where fine-grained material is bared after a slide. Shore brinks usually occur in the parts of the water systems with weak riffle and calm flow, and where the shores and the local environment is dominated by finer materials. Only brinks with an area over ten square metres are to be noted. The element is not to be mistaken for other forms of erosion.

Seepage area/spring: Marshy parts along the streams where water seeps up from the ground, or similar environments. In connection to seepage areas sometimes deposits of, for example, Limonite are formed (rust-red precipitate). To be noted, the area must be thoroughly wet, even during dry periods. Heavy impact from springs should be commented under A18-Additional information since this often constitute special biotopes.

Reaches with many boulders: Continuous stream reach, at least 50 m long, where boulders are the dominating bed substrate. During low water the stream runs mainly under and between the boulders. Even if boulders are not dominant in the reach as a whole, this may be noted.

Rapids/falls: Natural rapids with heavy turbulence down to the bed, and waterfalls. To be noted, they must be unaffected by clearing, canals, and water regulation.

Ravine: Stream in a more or less deeply incised valley. Both shores are very steep, the difference in height between the stream and a point 25 metres from the stream (on each side) exceeds 5 metres.

Steep slope: Either shore is very steep. The difference in height between the stream and a point 25 metres from the stream exceeds 5 metres.

Overflowed cliffs: Cliffs from neutral to mafic rock (for example slate, greenstone), overflowed by ground water or kept moist in the littoral zone by streams.

Open beaches: Open beaches, caused by glacial erosion, water level fluctuations, or grazing.

Sand beaches: Open, vegetation-free, minerogenic sand beaches within the area, affected by water level fluctuations. The assessment also concerns the stream outlet in a lake.

Mowed or grazed shore meadows: Mowed or grazed shore meadows constituting of open, flat areas, that can be flooded. The assessment also concerns the stream outlet in a lake.

Flooded forests: Flooded forests within the area which is regularly flooded.

Meandering stream reaches in the agricultural landscape: Concerns meandering reaches on arable land where the sinuosity is at least 1.5.

Beaver dam: Beaver dams with a damming effect. Dams without damming effect, (e.g. demolished dams), may be noted under the Other variable instead. If there are many beaver dams in the reach, it is sufficient to estimate the number.

Tributary: Note if the reach is a tributary in parallel with a main branch, (if the main branch is mapped as another reach). Do not use for multibranched channels and anastomosing without special reasons.

Lake reach: Reach through a lake. If a reach runs through a lake, it is not included in the river habitat survey, but it can be included in the GIS layer and made into a separate reach. In that case, it is to be marked here.

Subterranean stream reaches: The reach flows underground. Do not apply to culverted reaches.

Stone foundations: Concerns old mills, stone circles, bridges, dams, etc. that are more or less in ruins. Stone foundations shows interesting cultural environments but may also give hints on historical impact.

Other dam residue: Non-barrier residue from old dams. Noted for any cultural values and to facilitate an assessment of previous impact on the stream.

Stone bridge/remains of: Stone bridge or remains of a stone bridge.

Dam building of stone: Dam building of stone.

Cultural heritage: Potential cultural heritage values on or in connection to the reach.

Ditch: Note the number of ditches discharging into the reach. In many cases it may be easier to make the assessment afterwards, with GIS (height data).

Drainage: Note the number of drainages flowing into the reach. Includes all covered ditches, piped drainage, run-off pipes, and ordinary drainage on arable land. Ordinary drainage on arable land can be difficult to see, but it is sufficient to note the ones seen.

Sewage pipes: Note the number of sewage pipes discharging into the reach. Not to be mistaken for drainage or other pipes.

Water abstraction: Note the occurrence of water abstraction in the reach. Large water abstraction, for example for field irrigation, is to be noted under A18-Additional information as well.

Crossing road: The number of roads, passable by car, is to be noted.

Other: Here other structural elements are to be noted, assessed to be of importance for the stream.

3.5.1.14 A14-NON-NATIVE SPECIES AND COMMON REED

Non-native plant species (biotope): Findings of non-native plant species, that have a significant negative impact on the ecology, must be noted. Importance for the biotope means that it affects the hydraulics, grows over and changes structures, or similar impact. Noted as Yes or No. For example, *Glyceria maxima* is to be noted, since it often has a significant impact on the stream characteristics. The assessment concerns the channel as well as the local environment.

Non-native animal species (biotope): If non-native animal species, that have a significant negative impact on the ecology, it must be noted. State Yes or No. The assessment concerns the stream as well as the local environment.

Common reed: If common reed is present, it must be noted if it is assessed to be of importance to the biotope characteristics, and if it is assessed to occur in a higher amount than naturally. Of importance for the biotope means that it affects the hydraulic, grows over and changes structures, or has a similar impact. State Yes or No. If the common reed, for example, grows over a previous sedge meadow, or if it grows in the stream and has changed the stream's characteristics, it is to be noted. The assessment concerns the stream as well as the local environment. Figure 2-9 shows an example of using the variable.

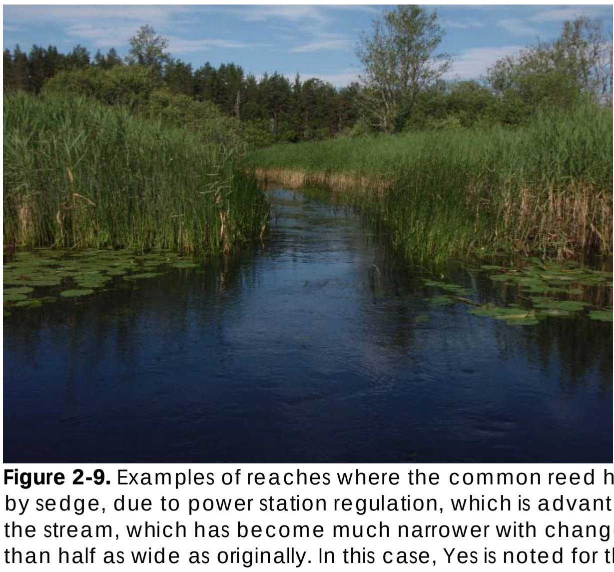

Figure 2-9. Examples of reaches where the common reed has grown over a meadow, previously dominated by sedge, due to power station regulation, which is advantageous for the reeds. The reeds have grown into the stream, which has become much narrower with changed hydraulic characteristics. The channel is less than half as wide as originally. In this case, Yes is noted for the Common reed variable.

3.5.1.15 A15-FLUVIAL PROCESSES

Dominant fluvial process: The variable is primarily intended to give a picture of the changing processes within the most dynamic stream types but is assessed for all stream types.

The variable describes the fluvial processes affecting the reach, since it is assessed for all sub-reaches it can be used to show how the stream works as a system. If one reach is affected by, e.g. aggradation and another reach upstream by erosion they are probably affected by each other. By weight of evidence, the fluvial processes and other variables creates a picture of how the processes in different reaches are connected and how different reaches affect each other.

In the assessment it is to be noted if the stream is stable or primarily affected by erosion, sedimentation or a combination of erosion and sedimentation. Stable does not entail that the stream is completely fixated. Natural meandering streams are included, where the change is slow, and the constant erosion is compensated through a similar sedimentation process (the stream is in balance).

When unnatural erosion or sedimentation occurs in a reach, several typical characteristics emerges. In addition, there are several characteristics showing that the stream is stable. These characteristics functions as indicators of the processes occurring. By studying the indicators and assessing them in common with other information about the reach, an assessment of the dominant processes may be performed. The indicators to use are shown in Appendix 6, but indicators from other, similar system can be used.

It is important to try to get a total picture of the indicators and try to find different types of indicators to make the right assessment. Indicators, pointing at erosion often occur in common with sedimentation indicators, which can be due to different impact on different parts of the reach. In addition, it may be due to the reach going through different phases and some indicators change slowly, (for example indicators based on vegetation). It is not enough to look at the indicators alone, it is important to weigh in other parts of the information collected in the river habitat survey, as well as other significant information, if applicable, for example if it is known that the flows have increased due to an increased amount of run-off.

The assessment is noted as the most fitting condition for the reach from Table 2-16. The division between shore erosion on one side and shore erosion on both sides concerns the whole section, not if it is on the right or left side, (if it is erosion on the left side of the reach, that later changes to erosion on the right side, it is counted as shore erosion on one side). Figure 2-10 and Appendix 7 shows examples. For TL reaches the assessment is to be noted under A18-Additional notes.

When peat streams are assessed, the natural sedimentation from organic material is not to be noted as sedimentation, only if there is a significant raising of the bed or similar, following an unnaturally higher sedimentation ratio. Finer substrates, transported through the system, that temporary sits on the bed, should not be assessed as sedimentation. That only concerns sedimentation which is important for the stream morphology from a long-time perspective.

The variable may be difficult to assess for TL stream, but an in-depth study of the importance of each indicator and how it emerges makes it easier to make a logical assessment. One of the difficulties is that the processes change over time and that there may be many different types of impact giving different symptoms within the same reach. For SL streams and peat streams, the assessment is fairly easy.

Even if the variable is intended for the most dynamic types of streams, it is useful for all streams. In SL streams the variable is mainly useful for assessing impact on shorter reaches with gravel bed or for assessment of increase in width or similar, (for example width increase during increased flow due to run-off).

Table 2-16. Classification for assessment of physical impact on flooding areas during river habitat survey, according to Protocol A.

Class	Description
0	Stable conditions
1a	Shore erosion on one side
1b	Shore erosion on both sides
2	Bed erosion
3a	Bed erosion in common with shore erosion on one side
3b	Bed erosion in common with shore erosion on both sides
4	Sedimentation/aggradation (concerns raising of the bed, not thin layers of sediment)
5	Sedimentation/aggradation in common with avulsion
6a	Sedimentation/aggradation in common with shore erosion on one side
6b	Sedimentation/aggradation in common with shore erosion on both sides

Stability: The variable is a complement to the Dominant fluvial process variable since it shows the severity of any instability. If Stable conditions is noted for Dominant fluvial process it is to be noted here as well. In other cases, the severity is noted as Class 1-3.

Instability does not concern a natural shift of the channel, where the occurring erosion is compensated through a similar sedimentation process, (the stream is balanced). Class 1-3 is only noted for instabilities, caused by human activity. The indicators in Appendix 6 and other variables describing the entirety, (e.g. changes in controlling sections, channel evolution phase) are used for the assessment.

The assessment is noted as the most fitting condition for the reach from Table 2-18. Figure 2-10 shows examples. For TL reaches and reaches with instability, the assessment should be commented under A18-Additional notes.

Table 2-17. Classification for assessment of the stability during river habitat survey, according to Protocol A.

Class	Description	Typical characteristics
0	Stable conditions	Stable conditions.
1	Weak instability	There are signs indicating that the morphology will be improved significantly within the next 50 years, but not in the next 10 years. Slides, erosion, or sediment accumulation, caused by human activities, occur moderately, (along <25% of the channel, and the channel edges). A specific flow effect has changed, at most 50% compared to unaffected conditions. *Characteristics, primarily concerning reaches where erosion is dominant:* Incision ratio, usually <1.2. Secondary floodplains are well-developed and contributes to stability. Large woody debris and well-developed vegetation stabilises the channel. Any trees along the channel are leaning at most 20% from the vertical. Some exposed roots on trees along the channel. Some pocket formation between the trees.
2	Moderate instability	There are signs indicating that the morphology will be changed significantly within the next 20 years. Slides, erosion, or sediment accumulation, caused by human activities, occurring extensively, (along 25-75% of the channel, and the channel edges). A specific flow effect has changed with 50-150% compared to unaffected conditions. *Characteristics, primarily concerning reaches where erosion is dominant:* The incision ratio is usually in the range of 1.2-1.7. An abundance of trees, leaning out towards the channel, or with bent trunks. Clear signs of root exposure on trees along the channel. Clear pocket formation between the trees. Clear signs of slips, slides, and unstable edges.
3	Severe instability	There are signs indicating that the morphology will be changed significantly within the next 10 years, and some changes are to be expected during each high flow. Slides, erosion, or sediment accumulation, caused by human activities, occurring extensively, (along >75% of the channel, and the channel edges). A specific flow effect has changed with more than 150%, compared to unaffected conditions. *Characteristics, primarily concerning reaches where erosion is dominant:* The incision ratio is usually over 1.7. Trees are heavily leaning out from the channel or are laying in the water. Severe exposure of tree roots. Clear signs of undermined root systems. In some cases, the erosion reaches behind the trees. Slips and slides are common along the complete reach. Clear signs of tension cracks above the edges of the channel. Extensive undermining with landslips. Bowl-formed slide scars are common

Figure 2-10. Examples of making assessments of the variables Dominant fluvial process and Stability in river habitat survey, according to Protocol A. **The two photos at the top:** The reach in the example has characters, which according to the indicators in Appendix 6 primarily indicates shore erosion, which was assessed as the dominant fluvial process. Examples of indicators showing this was J-shaped trees, plenty of exposed roots, secondary floodplains, undermining, a lack of flooding, and the fact that downstream from the reach there was a controlling section which was somewhat cleared. If you look closely gravel and stones are visible on the shore in the left photo, showing that an older bed existed at a higher level than the current bed. Bed erosion was mainly assessed to occur in the uppermost part of the reach, (the photo to the left), but previously this has probably occurred in the whole reach. The clearing in the downstream area, together with a changed land use in the floodplain was assessed as the cause for the shore erosion, which was noted under A18-Additional information In the uppermost part of the reach, the erosion occurred on both sides, but in total it was mainly assessed as one-sided. For the reach Class 1a, shore erosion on one side was noted, as well as Class 2, moderate instability.

At the bottom, to the left: Streams running through peat. This reach is heavily affected by lowering of the water level in the downstream area. The channel is stable without significant erosion and sedimentation, thus stable conditions are noted, (Class 0), for both variables. Even if the reach is affected and the shores are drier, it is in a balanced condition, which probably had not been the case if it had been a TL reach.

At the bottom, to the right: SL reach, (Bl type), boulders are dominating. The stream shows no signs of an increased width or sedimentation, and the large boulders make bed erosion impossible. The stream is stable, (Class 0).

3.5.1.16 A16-MEASURES

If measures are required, it is to be noted under the variable Measure requirements. Measure proposals are to be noted under the Measures variable.

Only measures leading to a more natural condition for the stream are concerned. The basic principle for assessment of needs and suitable measures is that the measures must lead to a status improvement for the quality element River Continuity or the quality element Morphologic condition in streams according to the Water Framework Directive or in other ways leading to a more natural condition.

Measures with the purpose of increasing the fish production or only to improve the conditions for a certain species, but not improving the natural conditions as above, may be noted under A18-Additional information instead. Measures only concerning barriers should be noted in Protocol D, but a reference to Protocol D must be noted.

For some types of streams, it is possible to see the needs for measures and the measures needed, but a lot of stream types require a higher level of competence and a more in-depth analysis. For the variable Measure requirements Yes or No can only be noted if the required material and competence to assess if a measure is needed exists. The same applies for the Measures variable where measure proposals only are to be noted if the required material and competency exists. Otherwise, Do not know, or Not assessed can be noted.

In Appendix 7 examples of common measures are shown, as well as examples of measure proposals.

Measure requirements: If there is any need of measures, it is noted as Yes, otherwise as No. May also be noted as Do not know, or Not assessed.

Measures: Note measure proposals. Free text (maximum 255 characters). May also be noted as Do not know, or Not assessed.

Stocked natural stone: Note if there are stocked natural stone or boulders that can be used for measures. State Yes or No. A volume can also be noted, (m^3).

Stocked quarried stone: Note if there is quarried stone that can be used for measures. State Yes or No. A volume can also be noted, (m^3).

Performed measures: If any other measure is carried out where the objective has been to improve the environment, it is to be noted as Yes in the protocol, otherwise noted as No. The measure should be commented under A18-Addition information. Measures, aiming at improvement, which have had a negative impact, are to be noted as well, for example sediment traps causing barriers.

3.5.1.17 A17-PHOTOS

Photos: State the number code for the photos taken, (for example 001-004). How to number the photos are optional. Location and an explanatory text can be noted under A18-Additional information.

3.5.1.18 A18-ADDITIONAL INFORMATION

Additional notes: Additional information is noted here as free text with a maximum of 8,000 characters. It can be notes about any threats to the site, occurrence of interesting plants or animals, information about fluvial processes, or information about photos. Notes about key biotopes or a preliminary natural value assessment can be written here.

The variable Dominant fluvial process must always be commented for TL streams. The variable Deviant ambition level: must always be commented if Yes was noted.

If a Weakly cleared controlling section, Heavily cleared controlling section, Culvert, Road Passage, Dam, Other unnatural damming controlling section, Other unnatural controlling section, or controlling section with regulatory possibility is stated under A19-Controlling sections, its impact on the fluvial processes for the upstream area and surrounding wetlands is to be commented. If all controlling sections are not noted in GIS, that deviation is also to be noted.

When a structure stops the migration upstream due to head cut erosion (see A20-Knickpoint/Knickzone), it should also be commented under Other, since a change of the structure, (for example a change to half-culvert), will cause the knickpoint to migrate upwards.

It may be proper to write a summary of the river habitat survey and an overview description of the stream for reach 1, under Other in the Protocol. It can be done as simple field notations, for example like this:

"Summary of river habitat survey of Gransjöbäcken:
Surveyed mostly during low flow but reach 9-15 mapped during high flow due to rain, which makes parts of the assessment uncertain.
Reach 1-4. Heterogenous Bx reaches with streaming and calm water. Mostly stones and boulders. Reach 4 is surrounded by a deep ravine. No physical impact.
Reach 5-8. Severely affected area. Completely redug and surrounded by arable land. At the bottom, cleared Bx (lowered base level and controlling section), otherwise Fx.
Reach 9-15. Bx and Cr reaches. The creek is lined with spruce production forest. At large no physical impact. Mostly winding and meandering. Suitable measure: Thin out more deciduous forest.
Reach 16: Cleared Bx reach with stones.
Reach 17: Meandering area (Ex). The reach is affected by erosion due to a controlling section lowest in the reach being cleared, probably 50 years ago. Suitable measure: Restore the controlling section.
Reach 18: A large mill pond at the bottom. The complete area is dammed. No activity since the 1960s."

3.5.2 Part 2-Variables to be filled out for TL reaches and peat reaches

3.5.2.1 A19-CONTROLLING SECTIONS

All controlling sections of importance for the reach is to be noted. Controlling sections are narrow, riffle reaches with many boulders which entails "damming" in the reach and thus affecting the local base level. For TL reaches they control the water level and where the sediments are discharged. For the peat streams, they describe the reach's hydrologic prerequisites, as well as the impact on the stream and the surrounding wetlands. Controlling sections are noted in numbers, and as point objects in GIS. Dammed or completely drained controlling sections are to be noted, even if they do not function as controlling sections from a hydraulic point of view during the conditions at present.

Changes in the local base level is to be noted as well. The change is almost always related to changes in controlling sections. In some cases, the changes of the local base level may be due to the stream discharging into another stream with a changed base level or a lake with changed level (lowered or dammed lake).

Controlling sections are often situated outside the reach in question but are to be noted in the protocol for the reach/reaches it affects. Figure 2-11 shows a principle sketch of how controlling sections are to be noted.

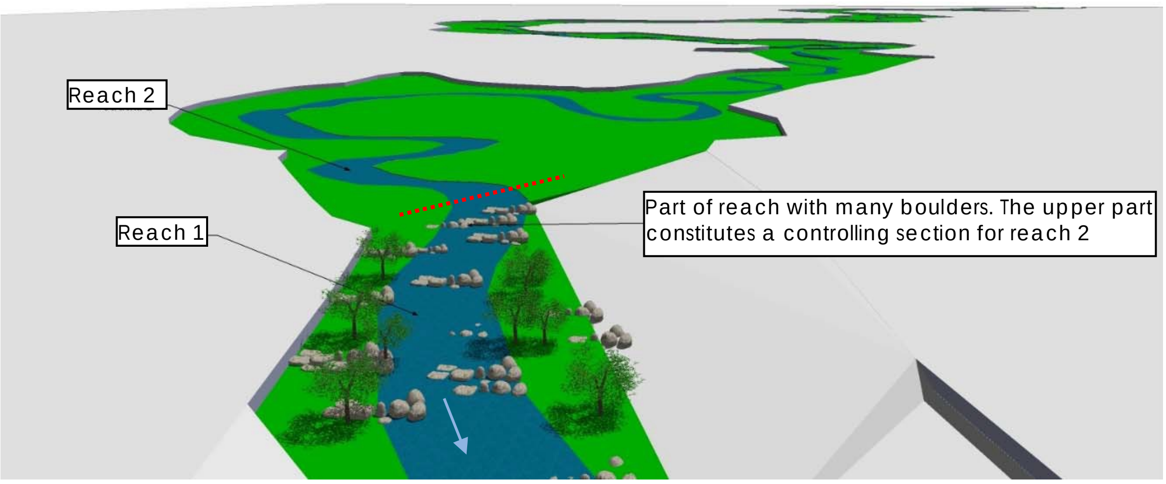

Figure 2-11. Example of notation for a controlling section. The red line shows the reach demarcation. The riffle part of reach 1 is a controlling section for reach 2. The riffle part is not cleared and therefore "Unaffected controlling section of stones, boulders, or similar" is to be noted in the protocol for reach 2. A mark is made on the map, at the top of reach 2, in the form of a point object.

If large woody debris is to be counted as a controlling section, it must have a clear impact upstream, during high flow. The wood must also be expected to stay there permanently if it is to be noted. Log jams or similar, which may be changing significantly or be washed away during high flow is are not to be counted as controlling sections. The smaller the stream, the higher the risk for large woody debris to function as a controlling section.

If a Weakly cleared controlling section, Heavily cleared controlling section, Culvert, Road Passage, Dam, Other unnatural damming controlling section, Other unnatural controlling section, or Controlling section with regulatory possibility is stated under A19-Controlling sections, its impact on the fluvial processes for the upstream area, and any surrounding wetland is to be commented in section A-18 Additional information.

Figure 2-14 shows examples of controlling sections, and guiding photos for the demarcation between weakly cleared and heavily cleared controlling sections.

It is important to remember that a controlling section, as well as any impact in the controlling section, may have effects far upstream. Usually a controlling section impacts the stream all the way to the next controlling section situated upstream. It is important to consider that the effect may vary with the flow, where some controlling section are becoming more or less important during high flows, among other things due to a so-called ”drowned-out effect”.

In some cases, several types of controlling sections must be noted for one location in GIS. For example, if a natural controlling section, (for example a stone terrace), is cleared and replaced with a dam. Then, it is important to note this, in both the Dam and Heavily cleared controlling sections to get a complete picture.

If reach 1 is a TL or Px reach, it is possible that there are controlling sections situated lower downstream (outside the mapped area), impacting the stream. The controlling section shall then be assessed. A common example is that reach 1 discharges in a lake, in which case an assessment of the morphology in the lake discharge or the reaches downstream from the lake must be made. If a controlling section exists downstream from section 1, it is noted with the variable Outside the demarcation.

Assessment is performed for the following variables:

Unaffected controlling section of stones, boulders, or similar: Concerns unaffected controlling sections such as natural, not cleared riffle heads, streaming reaches, and similar environments.

Beaver damming: Stable beaver damming with impact upstream.

Large woody debris: Large woody debris in the form of log jams, creating stable thresholds and falls. In small streams single logs may be noted if they function as stable thresholds.

Other unaffected controlling section: Other natural thresholds such as flat rocks.

Weakly cleared controlling section: The same as “Unaffected controlling section made of stone, block, or similar”, but with the difference that it is somewhat cleared.

Heavily cleared controlling section: The same as “Unaffected controlling section made of stone, block, or similar”, but with the difference that it is heavily cleared.

Culvert: Culvert, functioning as a block or is located higher than the rest of the bed and thus raising the surface upstream.

Road passage (not a culvert): Road passage, functioning as a block or located higher than the rest of the bed and thus raising the surface upstream.

Dam: Damming, raising the surface upstream.

Other unnatural damming controlling section: Concerns terraces created by humans, not dams, but having a significantly damming effect.

Other unnatural controlling section: Other terraces and blocks, created by humans.

Controlling section with regulation possibility: Concerns controlling sections where the basic level can be regulated, for example a dam with adjustable hatches.

Outside the limits: Note if at least one of the controlling sections is outside the limits of the area for the river habitat survey, i.e. below reach 1. State Yes or No.

Base level drop: Assess if, and if yes, how much the local base level is lowered through changes in fixed structures, (Figure 2-12). The fixed structures include thresholds/riffle reaches with stones, boulders or flat rocks, and lakes or larger watercourses where the stream discharges. Beaver dams, large woody debris, dams and other structures, created by humans are not included. For example, if a riffle head is lowered, but a dam is built on the site, raising the water, only the original stones and boulders are included in the assessment, not new boulders if they belong to the dam construction or any other construction.

The change is notes as how much lower in metres (two decimals), the base level is compared to the original condition. The assessment is done for average flow situations. No impact is noted as 0 metres. For example, if a natural stone terrace is cleared, lowering the water level 0.60 meters upstream from the terrace, -0.60 is to be noted. Sometimes it is difficult to know how much the water is lowered, then the amount of cleared material can be assessed instead, i.e. how much lower the crest of a terrace is. The value is not as certain, but it is sufficient.

Changed base level in total: Assess if, and if yes, how much the base level has changed in total (noted in metres, with two decimals). The assessment is the same as for the variable "Base level drop", with the difference that this includes any occurring controlling sections and other things impacting the base level. The variable describes how much the current base level deviates from the original.

In many cases the noted value is the same as for the variable "Base level drop", for example if the controlling sections only are fixed structures, either unaffected or lowered. In other cases, it can be more complicated since it concerns trying to make a weighted assessment of several types of impact. For example, if a terrace of boulders has been cleared at the same time a culvert damming the stream, there is one factor, (the clearing), indicating a lowered base level, and another factor, (the culvert), indicating a raised level, (Figure 2-13). This concerns assessing if the level currently is higher or lower, compared to the original condition.

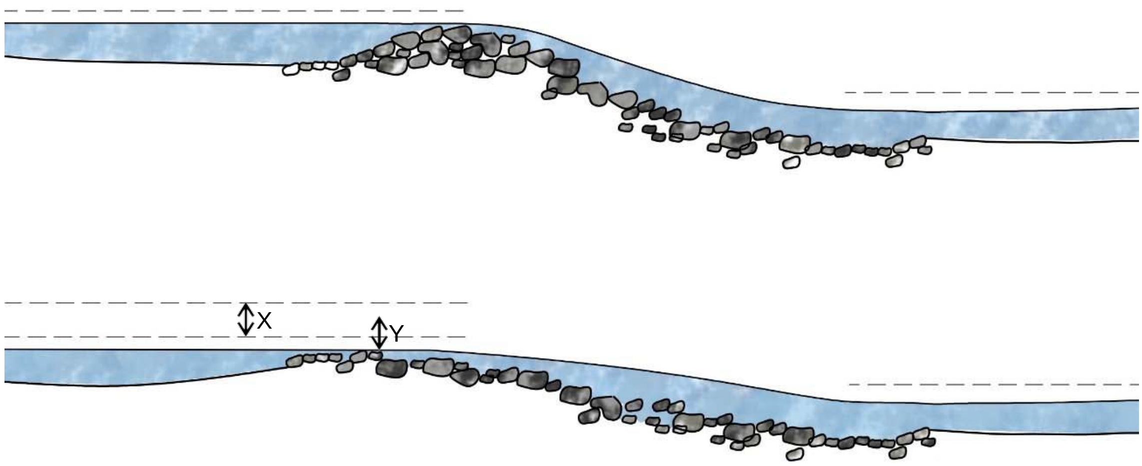

Figure 2-12. The figure shows how the variable fixed structure is assessed. In the first picture, a controlling section is not cleared. In the second picture, the controlling section is cleared, then the water level at average flow is lower, marked with an X. This is the value to be noted. In some cases, it may be difficult to assess, and the difference in height at the ridge can be estimated.

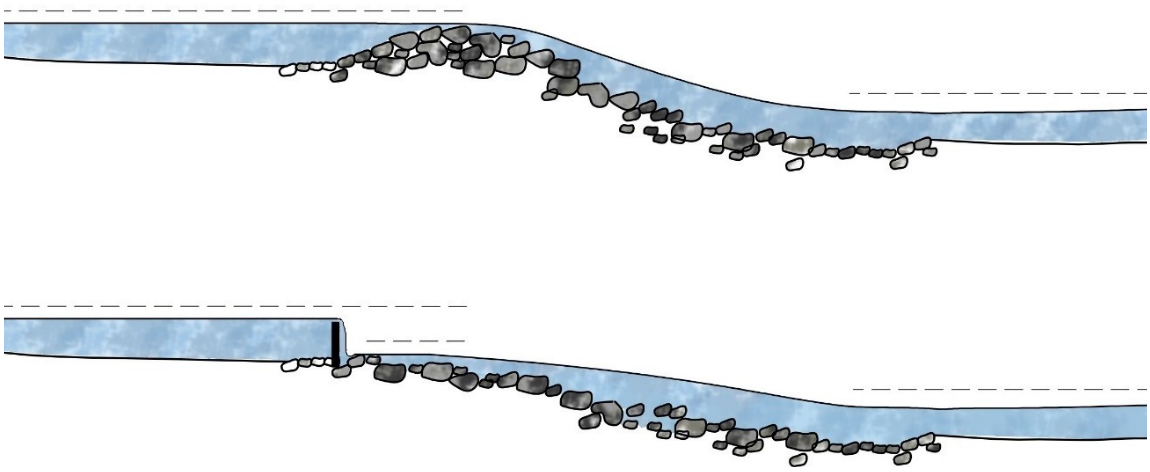

Figure 2-13. The figure shows haw the variables Lowered base level, fixed structure and Changed base level in total are assessed. In the first picture, a controlling section is not cleared and zero is set for both variables. In the second picture the controlling section is cleared, and the lowering is to be noted under Lowered base level, fixed structure. In the lower picture there is damming as well. For Changed base level in total, the total change of the level is to be noted. Since the dam is damming as much as the original terrace, zero is noted. If the damming entails more, a positive number is noted, and a negative number for less.

Unaffected controlling section with stones, boulders or similar

Weakly cleared controlling section

Heavily cleared controlling section

Beaver damming

Road passage

Other unnatural controlling section (bridge remnants)

Figure 2-14. Examples of controlling sections, to be noted during river habitat survey, according to Protocol A.

3.5.2.2 A20-KNICKPOINT/KNICKZONE

Knickpoint/Knickzone: The occurrence of a knickpoint/knickzone is to be noted as a number in the protocol and in the GIS layer as a point object. Knickpoints and knickzones are structures, mainly occurring in TL streams, but may also occur in peat streams.

A knickpoint is a part of a river where there is a sharp change in slope or elevation, (in explicit cases, there often is a small waterfall or a short drop). In most cases, the knickpoint originates from an increase slope, due to an emerging erosion process. The increased slope is often due to clearing of a controlling section or that the base level is lowered in another manner. Bed erosion by increased slope often begins at the lowest point downstream and the note has to show the demarcation between the lower area where the impact is highest and the areas upstream, not yet affected significantly by the erosion. By marking out the knickpoint it is possible to assess how far upstream the erosion impact have reached. Usually, there is only one clear knickpoint, but sometimes there are several.

Even if a knickpoint primarily is connected to base level drops, they can emerge under many different conditions. One example is when there are several consecutive SL reaches or peat reaches or when the degree of clearing is higher in the reaches farthest downstream. Then, a height difference between the reaches can emerge, which the stream will even out in approximately the same way as when the base level was lowered, i.e. the erosion migrates upward.

Sometimes the knickpoint is a small waterfall by a road passage or another structure, stopping the migration upstream. When a structure stops the migration upstream it should be commented under A18-Additional information since a change of the structure, (for example a change to half-culvert), will cause the knickpoint to continue migrating upwards.

In general, a knickzone the same thing as a knickpoint, but the bend is longer and consists of a steep reach instead of a waterfall. During survey, no difference is made between knickpoint and knickzone, both are noted with the same variable.

Figure 2-15 shows an example of how the variable is used, and Figure 2-15 shows examples of knickpoint and knickzone appearance. See also the sketch in Figure 6-3.

The term knickpoint usually includes natural waterfalls, but in the river habitat survey only knickpoints caused by human activity are to be noted, not natural water falls that are controlling sections.

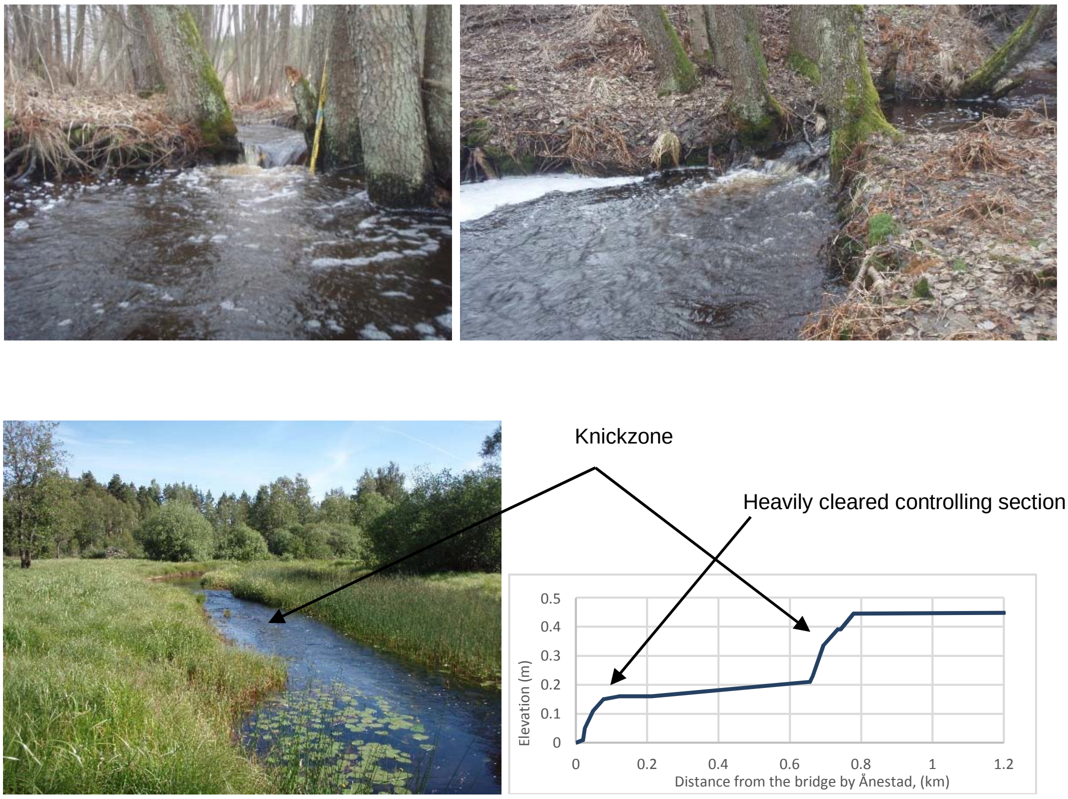

Figure 2-15. Examples of the appearance of a knickpoint/knickzone. The upper left photo is from a stream where the bed erosion started a bit downstream in connection to a lowering of the channel at that point. The erosion is due to an upwards migrating knickpoint, (head cut erosion), and currently the knickpoint has migrated 100 metres upward in the stream, to where the photo is taken. Below the knickpoint, there is a heavy impact from the erosion. Upstream, the impact from the knickpoint is not as significant, but when the knickpoint continues migrating upward, that area will be affected as well. The photo to the right shows that the channel is wider below the knickpoint, which is common. In addition, the photos show that the knickpoint temporarily stopped, due to the roots of two adjacent alders have grown together to a terrace, a phenomenon solely existing in small brooks. When the stream has undermined the alders to a large enough extent, the erosion will continue upward.

The photo below shows a knickzone, not consisting of a marked fall, but a longer reach with a significantly steeper slope than other parts of the stream. In this case the knickzone consists of sand, reinforced by plant roots. When the sand is eroded, a new knickzone or knickpoint will emerge in the next base area upstream, thus making the stream deeper in the upper reaches of the reach. The erosion is caused by the clearing of a controlling section 500 metres downstream. In the profile the cleared controlling section is visible, (due to natural causes it has a higher gradient), and the knickzone's clearly deviating gradient.

3.5.3 Part 3 - Variables to be filled out for TL reaches

3.5.3.1 A21-FLOODING FREQENCY ON THE FLOODPLAIN

The flooding frequency on the floodplain is assessed through the variables below. In the assessment it is important to distinguish floodplains from the terraces formerly being floodplains. Terraces can consist of recent terraces, i.e. former floodplains where the flooding frequency is reduced, and flooding occurs less than every ten years. They can also consist of older terraces which are not flooded any more, due to natural causes, for example those developed a very long time ago, under completely different circumstances.

Incision ratio: The incision ratio is calculated by dividing the height difference between the floodplain (active floodplain or recent terrace) and thalweg with the maximum depth during bankfull flow, (Figure 2-16). The assessment is performed for one or more cross-sections, representative for the sub-reach. The maximum depth at bankfull flow is defined as the height difference between 63 the water surface at bankfull flow, (here, the same as channel-forming discharge). Note that this is not the maximum depth, but the maximum depth of the thalweg in a representative section. The incision ratio is to be noted with one decimal.

If the value is 1, the floodplain is active and has a natural flooding frequency. Values above 1 indicate reduced flooding frequency. To assess the depth during bankfull flow, bankfull indicators are to be used, i.e. indicators that show how high the water is during bankfull flow. Normally, the ratio is only to be assessed or measured approximately, for example with a folding rule, but if the river habitat survey is to be the base for measures, the measurement should be performed with levelling instruments. Measuring of the floodplain is not to be done further away than three stream widths from the channel. Examples are shown in Figure 2-17.

Sometimes the floodplain is higher on one side of the stream. Then assessment/measuring is to be made on the lower side of the floodplain. It is important not to mistake a lower floodplain for a secondary floodplain that is lower as well.

The incision ratio gives a measure of how much the stream has incised into the floodplain, compared to earlier. An increased incision into the floodplain is often caused by human activity, though, in some cases it may be due to natural causes. An increased incision leads to reduced lateral connectivity, and an increased sediment contribution from the reach. The variable may be difficult to assess for inexperienced inventors but is simple to learn.

Sometimes there are factors pointing both at an increased incision ratio and at a decreased incision ratio. This may be due to a large amount of previous erosion, or that a lot of sediment coming from parts upstream, (due to erosion in upstream areas). In those cases, a good assessment of the incision ratio may be difficult.

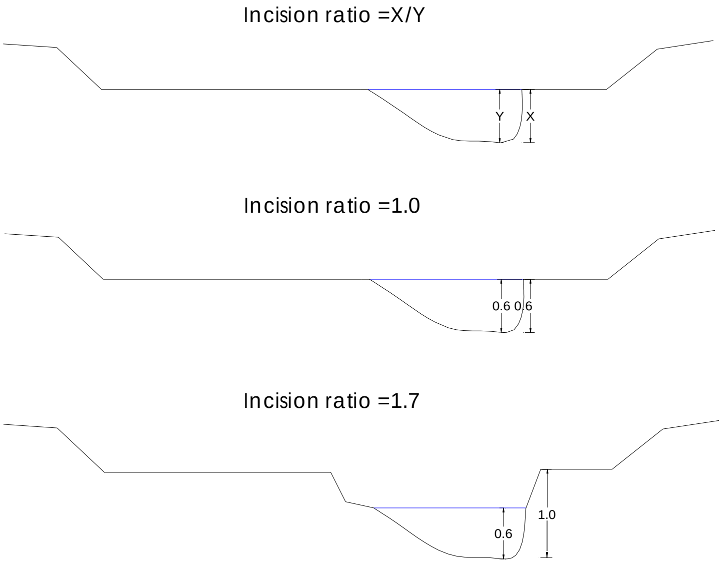

Figure 2-16. On top, the figure shows how to measure and calculate the incision ratio. The blue line shows the level at bankfull flow, (the bankfull level). The bankfull level is identified in the field through bankfull indicators. X is the height difference between the thalweg and the floodplain, Y is the maximum depth at bankfull flow. The ratio is calculated by dividing X with Y. The two sections below show examples of calculations. In the first example X has the same value as Y, indicating that the water level at bankfull flow is no lower than natural, and that the floodplain is active. In the other example, X is larger than Y, indicating that the incision is unnaturally large, or that the water level is lower than before, due to other causes. In the example the floodplain probably is not active, and thus classified as recent terrace.

Figure 2-17. Example of calculation of incision ratio and assessment if the floodplain is active. To the left: The stream bed is approximately 1.2 metres below the original floodplain, (right arrow). The bankfull level is visible in the secondary floodplain, (left arrow), and is around 0.5 metres below the floodplain, (i.e. 0.7 metres from the bed). Thus, X represents 1.2 metres, and Y 0.7 metres (compare to the sketch). The incision ratio is 1.2/0.7=1.7. There are no signs of the floodplain being flooded at any occasion, which, in common with the incision ratio, leads to the assessment that the floodplain is not active, and thus consists of a recent terrace. To the right: Example from another part of the same stream, where the incision is lower, and the incision ratio is around 1.4.

Active floodplain: If the floodplain is flooded at least every ten years, this is noted as Yes, (cannot be combined with Yes for recent terrace), otherwise noted as No. The assessment is based on the occurrence of sediment in the floodplain, the incision ratio, and other signs showing how frequently the floodplain is flooded.

The assessment should begin with a rough assessment, based on the incision ratio. Though the incision ratio only shows how much lower the surface level is compared to previously and tells nothing about friction resistance or how the cross-section area is changed by rising water levels and can only give an approximated picture of the situation. If the incision ratio is lower than 1.3, the floodplain probably is active. If the ratio is more than 1.7, this is less probable. For values between 1.3 and 1,.7, the floodplain may be active or not.

The next step should be to look for different signs, such as sediment in the floodplain, or other material, washed up on the floodplain. If sediment or other materials are washed up on the floodplain it is important to assess if it was washed up during an extreme flow or during a 10-year flow. It is also possible to look for material getting stuck in trees, or along the channel at a lower level than the floodplain. This may indicate that the floodplain cannot be flooded.

The variable can be easy to assess if the incision ratio is under 1.3 or over 1.7. If it is between these values, the assessment is difficult, which has to be considered in the evaluation.

Recent terrace: If the floodplain's flooding frequency is reduced, and flooding occurs less often than every ten years, this is noted as Yes, (cannot be combined with Yes for Active floodplain.), otherwise noted as No. The assessment only concerns floodplains developed during the last 200 years, not older terraces which are not flooded due to natural causes.

A prerequisite for Yes is that the floodplain remains and is not destroyed, e.g. by filling. If the impact on the floodplain is lesser, e.g. if it is restructured to arable land, it may be counted as a recent terrace.

Secondary floodplains: Secondary floodplains are young floodplains, often indicating instability and reduced flooding frequency. Secondary floodplains are only noted if they are assessed to indicate that the stream is affected and they shall not to be mistaken for sediment banks or terraces caused by slides. Occurrence is noted as Yes, otherwise noted as No. If it only occurs in a small part of the reach, (<30% of the length), it is noted as No.

3.5.3.2 A22-CHANNEL EVOLUTION PHASE

Channel evolution phase: The channel evolution phase is noted, based on how the stream has changed due to any disturbance. Phase 1 represents unaffected conditions. Phase 2a-7a, 2b- 6b, 2c-7c, and 2d-7d represents the different channel evolution phases a stream usually goes through after a disturbance. The first phases represent an early stage, while the last represents a new, dynamic state of balance.

The phases are noted as one of the alternatives in Table 2-18. The phases are divided into four different main groups. First the most suitable main group for the reach is chosen. When choosing the main group, look at the group description in Table 2-18, and check that the group has a final phase (the new balanced condition), corresponding to the condition the reach in question is heading towards. Then the most suitable phase is chosen. A sketch over the different phases is shown in Figure 2-18 - Figure 2-28.

The phases are to be seen as a conceptual model, and in practice the evolution of streams does not always follow the stated patterns, in many cases the stream may switch between different phases. This is due to the impact on the stream changing over time. For example, a stream with heavy bed erosion, at present in phase 4a, may switch to 4b and begin being affected by sedimentation instead, if the erosion in the upper reaches is severe and the sediment contribution then will be larger. In those cases, it may be difficult to make an assessment.

For some reaches, none of the phases fits, (if there were phases fitting all reaches, the number of phases would have to be innumerable). In those cases, the assessment can be facilitated if you base it on the descriptions of the new balanced conditions, (7a, 6b, 7c, 7d), and the phases just before the new balanced conditions and compare them to the probable new balanced condition for the reach in question.

In addition, literature describing channel evolution models (Channel Evolution Models or CEM) can support the assessment, for example Schumm et al. (1984) or Simon & Hupp, (1986) or later publications developed from Schumm's works.

The assessment is to be commented under A18-Additional information.

Table 2-18. Different channel evolution phases, noted during river habitat survey, according to Protocol A. The phases are divided into four different main groups. First the most suitable main group for the reach is chosen. Then the most suitable phase is chosen. The phases are also described in Figure 2-18 - Figure 2-28.

Group	Phase	Explanation/Description
Natural, unaffected conditions (Figure 2.18)	1	Stable system, in balance. The stream is in frequent contact with the floodplain, and the floodplain is flooded when the discharge exceeds the bankfull flow, (exceeds the channel-forming discharge). The shores are relatively stable, and the migration rate of meanderings are normal. The sediment, transported by the stream, mainly consists of suspended material, while material from shores and bed only occur sparsely. The bankfull indicators are around the same level as the floodplain. The channel is relatively shallow, (not incised).
Phase 2a-7a (Figure 2.19). Reaches dominated by erosion, are affected by erosion, or reaches with a secondary floodplain, but not redug. Reaches in this group have to be on their way to a condition, deviating from the original.	2a	A disturbance leading to imbalance and a commencing incision for the stream. An early stage where the erosion is unnaturally high, but the depth is not significantly increased. A knickpoint may be present, situated in the lower part of the assessed reach. Common causes are a reduction of the local base level, which may entail that the controlling section downstream is cleared, or other types of clearing has been performed downstream. The impact has led to an increased slope and an increased specific flow effect. The flooding frequency may be reduced, but may also be normal upstream the knickpoint.
	3a	The increased flow effect and the stream’s tendency to adapt to the lower base level, leads to the stream eroding down in the bed and the stream getting deeper and deeper. Often, the process takes place when a knickpoint migrates through the reach. The erosion continues until the stream's bed height adapts to the new conditions. This phase represents a later stage than phase 2, where the bed has reached a significantly deeper level than before the disturbance. The flooding frequency of the floodplain is significantly reduced. The bankfull indicators are at a lower level than the floodplain level.
	4a	Incision and increased width. The incision in phase 3 is extensive and the shores are more and more affected, and the channel tends to become wider. The increased width is included in the stream's striving to create a new floodplain at a lower level than before, but there still are no visible secondary floodplains. The sedimentation in the lower part of the assessed reach may have increased due to the stream's tendency to reduce the slope.
	5a	Increased width. This phase is a continuation of phase 4a. The phase is characterised by mostly affecting the shores. In many cases the erosion only occurs on one side, and on the opposite side there are tendencies toward a beginning of a new secondary floodplain. In some cases, tangible sedimentation occurs, followed by a raised bed due to upstream erosion. In some cases, the sedimentation is heavy, but temporary, which may entail that the stream will go through Phase 3-5a once more.
	6a	In this phase the stream is approaching a condition, partly similar to a natural condition. Erosion primarily occurs on one side of the stream, and on the opposite side there is a secondary floodplain at a lower level than the original. The secondary floodplain in this phase is still small, (a width less than 30% of the width of the original floodplain). The stream is not stable, and it stands clear that it tends to chisel out a new floodplain.
	7a	In this phase the stream is close to a new balanced condition. A secondary floodplain is created at a lower height than the original. The secondary floodplain is at least twice as wide as the stream or the width is more than 30% of the size of the original floodplain. The stream is relatively stable.

Continues on next page ⇨

Group	Phase	Explanation/Description
Phase 2b-6b (Figure 2-21). Reaches primarily affected by sedimentation, but not redug.	2b	Phase with a weak tendency towards a raised bed, with eventual increase in width. It stands clear that the bed level is raised, and that the old bed is largely covered by sediment, but it concerns a rather small portion of the total cross-section area which is filled with sediment. Many streams stop at this phase, or in Phase 3b, and never develop so far that avulsion emerges. Often the stream has been in one of the phases 3a-5a, before 2b, and then the stream might give the impression of stability, since the sedimentation process may work as a reparation for former erosion processes.
	3b	Phase with bed raising and an eventual increase in width. In some cases, there are characters found in streams with braided systems.
	4b	Phase with avulsion. The stream creates new channels.
	5b	The stream has largely abandoned older, more meandering channels. Oxbow lakes are filled with sediment.
	6b	New, dynamic balanced condition. If the sediment introduction is reduced, in the long term, the stream is on the way to the original condition, in other cases a new planform may characterise the new balanced condition.
Phase 2c-7c (Figure 2-23). Redug reaches where the controlling sections <u>are not</u> affected, and the system's basic prerequisites are relatively unaffected. Streams which are not redug, but with similar channel evolution phases are included in this group.	2c	The ditch characteristics remain in the reach.
	3c	Phase dominated by sedimentation.
	4c	A secondary floodplain has emerged within the ditch section. The secondary floodplain is lower than the original floodplain.
	5c	The channel is winding more and more. Parts of the original floodplain can be flooded.
	6c	Phase where the floodplain can be flooded again. The channel is still straighter than natural but may have regained a regular meandering. The secondary floodplain is at a level, which is almost as high or on level with the original floodplain. The channel may be within the ditch section or has left the ditch section through a lateral shift.
	7c	The channel is beginning to meander with a higher amplitude, and the floodplain has a normal flooding frequency. A new, dynamic balanced condition, which is largely similar to the original condition. The channel is not limited to the ditch section.
Phase 2d-7d (Figure 2-25). Redug reaches where the controlling sections have been lowered and/or the system's basic prerequisites are affected.	2d	The ditch characteristics remain in the segment.
	3d	Phase dominated by sedimentation. Bed erosion may occur, depending on the stream's flow effect. If the flow effect is low, it is possible that sedimentation dominated, eventually in combination with shore erosion.
	4d	Phase where a secondary floodplain has emerged within the ditch section. The secondary floodplain is lower than the original floodplain. Often the ditch section is wider due to a lateral shift, but if the ditch section was excessively large, the channel evolution may have occurred within the dug section.
	5d	Phase where the channel has begun to wind more. The secondary floodplain is larger than in phase 4. The amplitude is low and the erosion in the outer curves clearly shows that the stream tends to increase the amplitude. Usually the stream is shallower than in Phase 2d.
	6d	The phase has the same characteristics as Phase 6a.
	7d	The phase has the same characteristics as Phase 7a.

Figure 2-18. Cross-section and photos, showing the principle for Phase 1 in assessment of the channel evolution phase. Phase 1 represents relatively unaffected conditions and is characterised by a relatively stable system where the stream is in frequent contact with the floodplain. The channel is relatively shallow and close to the floodplain. The bankfull indicators are at the same level as the floodplain. The phase is described in more detail in Table 2-18.

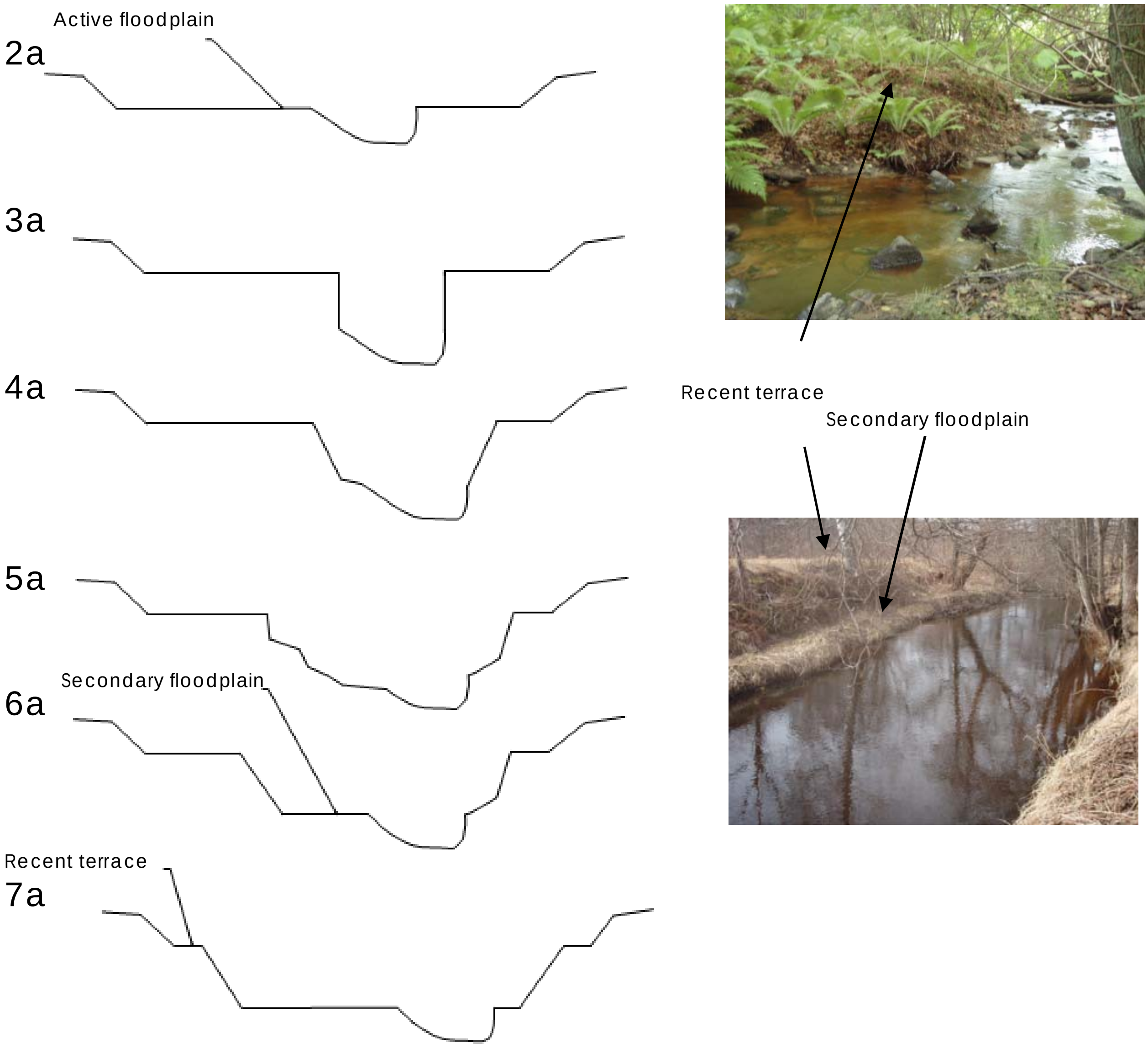

Figure 2-19. Conceptual model with cross-sections to be used in assessment of the channel evolution phase for reaches where erosion is domineering, is affected by erosion, or reaches with a secondary floodplain, but not redug. The phase is described in more detail in Table 2-18. In short, Phase 2a is an early stage where the bed erosion commenced recently. In succession the stream incises and begin to erode the shores. In Phase 5a-7a a secondary floodplain is developed at a lower level than the original, active floodplain. When the stream has abandoned the active floodplain, i.e. from Phase 3a, it is called Recent terrace instead. In Phase 7a the stream has achieved a new, dynamic balanced condition. The photos are showing Phase 3a, and 6a.

Figure 2-20. Photos showing different channel evolution phases. The photo to the left shows a stream, formerly in Phase 5b, but at present changed to Phase 3a, after a controlling section being lowered in the downstream area. This entails a heavy sediment seepage, which affects the channel evolution phase for the downstream reaches. To the right, a reach in Phase 5a.

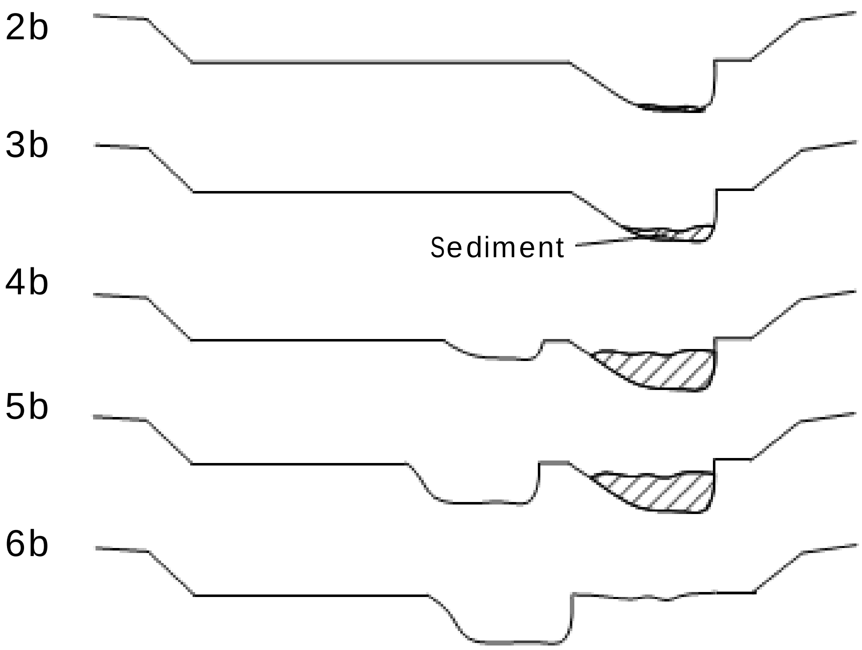

Figure 2-21. Conceptual model with cross-sections to be used in assessment of the channel evolution phase for reaches, mainly affected by sedimentation, but not redug. The phase is described in more detail in Table 2-18. In short Phase 2b-3b consist of early stages with sedimentation and raised beds, but not as severe impact that avulsion occurs. Many streams remain in Phase 3b. Phase
Phase 4b 6b consist of later phases with avulsion, and finally a new condition emerges in Phase 6b. As a rule, the floodplain is active throughout the channel evolution.

Figure 2-22. Photos showing different channel evolution phases. The photo to the left shows a reach, heavily affected by sedimentation. Some parts of the reach are completely filled with sediment. In the location where the photo is taken, the old meandering channel is partly abandoned, and the stream has created a completely new channel, (the old channel is not visible in the picture, but it can be found to the right). Before the sediment impact begun there were some erosion impact, and the stream was probably somewhere between Phase 1 and Phase 3a. At present, the stream is in Phase 5b. The photo to the right shows an area further down in the same stream, now in Phase 3b.

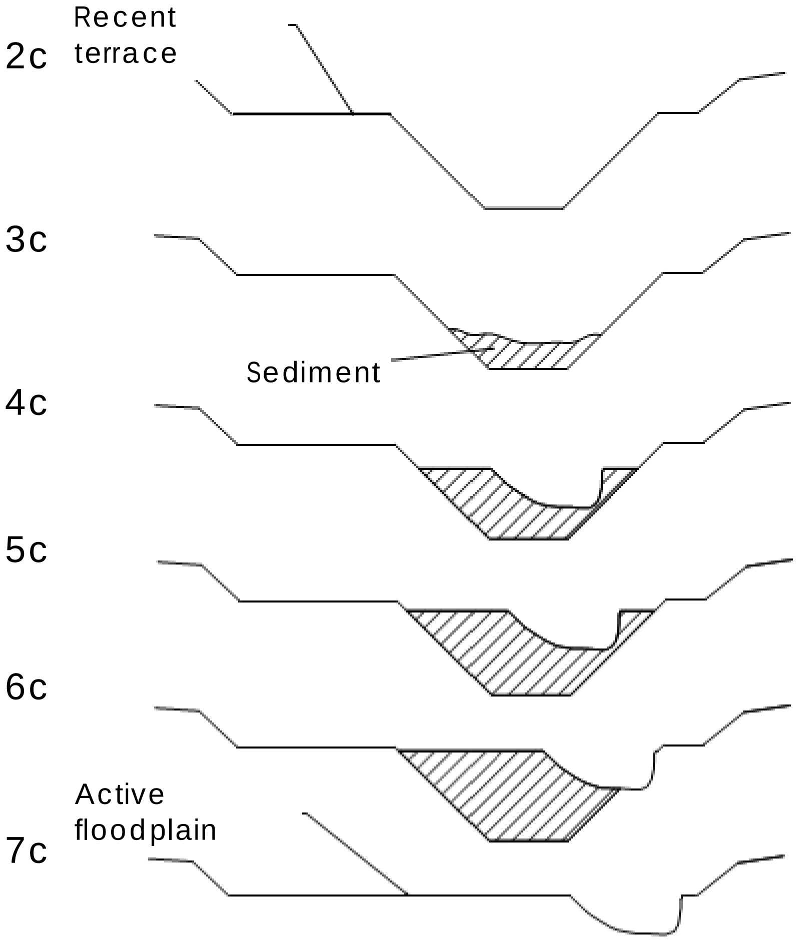

Figure 2-23. Conceptual model with cross-sections to be used in assessment of the channel evolution phase for redug reaches, where the controlling sections are unaffected, and the system's basic prerequisites are relatively unaffected. Streams with similar channel evolution phases, which are not redug, are included in this group. In short Phase 2c is a newly dug ditch and through Phase 3c to 7c the stream will, through sedimentation processes, go back to the condition before the redigging. In the beginning the floodplain is not active, but as more sediment fills the ditch, the more active the floodplain becomes. The phase is described in more detail in Table 2-18.

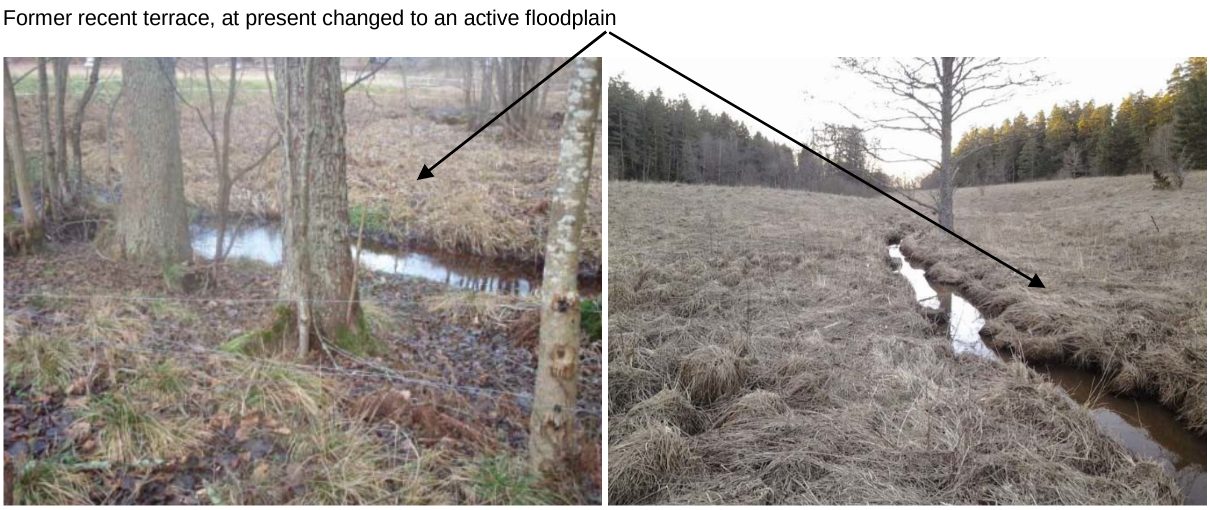

Figure 2-24. Photos showing different channel evolution phases. The photo to the left shows a stream which was redug around 100 years ago. Since a controlling section around 100 metres downstream was not cleared, the stream was able to return to a more natural condition through sedimentation processes. The ditch is filled up with sediment, and the channel is beginning to meander more. The floodplain is active. At present, the reach is in Phase 6c. The photo to the right shows a stream where the situation is similar, here as well the reach is in Phase 6c, but on the border of being classified as 5c, since the channel still is rather straight.

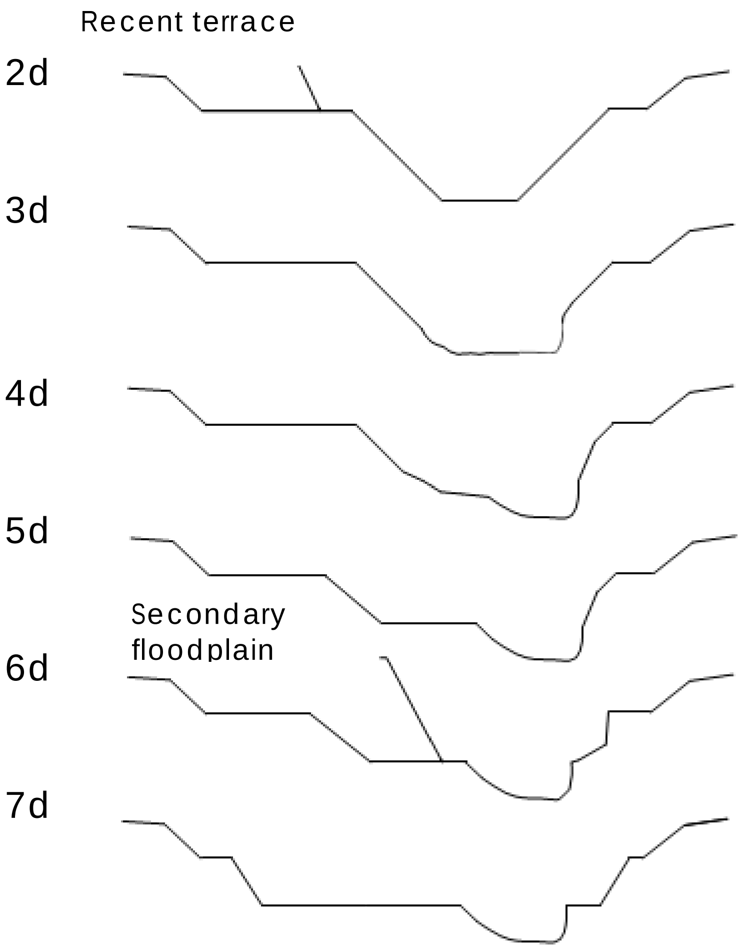

Figure 2-25. Conceptual model with cross-sections to be used in assessment of the stream's channel evolution phase for redug reaches, where the controlling sections are lowered, and/or the system's basic prerequisites are affected. The phase is described in more detail in Table 2-18. In short Phase 2d is a newly dug ditch, and through Phase 3d 7d, the stream will go towards a new dynamic balanced condition through erosion and sedimentation processes. In Phase 5d-7d a secondary floodplain is developed at a lower level than the original.

Figure 2-26. Photos showing different channel evolution phases. The photo to the left shows a stream which was redug around 100 years ago. The stream is cleared far downstream and the controlling sections are removed. The stream is shifted to the side and parts of the embankment are eroded in the dug section. Across the outer curves, where the erosion is, there are secondary floodplains, around two metres wide. The secondary floodplains are around 50 cm below the recent terrace, which currently consists of arable land. The stream has begun to meander, but the amplitude is still low. The reach is in Phase 5d. To the right, a reach in Phase 2d.


2a


3a


4a


5a


2a


3a


3b


5b

Figure 2-27. Photos showing different channel evolution phases that can be noted in river habitat survey according to Protocol A. The last photo shows a reach that is mostly affected by sedimentation, but also by heavy erosion. The tree in the middle of the channel shows that large parts of the floodplain has been washed away, (the blue line shows the previous, more meandering course).

4c

4c

5c

6c

5d

7d

Figure 2-28. Photos, showing examples of different channel evolution phases that can be noted in river habitat survey according to Protocol A.

3.5.4 Part 4 Optional variables

3.5.4.1 A26-TROUT BIOTOPE

An assessment of the stream's suitability for trout is made through three variables describing spawning area, growth area, and access to holding spot for larger fish, (Table 2-19). If the survey is carried out during high discharge, the assessment may be difficult due to the bed not being sufficiently visible, which should be commented under A18-Additional information.

An assessment requires good knowledge about the habitat preferences of trout.

Table 2-19. Classification for assessment of trout biotopes in river habitat survey according to Protocol A - Amendment.

Class	Spawning areas	Nursery areas	Holding spots
0	Spawning possibilities missing	No suitable nursery area	Missing (too shallow)
1	No visible spawning areas, but the right discharge conditions	Possible, but not good nursery area	Possible holding spots for some larger trout
2	Relatively good, but not optimal spawning possibilities	Relatively good nursery areas	Relatively good conditions for larger trout
3	Good to very good spawning possibilities	Good to very good nursery areas	Good to very good conditions for larger trout

Spawning area: Assessed from the occurrence of gravel and stone in a sufficient fraction, and if there are banks of the material, suitable for trout spawning. Assessed according to Table 2-19. In the assessment, the trout size is accounted for, compared to the bed substrate in the potential spawning beds, (small trout can spawn in finer grained material). The spawning beds cannot have to high amounts of fine-particle material, and the discharge must be high enough. The spawning beds' location in relation to each other are also important. The prerequisite is that fry and parr usually do not move more than 100 m in the first summer. This entails that a spawning area is needed each two hundred metres for the area to be assessed as Class 3. Class 3 means that biotope measures cannot bring about any improvement of the trout's reproduction possibilities and that the access to spawning beds are not limiting the reproduction in the reach. Class 2 means that there are spawning beds, but that they are not good enough or not located close enough to each other. It does not mean that the spawning possibilities really are limited for the trout's reproduction in the reach, since that is really difficult to assess.

Nursery areas: Assessed according to Table 2-19. The assessment is primarily based on bed structure, flow condition, and secondly on shadowing and local environment. The assessment concerns prerequisites for this year's as well as last year's troutlets. When Class 3 is noted, biotope measures are not assessed as bringing about any improvement for the trout reproduction possibilities on the premises. In studies of electrofishing, the difference in density is usually large between the classes. Class 1 only contains singular individuals.

Holding spots: The assessment of the supply of holding spots for larger trout is made according to Table 2-19. The assessment concerns holding spots for larger (adult) trout, for example deep holes or larger boulders. When Class 3 is noted, biotope measures is not assessed to bring improved possibilities for larger trout to dwell on the reach.

3.5.4.2 A28-DISCHARGE

Estimated flow: The estimated discharge is noted in m^3/s.

3.5.4.3 A33-SLOPE

Slope: The channel slope is calculated on a representative stretch within the surveyed reach. In flat, meandering streams, single, short fall reaches are not to be included. Noted as metres per 100 metres with two decimals. The slope may be easier to estimate in GIS-analysis if detailed elevation data is available.

The floodplain slope: The floodplain slope may be measured in the field or through GIS analysis. If there are steep, non-representative sections within the reach, they should not be included in the calculation. Noted as metres per 100 metres with two decimals.

3.5.4.4 A36-LOCAL ENVIRONMENT

Dominating local environment, left: The local environment is the area from the stream, to a border 30 m from the shore. The left and right side of the local environment are assessed separately.

Only the dominant type of land is to be noted. The land types to be noted are shown in Table 2-20. Noted as codes.

The inventory of the local environment can be carried out in the field, but GIS analysis is the recommended method.

Dominating local environment, right: Assessed as Dominating local environment, left, but for the right side.

Table 2-20. Types of land to be noted for the variables Dominant local environment and Type of land on floodplain during river habitat survey, according to Protocol A.

Category	Code	Description
Forest	CF	Coniferous forest. The forest is dominated by coniferous trees, (at least two thirds of the forested area is coniferous). The crown cover in the forest is >30%.
	CD	Mixed coniferous forest. The forest consists of both conifers and broad-leaf trees, none are dominating. The crown cover in the forest is >30%.
	D	Deciduous forest. The forest is dominated by broad-leaf trees, (at least two thirds of the forested area). The crown cover in the forest is >30%.
Mountain	M	Mountain.
Clearcutting/ reforestation	C	Clear-cut area, bare, or where reforestation is carried out. Noted as such until the forest has reached an average height of 1.3 m, (chest height).
Farm land	F1	Land used for agriculture.
	F2	Arable land, not being used for agriculture at the present, but might be used. A more or less firm and clear grass turf has been formed. Cultivated grassland and/or grazing may occur. May be difficult to separate from O1.
	F3	Berry and fruit crops, and energy forest/Salix crops.
Open land	O1	Grazed or mowed open land, (<30% crown cover).
	O2	Overgrowing open land, (<30% crown cover).
	O3	Wooded grazing land having a >30% crown cover but cannot be counted as forest.
Wetland	WM1	Open, grazed or mowed wetland (<30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WM2	Open wetland, (<30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WM3	Wooded wetland, (>30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WB1	Wooded bogs, (>30% crown cover). In a typical bog, the water only comes from precipitation. In other wetlands, water is supplied from the surrounding environment. Bogs are never flooded from the stream.
	WB2	Open bogs, (<30% crown cover).
Artificial land	A1	Building plots.
	A2	Road with embankment
	A3	Industry and other impervious surfaces.
	A4	Agglomeration/buildings.
	A5	Other, permeable surfaces, e.g. golf courses, farm environments.

Land type on left floodplain: Land type on floodplain is noted in the same way as dominating local environment, but the assessed area is limited by the floodplain spread instead of the 30-metre limit for the local environment. If the floodplain is not active due to for example incision, the assessment is made for the recent terrace. The reach demarcation is made in the same manner as for the local environment. It is optional to follow the reach demarcation for the local environment or making your own demarcation.

Land type on right floodplain: Assessed as Land type on left floodplain, but for the right side.

Protection zone left: If the local environment, (the area from the stream channel to 30 m from the channel), consists of at least 15% arable land or artificial land on the left side, (to the left looking toward the flow), the width of the protection zone is noted in metres. If the protection zone is missing, zero metres is noted. If there is not artificial land or if it is less than 15%, >30 m is noted.

The protection zone can consist of forest, open land, or wetland. The width concerns the width between the stream's average water level and the arable/artificial land. It is optional to follow the reach demarcation for the local environment or making your own demarcation.

Protection zone, right: Assessed as Protection zone, left, but for the right side.

Changed use of land on floodplain: For many streams it is common to find that the use of land on the floodplain is changing. A lot of times this entails radical changes in the stream's biotopes and the factors controlling the geomorphology can be significantly changed. For example, overgrowing meadows can lead to extensive changes when the sward disappears. The same thing is valid when streams with long woodland continuity on the floodplain are opened up. If significant changes of land use on the floodplain are assessed to exist, this is to be noted. Primarily, the impact on the fluvial processes is to be noted, (which often is correlating with biological effects). Note in free text, (maximum 50 characters).

The example below entails that a note should be made, but there may also be many other reasons to make a note:

- Spruce has been planted on grazing land or meadows
- Grazing land or meadows are growing over due to a ceased grazing or mowing
- Broad-leaf forest has been replaced by spruce forest, (spruce has shallow roots, entailing bad conditions for stability)
- Wooded floodplain has been cleared of trees

Floodplain history: The floodplain history is commented if any information is of interest for the present biotopes, for example if the floodplain previously was used as arable land or if the floodplain's elevation is higher due to previous damming, (sedimentation on the floodplain). Note in free text, (maximum 50 characters).

3.6 Protocol D – Migration Barriers

Protocol D is used survey of migration barriers. In the section below all variables are described, and how they are to be filled out. The variables are sorted under different headings (for example D1-Survey) and for clarity the variables are always marked in bold type (see below).

Inventory taker, Date, Field number, Type of barrier, N coordinate, E coordinate, are compulsory variables. The others are optional and if you should include them or not depends on the purpose of the inventory.

Appendix 2 includes a short summary of all variables, intended to be used as a quick reference in the field or to get an overview of the method.

3.6.1 Included variables

3.6.1.1 D1-STUDY

Organisation: The organisation, department, or similar in charge of the survey. Free text, maximum 50 characters.

Inventory personnel: Name of the person/persons carrying out the survey. Free text maximum 50 characters.

Date: Note the date when the barrier inventory is carried out, in the format "2015-01-01".

3.6.1.2 D2-SITE INFORMATION

Main stream: Note the main river basin according to national or EU standard. For streams without their own number, the adjacent are to be noted.

Watercourse: Name and watercourse ID number according to national or EU standard. If the name is missing in these registers, it is to be taken from a map. Otherwise a local name is to be noted.

Reach number: The reach number. Reaches are numbered from the lowest and upwards within each stream. The reach is to be noted in the GIS layer as well.

Migration barrier number: The barriers are demarcated and numbered from the lowest and upwards within each watercourse. The barrier number is noted in the protocol and in the GIS layer.

Photo: State the number code for the photos taken, (for example 001-004). How to number the photos are optional.

Site: A name for the site is to be noted, if applicable, for example the Mill Pond.

Coordinate system: Note which coordinate system that is used for spatial identification.

N-coordinate: The N-coordinate for the site is to be noted.

E-coordinate: The E-coordinate for the site is to be noted.

3.6.1.3 D3-MIGRATION BARRIER INFORMATION

Type of migration barrier: The type of barrier: is to be noted as the most fitting of the alternatives in Table 2-21. A beaver dam is counted as a natural barrier. Other natural barriers can be e.g. Waterfalls or flat rocks.

Natural falls and other natural barriers are often valuable environments, and thus noteworthy under D8-Notes.

Table 2-21. Type of barrier to be stated during river habitat survey according to Protocol D.

Type of barrier
Dam
Fish grid
Natural barrier
Discharge in lake
Culvert
Road passage
Eel hatch
Other barrier

Total drop: The migration barrier's total drop is measured/estimated and noted in metres. If there are several terraces, they are counted together to a common height. The total drop is to give an idea of the height to take into account if a fishway is to be built. Therefore, the total drop is measured in the optimal location for building a fishway in the stream, if there are several channels. Stated in metres with one decimal.

Discharge classification: An assessment if the discharge is high, average, or low on a yearly basis is made and noted as Low, Average, or High. See the description under Protocol A for division between the classes.

Length of the crest of the dam: The length of the crest of the dam is measured across the stream, noted in metres with one decimal.

Width of the crest of the dam: The width of the crest of the dam is measured in the direction of the stream, noted in metres with one decimal.

Number of spillways/culverts: The number of spillways in dam or the number of culverts at, e.g. road passages is noted.

Dry stream: Occurrence of dry streams are noted as Yes, No, or Not assessed. Dry stream means the drained part of the channel at the barrier, for example a dry channel in parallel with a power station, which is the most common type.

Dry stream, length: Note the length of the dry stream in metres, if applicable.

Natural barrier: An assessment whether the barrier originally was a natural barrier. Noted as one of the alternatives in Table 2-22. Since it often is difficult to assess, Yes and No can be combined with the amendment Uncertain.

Table 2-22. Alternatives to be noted in assessment whether the migration barrier is natural or not in river habitat survey, according to Protocol D.

Code	Description
Yes	The migration barrier is natural
Yes, uncertain	The migration barrier is probably natural
No	The migration barrier is artificial
No, uncertain	The migration barrier is probably artificial

3.6.1.4 D4-CULVERT

The variables below are assessed for culverts (road culverts and other culverts).

Culvert, length: Culvert length in metres with one decimal.

Culvert, diameter: Culvert diameter in metres with one decimal.

Culvert, speed: Water speed in metres per second with two decimals.

Culvert, bed material: Note if there are natural material, (e.g. sand, gravel, or stones) in the culvert (noted as Yes), or unnatural materials (e.g. quarried stone, or concrete), (No).

Culvert, drop by outlet: The drop by the outlet, (Figure 2-29), is noted in metres with one decimal, (the distance from the culvert's inner edge to the water surface below the culvert).

Culvert, free end: Occurrence of a free end is marked as Yes, or No. Free end means that there is a fall at the outlet side and that the culvert's lower edge do not connect to any substrate, but protrudes freely, (Figure 2-29).

Culvert, pool below: The occurrence of a pool (basin) below the culvert, were the water falls, is stated as Yes or No. (Figure 2-29).

Culvert, outlet depth: Note the water depth downstream from the culvert in metres with one decimal, (Figure 2-29). If there is a pool downstream from the culvert, the depth of the pool is measured, otherwise the depth is measured just downstream from the culvert.

Culvert, depth: The water depth inside the culvert is noted in metres with at most two decimals.

Bed with terrace possibility: Note if the bed downstream has a terrace possibility, i.e. If it is possible to place a terrace downstream to increase the passability. State Yes or No.

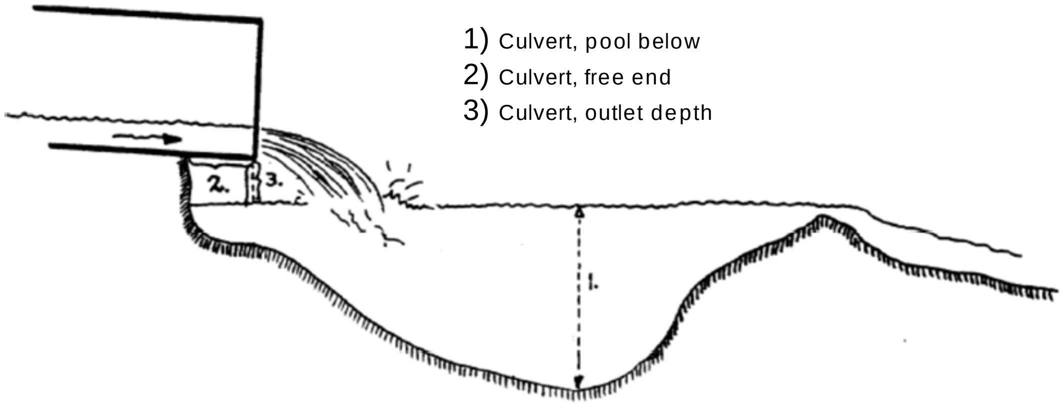

Figure 2-29. Illustration of the variables Culvert, drop by outlet: (3), Culvert, free end (2), and Culvert, pool below (1), and Culvert, outlet depth (1), included in Protocol D.

3.6.1.5 D5-FISH INFORMATION

Assessment of the variables Passability trout and Passability roach are among the most important parts in Protocol D.

To make an assessment, basic knowledge is required about how different types of migration barriers can hinder different types of fish. Important parts for assessment is drop, the water's speed, and occurrence of pools below falls, and the bed structure by for example culverts.

Passability trout: Assess the possibility for trout to pass upstream. The variable aims at describing the passability for trout and other fish with the same ability to pass barriers. The passability is noted as partially or definitely passable, according to the codes in Table 2-23.

Table 2-23. Alternatives to be noted in assessment whether the barrier is passable or not, during river habitat survey, according to Protocol D.

Code	Passability	Description
0	Passable	The barrier is passable, (only noted for trout).
1	Partial barrier	The barrier is passable under certain advantageous conditions.
2	Definitive barrier	In all probability, the barrier may not be passed under any conditions

Passability, roach: The variable aims at describing the passability for fish, which cannot force barriers as easily as trout. The variable is assessed in the same manner as the variable Passability, trout, but the assessment concerns roach and other fish with the same ability to pass barriers. For this variable, 0-Passable cannot be noted, (since that would have implied that no barrier existed).

Fine mesh screens: Yes or No is noted if there are fine mesh screens or not at hydroelectric power stations, (fine mesh screens have 20 mm bar space or less).

Injuries: An assessment if fish are injured during passage past the barrier in the flow direction is carried out and noted as Yes or No. Injuries can occur, e.g. if the water falls with high velocity towards a flat rock. A hydroelectric power plant without working fine mesh screens (around 20 mm bar space) is noted as Yes.

3.6.1.6 D6-USAGE

Current usage: Note what the structure currently is used for. Noted as a code, according to the alternatives in Table 2-24. Choose the most suitable alternative. Wetland dam is a relatively low damming rendering shallow water level or only wet parts within the dammed area.

Table 2-24. Alternatives to be noted in assessment of the current usage of a barrier during river habitat survey, according to Protocol D

Code	Description
1	Road passage
2	Dam
3	Hydroelectric power station
4	terrace for lake surface
5	Calibrating flow measuring
6	Water inflow
7	Road, not for vehicles
8	Mirror pond
9	Bathing area
10	Wetland dam (significantly shallow pond)
11	Fish farm
12	Eel hatch
13	Sawmill pond
14	Mill pond
15	Nothing (no working or broken barriers)
16	Other
17	Do not know
18	Beaver damming

Previous use: If possible, note previous use of the barrier in the same manner as the variable Current use. For example, if the present use is noted as Nothing, the previous use can be noted as a mill pond if it concerns a partly demolished mill pond.

Cultural heritage, barrier: Note if the construction may be of interest from a cultural heritage point of view. The demarcation may be difficult, but a rule of thumb is that there should be something interesting and noteworthy. A demolished mill pond can be noted, but a relatively modern concrete dam should not. Noted as one of the alternatives in Table 2-25.

Table 2-25. Alternatives to be noted in assessment whether a barrier or buildings in the vicinity are cultural heritage.

Code	Description
0	No
1	Unsure
2	Yes

Cultural heritage, building: Note if buildings in the vicinity could be of interest from a cultural environment point of view. Noted according to Table 2-25.

Owner: If possible, state name, address, mail address, and phone number to the owner or other contact, (tenant, company). Free text (maximum 255 characters).

3.6.1.7 D7-MEASURES

Possibilities: An assessment whether there are possibilities to make the barrier passable for trout and other fish is made. One of the alternatives in Table 2-26 is chosen. If "Other measure" is chosen, the measure proposal should be commented under Comments.

In many projects the ambition is not to create finished measure proposals, then it is not necessary to fill out the measure proposal. Make a note of possible measures to be carried out under Comments instead.

Table 2-26. Alternatives to be noted in assessment of suitable measures at barriers during river habitat survey, according to Protocol D.

Code	Measure
0	Difficult to improve passability
1	Demolition
2	Fishway/ladder
3	Fauna passage
4	Half-culvert instead of culvert
5	Placing a pool downstream (usually by terracing)
6	Natural channel in the stream (inlet)
7	Terracing
8	Demolition in combination with restoration of natural terraces
9	Demolition in combination with construction of an artificial terrace or riffle reach
10	Other measure

Roads: The accessibility is important if any measures are to be carried out, therefore it should be noted if there is a road leading up to the barrier, (Yes/No).

3.6.1.8 D8-FISHWAYS

Fishway: Note if there is a fishway around the barrier. Noted as Yes or No.

Type of fishway: Note the type of fishway, if any. Free text (maximum 255 characters).

Function: Note the function of the fishway. Free text (maximum 255 characters). On assessment it is important to consider that the function may vary depending on the flow.

3.6.1.9 D8-OTHER

Comment: Other noteworthy information. It can be anything from biological information to further comments about the barrier itself. Free text, maximum 8,000 characters.

3.6.1.10 D9-SKETCH

Sketch: A sketch of the barrier may well be drawn. The ambition level should be on the level of the inventory project.

The sketch should include all channels, dams and other constructions, as well as connecting roads, scale, north arrow, and flow direction. Photo angles and photo numbers should be drawn in.

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5 Appendix 1-Field Manual Protocol A - Water biotope

The field manual is an abbreviated version of the method description for Protocol A and D. The field manual is intended for use in the field, or to give a better overview in other contexts.

Variable/heading	Instruction	Response alternatives
Part 1 - Variables to be filled out for every stream		
A1-SURVEY		
Organisation	The organisation responsible for the survey.	Free text, maximum 50 characters
Inventory personnel	Name of the person/persons carrying out the survey.	Free text, maximum 50 characters
Date	Note the date for the field inventory of the reach.	In the format "2015-01-01"
A2-LOCAL INFORMATION		
Main watercourse	Note the river basin according to national or EU standard	According to national or EU standard
Watercourse	Name and ID number for the stream, according to national or EU standard	According to national or EU standard
Reach no	The number of the reach. Reaches are numbered from the lowest and upwards within each watercourse. The segment is to be noted in the GIS layer as well. Each reach should be of the same hydromorphological base type and have the same degree of human impact. If the changes are significant, a new reach Is made.	From 1 and up
Coordinate system	Note which coordinate system that is used	Free text, maximum 50 characters
Start coordinate N	Note the N coordinate for the start of the reach according to national standard.	
Start coordinate E	Note the E coordinate for the end of the reach according to national standard.	
End coordinate N	Note the N coordinate for the end of the reach according to national standard.	
End coordinate E	Note the E coordinate for the end of the reach according to national standard.	
Discharge classification	An assessment if the discharge is high, average, or low on a yearly basis is made and noted as Low, average, or High.	Low/Average/ High
Divergent ambition level	If a reach inventory is performed less carefully in the field, this must be noted. The deviation is to be saved under A18 – Additional information. Only to be used if it will not affect the quality of the survey result.	Yes/No

A3-HYDROMORPHOLOGICAL TYPE, PLANFORM		
HyMo type	State the hydromorphologic base type for the reach. Base type must always be noted, subtype is optional. The flowchart in Appendix 3, and the table in Appendix 4 is to be used for assessment. Noted as a letter combination, (e.g. Aa or Ax if the subtype is not noted). If the reach is a multichannel stream, is anastomosing, or if the morphology is formed by large woody debris or beaver, an amendment is to be appended to the letter combination, (M, A, LWD, BMC). The amendments may be combined in the following manner: M, MLWD, MBMC, A, ALWD, ABMC, LWD, and BMC, (e.g. ExALWD).	Zz Ax/Aa/Ab/ Bx/Bc/Bs/Bp/Bl Cx/Ct/Cr Dx Ex Fx Px (plus, any amendments)
Original HyMo type	Note the original type in the same manner as the variable HyMo type. Original type means the type before the stream was affected by human activity. Amendments are noted as well. The amendments LWD, BMC are difficult to assess, and must only be noted if there are signs in the field that the morphology has been affected by large woody debris or beaver.	According to the variable HyMo type or Missing
Valley confinement	Note the confinement of the valley, based on Confinement degree (CD) and Confinement index (CI). On assessment of CD and CI, only active flooding areas should be included, (floodplains, mires, marshes, and other areas around which are flooded at least every ten years). Areas that no longer are flooded are not included, with entails that incised streams and other streams that are more incised than previously could have a higher confinement than before the impact. Noted as one of the following alternatives, (the values within parentheses concern streams with several parallel channels): **Vh High confinement**. CD>90% **Vh High confinement**. CD 10-90 % <u>and</u> CI ≤ 1.5 **Vm Moderate confinement** CD 10-90 % <u>and</u> CI ≤ 1.5 **Vm Moderate confinement** CD<10 % <u>and</u> CI ≤ 5 (2) **Vl Low confinement**. CD <10 % <u>and</u> CI ≤ 5 (2)	Vh/Vm/Vl
Original confinement	Note the original type, (before the stream was affected by human activity). Noted as the variable Valley confinement. For example, “Incised alluvial streams” could be classified as Vh at present, but with Vl as the original confinement. The assessment is usually made in connection to assessment of the variable HyMo type.	Vh/Vm/Vl Missing
Planform	Note the appearance of course/planform. A visual assessment is sufficient. The assessment is made for a part of the stream, at least 20 stream widths long. Noted as follows: **A Straight to weakly curving stream.** Sinuosity 1-1.05. **B Winding or weakly meandering l**. Sinuosity 1.05-1.3 **C Meandering furrow**. Sinuosity >1.3 **D Branched stream**. There are at least two channels along the major part of the reach. **E Braided river**. There are several channels, separated by moving middle banks.	A/B/C/D/E

A4-LENGHT, WIDTH, DEPTH		
Length	Note the length of the reach. Usually calculated in GIDGIS. Short reaches can be paced out/measured in the field.	Number of metres
Average width	Note the average width during normal low discharge. The width is measured or estimated.	Number of metres (1 decimal)
Minimum width	Note the minimum width during normal low discharge.	Number of metres (1 decimal)
Max. width	Note the maximum width during normal low discharge.	Number of metres (1 decimal)
Average water depth	Note the average depth. Measured or estimated in the field.	Number of metres (2 decimals)
Max. water depth	Note the maximum depth during the visit. Measured or estimated.	Number of metres (2 decimals)
Area	The reach area is calculated as the average width times the reach's length.	Number of square metres
A5-BED SUBSTRATE		
	The coverage of different bed substrates is noted as Classes. The classification is the same as for flow condition, water vegetation, and shadowing. The dominating substrate is noted as class 3, (even if it does not cover more than 50%). **Class 0** Missing or insignificant presence **Class 1** <5% coverage **Class 2** 5-50% coverage **Class 3** >50% coverage	
4,000	Flat rock, >4,000 mm.	0-3
200	Boulder, 200-4,000 mm.	0-3
63	Stones, 63-200 mm	0-3
2	Gravel, 2-63 mm	0-3
0.063	Sand, 0.063-2 mm	0-3
0.002	Silt, 0.002-0.063 mm (2-6,3 µm)	0-3
<0.002	Clay, <0.002 mm (<2 µm)	0-3
Fine detritus	More or less decomposed organic material	0-3
Coarse detritus	Leaves, branches, logs, or similar wood not decomposed	0-3
Artificial materials	Artificial materials, for example crushed stone, concrete, bricks	0-3
A6-WATER VEGETATION		
	The coverage ratio for plants and the coverage in total of the water vegetation and freshwater sponges are to be noted on the same scale as bed substrate.	
Coverage in total	The water vegetation's total coverage ratio in the reach.	0-3
Rooted and/or amphibious emerging plants	Examples: common reed, rush.	0-3
Floating plants	Examples: yellow water-lily, Floating pondweed.	0-3
Free-floating plants	Examples: duck weed, frogbit, Common bladderwort.	0-3
Submerged broad-leaved plants	Examples: perfoliate pondweed, Shining pondweed	0-3
Submerged *Myriophyllum* plants	Example: water-milfoil	0-3
Rosette plants	Example: water lobelia	0-3
***Fontinalis* or similar species**	Concerns water moss, (the *Fontinalis* species), or other moss species with similar living conditions.	0-3
Other moss species	Concerns moss species, living in the stream.	0-3
Philamentous algae (e.g. *Cladophora*)	To be noted if a significant number is present, since it usually indicates some kind of impact. Otherwise Cladophora algae do not need to be noted.	0-3

Periphyton algae	Only to be noted if there are something above the usual, such as species in the *Nostoc* family or there are extensive masses of any species. The growth is to be heavy and noted visually, not just felt.	0-3
Fresh-water sponges	Concerns freshwater sponges (to be noted, although they are not plants).	0-3
Examples of species	Note examples of species/families. Note only if a relevant determination of species can be performed. In other cases, the field may be left empty. To note the species followed by a question mark is also possible.	Free text, maximum 255 characters
A7-DISCHARGE CONDITIONS		
	The coverage is to be noted on the same scale as bed substrate. The assessment is primarily carried out from the appearance of the water and the water turbulence. The dominating flow is noted as Class 3, even if it does not cover more than 50%.	
Calm water	Water with little turbulence. In some places there may be eddies, but not to such extent as in weakly flowing water.	0-3
Glide	Weakly flowing water moves slowly and have some turbulence in the form of eddies. No waves on the surface, but there are riffles if the stream is shallow.	0-3
Run/Riffle	The water is significantly more turbulent than weakly flowing water. The flow speed is relatively high, but lacks standing waves, breaking the surface. The sound level is relatively low, with gurgling or clucking sounds.	0-3
Rapid	The water flows relatively fast downstream and extensive turbulence occurs with breaking waves forming white-water. The sound level is relatively high.	0-3
A8-SHADOWING		
Shadowing	How large amount of the stream surface is shadowed is noted on the same scale as bed substrate. The assessment is to be made from the estimated shadowing at 13.00 at summer solstice, in full sunlight.	0-3
A9-LARGE WOODY DEBRIS		
Large woody debris (number)	The occurrence of large dead woody debris (pieces of wood with a diameter >0.1 metre, length >1 metres. To be included the wood must be along the stream's edges, in the water or across the water. The wood may occur above the surface if it is within the edges of the stream, (it may not be to the right or left of the stream's edges). Dead trees on root, hanging over the stream are to be counted.	Number of
Large woody debris (number/100 m)	Calculated by dividing the value of "Large woody debris (number)" with the length of the reach, multiplied with 100 (calculated after the field work).	Number per metre, (1 decimal)
A10-CLEARED/IMPACT		
	The variables below are to be assessed for each reach. Several types of impact can be combines.	

Clearing	The clearing ratio of the stream is noted as one of the alternatives below. In river habitat survey, clearing entails that substrate has been removed from the stream, manually or by machine, that the bed structure is homogenised, or that the stream has been restructured in another manner. Clearing of large woody debris is not included here. **Class 0** The reach is not cleared. **Class 0** The reach is carefully cleared. The changes in the reach are so small that the ecological function is maintained. **Class 2** The reach is heavily cleared. The reach is clearly changed, and the original ecological function is/may be expected to be severely disturbed. **Class 3** The reach is redug and/or straightened. The water course is changed and the ecological function in the reach is/may be expected to be severely disturbed or completely eradicated. In many cases the clearing can be seen in an aerial photo.	0-3
Culverted	Marked as Yes in the protocol if the stream runs through a culvert. Short reaches, such as culvert do not have to be noted.	Yes/No
Filling	Marked in the protocol if the shore and/or the stream is filled out with infill or similar. May also be noted for heavily cleared streams if the cleared masses are on the shore, functioning as infill.	Yes/No
Flooding protection	Flooding protection is noted if the shores in full or partially consist of embankments or similar to stop flooding during high water.	Yes/No
Dam	Marked if the reach is an artificial dam. Includes dammed areas where the water surface has increased significantly and dug dams.	Yes/No
Dammed	Marked as Yes for reaches upstream from a dam (a dammed area), where the gradient of the reach is changed to a flatter gradient. Do not include beaver dams.	Yes/No
Tributary cut-off	Noted if a tributary is cut-off.	Yes/No
Dry stream	Noted if the reach is drained all year, or parts of the year, due to the water being channelled away by human activities. To be noted, even if there is a minimal tapping into the gully. Dry stream is not to be noted for reaches with downstream constructions, such as reaches downstream from hydroelectric power stations with zero tapping.	Yes/No
Regulated discharge	To be noted if the discharge is regulated somewhere upstream. To be counted as regulated, at least 15% of the discharge must have a significant regulation. No is also noted if you are sure that it is isn't regulated. May also be noted as Do not know, or Not assessed.	Yes/No/Do not know/Not assessed
A11-UPSTREAM IMPACT		
Upstream impact	If any impact (e.g. clearing or a dam) is noted under A10-Cleared/impact, and it is of importance for the morphology in one or more reaches situated upstream, it must be noted as Yes, otherwise No. One example is if a reach is cleared and the bed is lowered, and that intervention impacts one or several reaches upstream. The note in the protocol is made for the reach where the intervention is.	

A12-FLOODING AREAS		
Flooding frequency/ ground water level	The variable is assessed for all reaches were moderate or low confinement have been noted for the variable Original confinement. The variable describes if human impact has led to a reduced flooding frequency and reduced ground water level for flooding areas on the sides. The assessment is made on a four-degree scale: **Class 0:** No reduction. **Class 1**: Moderately reduced flooding frequency/Moderately reduced ground water level. **Class 2**: Severely reduced flooding frequency/Severely reduced ground water level. **Class 3:** Very severely reduced flooding frequency/Very severely reduced ground water level.	0-3
Physical impact on flooding area	The variable is assessed for all segments were moderate or low confinement have been noted for the variable Original confinement. Assessed according to the same principles as the assessment of clearing under A10-Cleared/impact. The assessment is made on a four-degree scale: **Class 0**: Natural, unaffected conditions. **Class 1**: Moderate impact. Impact may consist of small ditches, e.g. **Class 2**: Severe impact. The floodplain is visibly changed, and the original ecological or hydromorphological function is/may be expected to be severely disturbed. Impact may consist of severe drainage, filling of hollows, and similar. **Class 3**: Very severe impact. The original ecological or hydromorphological function is/may be expected to be severely disturbed. Impact may consist of filling, presence of buildings, and similar.	0-3
A13-STRUCTURAL ELEMENTS		
	If any/some of the structural elements below are found in the reach they are to be noted.	
Inflowing streams	Note the number of inflowing streams to the reach (water flowing during a major part of the year).	Number
Neck	A short element, (<30 m), with riffles in a reach with calm water can be noted as a neck. The purpose is to reduce the need for reach demarcation. If the neck is a controlling section in a shallow stream or in other ways significant for the geomorphology, reach demarcation may be needed anyway.	Number
Pool	Shorter inserts, (less than 30 m), with calm waters in reaches with riffles can be denoted as pools. The purpose is to reduce the need for reach demarcation.	Number of
Lake outlets	State the number of lake outlets.	Number
Lake inlets	State the number of lake inlets.	Number
Confluence	State the number of confluences, (the area where two streams are joining). The river basins in both streams are each to be larger than 20 km^2 to be counted as a confluence.	Number

Oxbow lake	Note the number of oxbow lakes. Concerns oxbow lakes in hydrological contact with the stream, as well as those completely isolated.	Number
Delta	State the number of deltas. Consists of a low, flat area of land, raised by discharge in a lake. To be noted, the area must exceed one hectare	Number
Brink/steep sandy bank/slide scars	Note the number of brinks, steep sandy banks, and slide scars. The surface must be at least ten square metres. Not to be mistaken for other forms of erosion.	Number
Seepage area/spring	Note the number of seepage areas and springs. Heavy impact from springs should be commented under A18 – Additional information.	Number
Reaches with many boulders	Stream reaches, at least 50 m long, where boulders are the dominating bed substrate, are to be noted.	Yes/No
Rapids/falls	The number of rapids and waterfalls, unaffected by clearing, canalisation, and water regulation, are noted	Number
Ravine	Noted if the stream is surrounded by steep shores. The difference in height between the stream and a point 25 metres from the stream should exceed 5 metres.	Number
Steep slope	Noted if either shore is very steep. The difference in height between the stream and a point 25 metres from the stream should exceed 5 metres.	Number
Overflowed cliffs	Note if there are cliffs from neutral to mafic rock (for example slate, greenstone), overflowed by ground water or kept moist in the littoral zone by streams.	Number
Open beaches	Note if there are open beaches, caused by glacial erosion, water level fluctuations, or grazing.	Number
Sand beaches	Note if there are open, vegetation-free, minerogenic sand beaches, affected by water level fluctuations. Also concerns the stream outlet in a lake.	Number
Mowed or grazed shore meadows	Note if there are mowed or grazed shore meadows. Also concerns the stream outlet in a lake.	Number
Flooded forest	Note if there is regularly flooded alluvial forest.	Number
Meandering stream reaches in the agricultural landscape	To be noted if the stream meanders in an agricultural landscape and the sinuosity is at least 1.5.	Yes/No
Beaver damming	State the number of beaver dams. If there are many, the number is estimated.	Number
Tributary	Note if the reach is a tributary.	Yes/No
Lake reach	Note if the reach runs through a lake. Then, the reach is not to be mapped, but may be included in GIS, in that case it is marked here.	Yes/No
Subterranean stream reaches	Note if the reach flows underground. Do not apply to culverted reaches.	Yes/No
Stone foundations	State the number of stone foundations. Concerns old mills, stone circles, bridges, dams, etc. that are more or less in ruins.	Number
Other dam residue	State the number of dam residues not constituting barriers.	Number
Stone bridge/ruins of	State the number of stone bridges and ruins of stone bridges.	Number
Dam building of stone	State the number of dam buildings of stone.	Number
Cultural heritage	State the potential cultural heritage values on or in connection to the reach.	Number
Ditch	Note the number of ditches discharging into the reach.	Number
Drainage	Note the number of drainages discharging into the reach. Concerns ordinary drainage ditches on arable land, other covered ditches, drainage pipes, run-off	Number

	pipes. Can be difficult to see, but it is sufficient to note the ones seen.	
Sewage pipes	Note the number of sewage pipes discharging into the reach.	Number
Water abstraction	Note the occurrence of water abstraction.	Number
Crossing road	State the number of roads, passable by car.	Number
Other	Note other structural elements, assessed to be of importance for the stream.	Free text, maximum 255 characters
A14-NON-NATIVE SPECIES AND COMMON REED		
Non-native plant species (biotope)	If non-native plant species, have a significant negative impact on the ecology, it must be noted. For example, *Glyceria maxima* is to be noted, since it often has a significant impact on the stream characteristics. Concerns the stream as well as the local environment.	Yes/No
Non-native animal species (biotope)	If non-native animal species, that have a significant negative impact on the ecology, it must be noted. Concerns the stream as well as the local environment.	Yes/No
Common reed	If common reed is present, it must be noted if it is assessed to be of importance to the biotope characteristics, <u>and</u> if it is assessed to occur in a higher amount than naturally.	Yes/No
A15-FLUVIAL PROCESSES		
Dominant fluvial process	Describe the fluvial processes with the most fitting of the alternatives below. Stable does not mean a completely fixed stream, it also includes natural, meandering streams with a slow change around an equilibrium. Indicators is to be used in the assessment (Appendix 6-Indicators for fluvial processes). Remember that there might be indicators pointing at different conditions, due to different impacts on different parts of the reach, and that the reach has passed through different phases, and that some indicators are changing slowly, (e.g. indicators, based on vegetation). For TL reach the assessment is to be noted under A18-Additional information. When peat streams are assessed, the natural sedimentation from organic material are not to be noted as sedimentation, only if there is a significant rise of the bed and similar, following an unnaturally higher sedimentation ratio. **0** Stable conditions **1a** Shore erosion on one side **1b** Shore erosion on both sides **2** Bed erosion **3a** Bed erosion in common with shore erosion on one side **3b** Bed erosion in common with shore erosion on both sides **4** Sedimentation/aggradation (concerns raising of the bed, not thin layers of sediment) **5** Sedimentation/aggradation in common with avulsion **6a** Sedimentation/aggradation in common with shore erosion on one side **6b** Sedimentation/aggradation in common with shore erosion on both sides	0/1a/1b/2/3a/3b/4/5/6a/6b

Stability	The variable is a complement to the Dominant fluvial process variable since it shows the strength of any instability. If Stable conditions is noted for Dominant fluvial process it is to be noted here as well. In other cases, class is stated as below. The assessment concerns instability caused by human activity, not a natural shift of meanderings and similar. The indicators in Appendix 6 and other variables describing the entirety, (e.g. changes in controlling sections, channel evolution phase) are used for the assessment. **0** Stable conditions **1** Weak instability **2** Moderate instability **3** Severe instability	0-3
A16-MEASURES		
	Under A16 needs for measures and measure proposals are noted. This only concern measures leading to a more natural condition for the stream. The basic principle for assessment of needs and suitable measures is that the measures must lead to a status improvement for the quality element River Continuity or the quality element Morphologic condition in streams according to the Water Framework Directive or in other ways leading to a more natural condition. Measure with the purpose of increasing the fish production or only to improve the conditions for a certain species, but not improving the natural conditions as above, can be noted under A18-Additional information. Measures only concerning barriers should be noted in Protocol D, but a reference to Protocol D must be noted. In Appendix 9-Examples of measures are shown, as well as examples of measure proposals. For the variable Measure requirements Yes or No can only be noted if the required material and competency to assess if a measure is needed exists. The same applies for the Measures variable. In other cases, Do not know, or Not assessed can be noted.	
Measure requirements	Note if there are any needs for measures. May also be noted as Do not know, or Not assessed.	Yes/No/Do not know/Not assessed
Measures	Note measure proposals. May also be noted as Do not know, or Not assessed.	Free text, maximum 255 characters/Do Not know/Not assessed
Stocked natural stone	Note if there are stocked natural stone or boulders that can be used for measures.	Yes/No/Number m^3
Stocked quarried stone	Note if there is quarried stone that can be used for measures	Yes/No/Number m^3.
Performed measures	If any measure has been carried out where the objective was to improve the environment, it is to be noted. The measure should be commented Under A18-Additional information. Measures, aiming at improvement, which have had a negative impact, are to be noted, for example sediment traps causing barriers.	Yes/No
A17-PHOTOS		
Photos	Note the number code for the photos taken.	Numbered according to optional system

A18- ADDITIONAL INFORMATION		
Additional information	Note other information, e.g. any threats to the premises, interesting plants or animals, information about fluvial processes or key biotopes. In some cases, it may be proper to write a summary of the river habitat survey and an overview description of the stream. This is made under Additional information in the Protocol for reach 1. The following notations must always be made: • The variable Dominant fluvial process must always be commented for TBTL streams. • If Yes is noted for the variable Divergent ambition level, it must be commented here. • If a Weakly cleared controlling section, Heavily cleared controlling section, Culvert, Road Passage, Dam, Other unnatural damming controlling section, Other unnatural controlling section, or controlling section with regulatory possibility is noted under A19-Controlling sections, its impact on the fluvial processes for the upstream area and surrounding wetlands is to be commented. If all controlling sections are not noted in GIS, that deviation is also to be noted. • When a structure stops the migration upstream due to head cut erosion (see A20-Knickpoint/Knickzone), it should also be commented under Additional information, since a change of the structure, (for example a change to half-culvert), will cause the knickpoint to continue the upward migration.	Free text, maximum 8,000 characters

Part 2-Variables to be filled out for TL reaches and peat reaches		
A19-CONTROLLING SECTIONS		
	All controlling sections of importance for the reach is to be noted. Controlling sections are often outside the reach in question but are to be noted in the Protocol for the reach/reaches it affects. Dammed controlling sections are noted in numbers, and in GIS. Dammed or completely drained controlling sections are to be noted, even if they do not function as controlling sections during the conditions at present, from a hydraulic point of view. Changes in the local base level are to be noted as well, it is almost always related to changes in controlling sections. It may also be caused by discharge into another stream with changed base level or a lake with changed level (lowered or dammed lake). If a Weakly cleared controlling section, Heavily cleared controlling section, Culvert, Road Passage, Dam, Other unnatural damming controlling section, Other unnatural controlling section, or controlling section with regulatory possibility is stated, the impact on the fluvial processes for the upstream area and surrounding wetlands is to be commented under A18-Additional information. It is important to remember that a controlling section, as well as any impact in the controlling section may have effects far upstream, rather often all the way up to the next controlling section upstream. Sometimes even longer, due to a so-called "drowned-out effect". Sometimes there are controlling sections downstream of reach 1, (outside the mapped area). E.g. if a reach outlet is in a lake. Then, the controlling section is to be assessed in any case and a notation for the variable Outside the demarcation is to be made.	
Unaffected controlling section of stone, boulder, or similar	State the number of controlling sections.	Number
Beaver damming	State the number of beaver dams.	Number
Large woody debris	State the number. To be included the wood must have a clear impact upstream during high flow and be permanent. The smaller the stream, the higher the risk for large woody debris to function as a controlling section.	Number
Other unaffected controlling section	State the number.	Number
Weakly cleared controlling section	State the number.	Number
Heavily cleared controlling section	State the number.	Number
Culvert	State the number.	Number
Road passage (not a culvert)	State the number.	Number
Dam	State the number.	Number
Other unnatural damming controlling section	State the number. Concerns terraces created by humans, not dams, but having a significantly damming effect.	Number

Other unnatural controlling section	State the number.	Number
Controlling section with regulatory possibility	State the number. Concerns controlling sections where the basic level can be regulated, for example a dam with adjustable hatches.	Number
Outside the demarcation	Note if at least one of the controlling sections are outside the demarcation of the area for the river habitat survey, i.e. below reach 1.	Yes/No
Base level drop	Assess if, and how much of the local base level is lowered through changes in fixed structures (thresholds/riffle reaches with stones, boulders or flat rocks, and lakes or larger watercourses where the stream discharges). Beaver dams, large woody debris, dams, and other structures, created by humans, are not included. The change is noted as the lowering, in metres (two decimals), of the base level, compared to the original condition.	Metres (2 decimals)
Changed base level in total	Assess if, and if yes, how much the base level has changed in total. The assessment is the same as for the variable "Base level drop", with the difference that this includes any occurring controlling sections and other things impacting the base level. The variable describes how much the current base level deviates from the original.	Metres (2 decimals)
A20-KNICKPOINT/KNICKZONE		
Knickpoint/ knickzone	The occurrence of a knickpoint/knickzone is to be noted as a number in the protocol and in the GIS layer as a point object. A knickpoint is a part of a river where there is a sharp change in slope or elevation. In most cases, the knickpoint originates from an increased slope or an emerging erosion process. The increased slope is often due to clearing of a controlling section or that the base level is lowered in another manner. Bed erosion by increased slope often begins at the lowest point downstream and the note has to show the demarcation between the lower are where the impact is highest and the areas upstream, not yet affected significantly by the erosion. Usually, there is only one clear knickpoint, but sometimes there are several. In general, a knickzone the same thing as a knickpoint, but the bend is longer and consists of a steep reach instead of a waterfall. During the inventory, there is no distinction between these types. Sometimes the knickpoint is a fall by a road passage or another structure, stopping the migration upstream. When a structure stops the migration upstream it should be commented under A18-Additional information since a change of the structure, (for example a change to half-culvert), will cause the knickpoint to continue migrating upwards. The term knickpoint usually includes natural waterfalls, but in the river habitat survey only knickpoints caused by human activity are to be noted, not natural water falls that are controlling sections.	Number

Part 3 - Variables only to be filled out for TL segments		
A21-FLOODING FREQENCY ON THE FLOODPLAIN		
.	The flooding frequency on the floodplain is assessed through the variables below. In the assessment it is important to distinguish floodplains from terraces. Terraces can consist of recent terraces, i.e. former floodplains where the flooding frequency is reduced, and flooding occurs less than every ten years. They can also consist of older terraces which are not flooded any more, due to natural causes	
Incision ratio	The incision ratio is calculated by dividing the height difference between the floodplain (active floodplain or recent terrace) and the thalweg with the maximum depth (maximum depth at a representative cross-section, not the maximum depth of the reach) during bankfull flow (here the same as channel-forming discharge). To assess the depth during bankfull flow, bankfull indicators are to be used. If the value is 1, the floodplain is active. Values above 1 indicate reduced flooding frequency. Sometimes the floodplain is higher on one side of the stream. Then assessment/measuring is to be made on lower side of the floodplain. It is important not to mistake a lower floodplain for a secondary floodplain that is lower as well.	Ratio (1 decimal)
Active floodplain	Noted if flooded at least every ten years. Cannot be combined with Yes for recent terrace	Yes/No
Recent terrace	Noted if the flooding frequency is reduced and flooding occurs less than every ten years. The assessment only concerns floodplains developed during the last 200 years, not older terraces which are not flooded due to natural causes. Cannot be combined with Yes for Active floodplain. If the floodplain is destroyed, (e.g. extensive filling), Recent terrace cannot be noted. If the impact on the floodplain is lesser, e.g. If it is restructured to arable land, it may be counted as a recent terrace.	Yes/No
Secondary floodplains	Note if there are secondary floodplains, i.e. young floodplains, often indicating instability and reduced flooding frequency. Note if they are assessed to indicate that the stream is affected. Not to be mistaken for sediment banks or slides. If it only occurs in a small part of the reach, (<30% of the length), state No.	Yes/No

A22-CHANNEL EVOLUTION PHASE		
Channel evolution phase	Channel evolution phase is noted, based on how the stream has changed due to any disturbance. Phase 1 represents unaffected conditions. The other phases represent the channel evolution phases a stream usually goes through after a disturbance. The first phases represent an early stage, while the last represents a new state of balance. The phases are noted according to one of the alternatives in Table 2-19. The phases are divided into four different main groups. First the most suitable main group is chosen. Then the most suitable phase is chosen. The assessment is to be commented under A18 – Additional information. It is important to consider that the phases are to be seen as conceptual model and in practice the stream's channel evolution do not always follow the patterns in the table. The division below only shows the main groups. **Phase 1** Stable system, in balance. The stream is in frequent contact with the floodplain. The bankfull indicators are around the same level as the floodplain. **Phase 2a-7a** Reaches, dominated by erosion, are affected by erosion, or reaches with a secondary floodplain, but not redug. Reaches in this group have to be on their way to a condition, deviating from the original. **Phase 2b-6b** Reaches, primarily affected by sedimentation, but not redug. **Phase 2c-7c** Redug reaches where the controlling sections are not affected, and the system's basic prerequisites are relatively unaffected. Streams which are not redug, but with similar channel evolution phases are included in this group. **Phase 2d-7d** Redug sections where the controlling sections have been lowered and/or the system's basic prerequisites are affected.	Phase 1 Phase 2a-7a Phase 2b-6b Phase 2c-7c Phase 2d-7d

Part 4 – Optional variables		
A26-TROUT BIOTOPE		
	An assessment of the stream's suitability for trout is made through three variables describing spawning area, growth area, and access to holding spot for larger fish. If the survey is carried out during high discharge, the assessment may be difficult due to the bed not being sufficiently visible, which should be commented under A18-Additional information.	
Spawning area	Assessed from the occurrence of gravel and stone in a sufficient fraction, and if there are banks of the material, suitable for trout spawning. Fry and parr usually do not move more than 100 m in the first summer. Thus, a spawning area is needed each two hundred metres for the area to be assessed as Class 3. Class 3 means that biotope measures cannot bring about any improvement of the trout's reproduction possibilities and that the access to spawning beds are not limiting the reproduction in the reach. Class 2 means that there are spawning beds, but that they are not good enough or not located close enough to each other. **Class** **Spawning areas** **0** Spawning possibilities missing **1** No visible spawning areas, but the right discharge conditions **2** Relatively good, but not optimal spawning possibilities **3** Good to very good spawning possibilities	0-3
Nursery areas	The assessment is primarily based on bed structure, flow condition, and secondly on shadowing and local environment. The assessment concerns prerequisites for this year's as well as last year's troutlets. When Class 3 is noted, biotope measures are not assessed as bringing about any improvement for the trout reproduction possibilities on the premises. **Class** **Nursery areas** **0** No suitable nursery area **1** Possible, but not good nursery area **2** Relatively good nursery areas **3** Good to very good nursery areas	0-3
Holding spots	The assessment concerns holding spots for larger (adult) trout, for example deep holes or larger boulders. When Class 3 is noted, biotope measures is not assessed to bring improved possibilities for larger trout to dwell on the reach. **Class** **Holding spots** **0** Missing (too shallow) **1** Possible holding spots for some larger trout **2** Relatively good conditions for larger trout **3** Good to very good conditions for larger trout	0-3
A28-DISCHARGE		
Estimated flow	The estimated discharge is noted in m^3/s.	Volume in m^3
A33-SLOPE		
Slope	The channel slope is calculated on a representative stretch within the surveyed reach. May be estimated in GIS-analysis.	Metres per 100 m (2 decimals)

The floodplain slope	The floodplain slope may be measured in the field or through GIS analysis. If there are steep, non-representative sections within the reach, they should not be included in the calculation.	Metres per 100 m (2 decimals)

A36-LOCAL ENVIRONMENT

The local environment is the area from the stream to a border 30 m from the shore. The left and right side of the local environment are assessed separately. Only the dominant type of land is to be noted. Codes of different land types to be noted are shown below.

Category	Code	Description
Forest	**CF**	Coniferous forest. Tree crown cover >30%.
	CD	Mixed coniferous forest. Tree crown cover >30%.
	D	Deciduous forest. Tree crown cover >30%.
Mountain	**M**	Mountain.
Clearcutting/ Reforestation	**C**	Clear-cut area, bare or trees less than 1.3 m (chest height)
Farm land	**F1**	Land used for agriculture.
	F2	Farm land, not being used for agriculture at the present.
	F3	Berry and fruit crops, energy forest/Salix crops.
Open land	**O1**	Grazed or mowed open land, (<30% crown cover).
	O2	Overgrowing open land, (<30% crown cover).
	O3	Wooded grazing land having a >30% crown cover but cannot be counted as forest.
Wetland	**WM1**	Open, grazed or mowed wetland (<30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WM2	Open wetland, (<30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WM3	Wooded wetland, (>30% crown cover), (marsh, marshy meadow, and similar, not bogs).
	WB1	Wooded bogs, (>30% crown cover).
	WB2	Open bogs, (<30% crown cover).
Artificial land	**A1**	Building plots.
	A2	Road with embankment
	A3	Industry and other impervious surfaces.
	A4	Agglomeration/buildings.
	A5	Other, permeable surfaces, e.g. golf courses, farm environments.

Dominating local environment, left	Note the code of dominating local environment on the left side of the river (walking upstream from the river mouth).	Land use codes

Dominating local environment, right	Note the code of dominating local environment on the right side of the river (walking upstream from the river mouth).	Land use codes
Land type on left floodplain	Land type on floodplain is noted in the same way as dominating local environment, but the assessed area is limited by the floodplain spread instead of the 30-metre limit for the local environment. If the floodplain is not active due to for example incision, the assessment is made for the recent terrace.	Land use codes
Land type on right floodplain	Assessed as Land type on left floodplain, but for the right side, walking upstream from the river mouth.	Land use codes
Protection zone left	If the local environment consists of at least 15% arable land or artificial land on the left side, the width of the protection zone is noted in metres. If the protection zone is missing, zero metres is noted. If there is not artificial land or if it is less than 15%, >30 m is noted. The protection zone can consist of forest, open land, or wetland. The width concerns the width between the stream's average water level and the arable/artificial land.	m
Protection zone right	Assessed as Protection zone, left, but for the right side.	m
Changed use of land on floodplain	Note significant changes in land use on the floodplain. Primarily, the impact on the fluvial processes is to be noted. Examples of land-use changes that should be noted: • Spruce has been planted on grazing land or meadows • Grazing land or meadows are growing over due to a ceased grazing or mowing • Broad-leaf forest has been replaced by spruce forest, (spruce has shallow roots, entailing bad conditions for stability) • Wooded floodplain has been cleared of trees	Free text, (maximum 50 characters)
Floodplain history	The floodplain history is commented if any information is of interest for the present biotopes, for example if the floodplain previously was used as arable land or if the floodplain's elevation is higher due to previous damming, (sedimentation on the floodplain).	Free text, (maximum 50 characters)

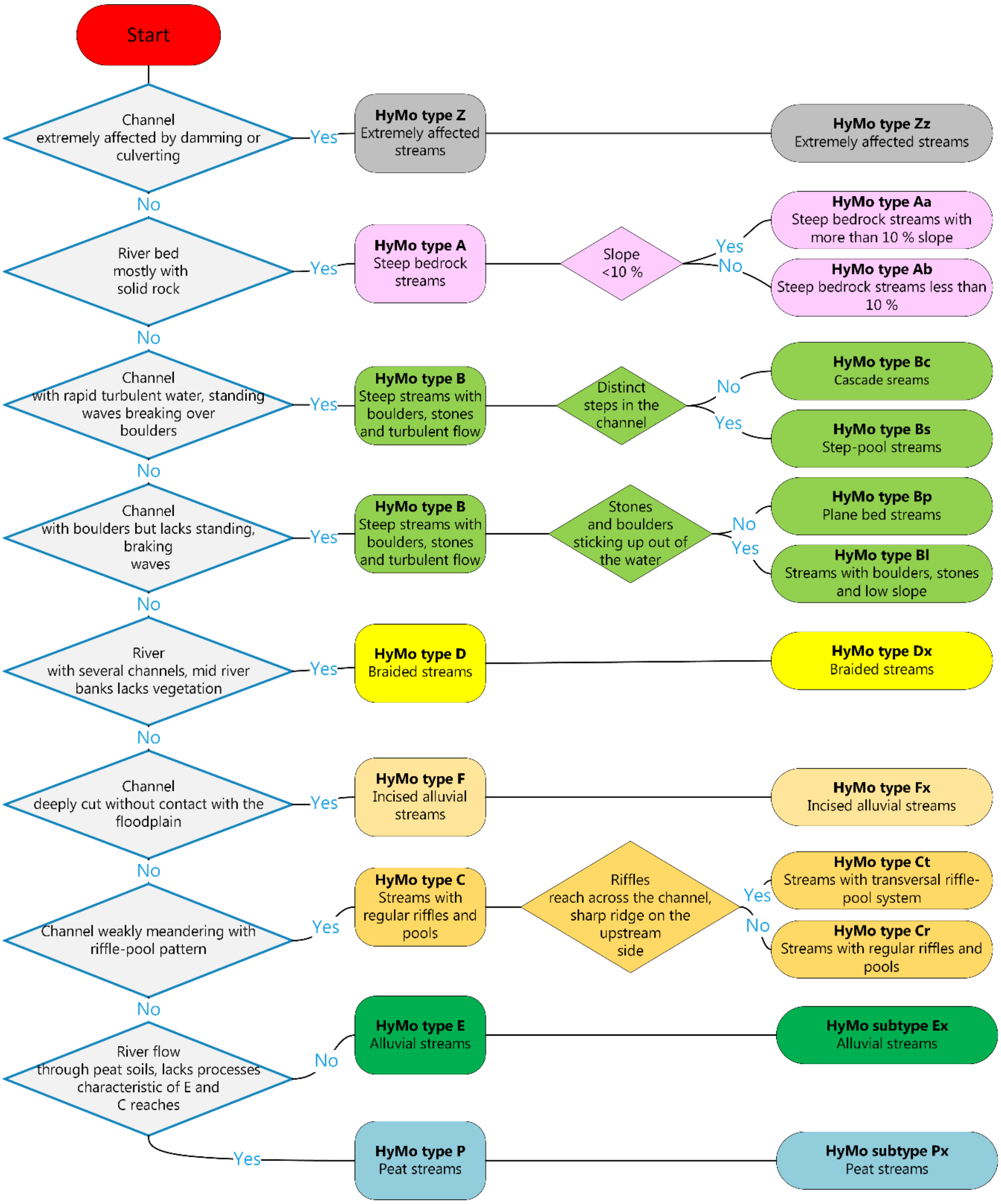
6 Appendix 2-Field Manual Protocol D Migration Barriers

Variable/heading	Instruction	Response alternatives
D1-SURVEY		
Organisation	The organisation responsible for the survey.	Free text, maximum 50 characters
Inventory personnel	Name of the person/persons carrying out the survey.	Free text, maximum 50 characters
Date	Note the date for the barrier inventory.	In the format "2015-01-01"
D2-PREMISES INFORMATION		
Main stream	Note the main river basin according to national or EU standard	According to national or EU standard
Watercourse	Name and ID number for the watercourse, according to national or EU standard	According to national or EU standard
Reach no	The number of the reach. Reaches are numbered from the lowest and upwards within each stream. The segment is to be noted in the GIS layer as well.	From 1 and up
Migration barrier number	The migration barriers are demarcated and numbered from the lowest and upwards within each watercourse. The barrier number is noted in the protocol and in the GIS layer.	From 1 and up
Photo	Note the number code for the photos taken.	Numbered according to an optional system
Site	A name for the site is to be noted, if applicable, for example the Mill Pond.	Free text (maximum 50 characters)
Coordinate system	Note which coordinate system that is used for spatial identification of the barriers	Free text (maximum 50 characters)
N coordinate	Note the N coordinate for the premises according to national standard	Free text (maximum 20 characters)
E coordinate	Note the E coordinate for the premises according to national standard	Free text (maximum 20 characters)
D3-BARRIER INFORMATION		
Type of migration barrier	Note the type of barrier as one of the available alternatives. A beaver dam is counted as a natural barrier. Other natural barriers can be e.g. waterfalls or flat rocks. Natural falls and other natural barriers are often valuable environments, and thus noteworthy under Comments.	Dam Fish lattice Natural barrier Discharge in lake Culvert Road passage Eel hatch Other barrier
Total drop	State the migration barrier's total drop (measured/estimated) in metres. If there are several terraces, they are counted together to a common height. The total drop is to give an idea of the height to take into account if a fishway is to be built.	Number of metres (maximum 1 decimal)
Discharge classification	An assessment if the discharge is high, average, or low on a yearly basis	Low/Average/High
Length of the crest of the dam	Note the length of the dam ridge, measured across the stream.	Number of metres (maximum 1 decimal)
Width of the crest of the dam	Note the width of the dam ridge, measured in the direction of the stream.	Number of metres (maximum 1 decimal)

Number of spillways/culverts	Note the number of spillways in dams or the number of culverts by, e.g. road passages.	Number
Dry stream	Not if dry streams occur (may also be noted as Not assessed). Dry stream means that a part of the channel is drained by the barrier, e.g. a dry stream in parallel with a power station.	Yes/No/Not assessed
Dry stream, length	Note the length of the dry stream, if applicable.	Metres
Natural barrier	Assess if the barrier originally was a natural barrier. State Yes or No. It can be difficult to assess if it is natural, therefore the answer can be appended with "Uncertain".	Yes/Yes-uncertain /No/No-uncertain
D4-CULVERT		
	The variables below are assessed for culverts (road culverts and other culverts).	
Culvert, length	Note the length of the culvert.	Metres (1 decimal)
Culvert, diameter	Note the diameter of the culvert.	Metres (1 decimal)
Culvert, speed	Note the flow speed of water.	Metres per second, (maximum 2 decimals)
Culvert, bed material	Note if the bed material in the culvert is natural, (e.g. sand, gravel, stones), or unnatural, (e.g. quarried stone, concrete).	Yes/No
Culvert, drop at outlet	Note the drop at the outlet, (the distance from the inner edge of the culvert to the water surface below the culvert).	Metres (maximum 1 decimal)
Culvert, free end	Note if the end of the culvert is free. Concerns a fall on the outlet side where the lower edge at the end of a culvert protrudes without being connected to any substrate.	Yes/No
Culvert, pool below	Note if there is a pool where the water falls below the culvert.	Yes/No
Culvert, outlet depth	Note the depth of the water downstream from the culvert. If there is a pool, the depth of the pool is measured, otherwise the depth is measured just downstream from the culvert.	Metres (maximum 1 decimal)
Culvert, depth	Note the water depth inside the culvert.	Metres (maximum 2 decimals)
Bed with terrace possibility	Note if it is possible to place a terrace downstream to increase the passability.	Yes/No
D5-FISH INFORMATION		
Passability trout	Assess the possibility for trout to pass upstream. The passability is noted as one of the following: **0** Passable: The migration barrier is passable. **1** Partial migration barrier: The barrier is passable under certain advantageous conditions. **2** Definitive migration barrier: In all probability, the barrier may not be passed under any conditions.	0-2
Passability roach	The variable is assessed in the same manner as the variable passability for trout, but the assessment concerns roach and other fish with the same ability to pass migration barriers.	1/2
Fine mesh screens	Note if there are fine mesh screens at the hydroelectric power station, (maximum 20 mm bar space).	Yes/No
Injuries	Assess if fish are injured during passage past the barrier in a downstream direction. E.g. if the water falls with high velocity towards a flat rock. A hydroelectric power station without working fine mesh screens entails Yes.	Yes/No

D6-USAGE		
Current use	Note what the structure is used at present, chose one of the following alternatives: **1** Road passage **2** Dam **3** Hydroelectric power station **4** Terrace for lake surface **5** Calibrate flow measure functional/broken) **6** Water inflow, barrier **7** Road, not for vehicles **8** Mirror pond **9** Bathing area **10** Wetland pond (markedly shallow pond) **11** Fish farm **12** Eel hatch **13** Sawmill pond **14** Mill pond **15** Nothing (non- **16** Other **17** Do not know **18** Beaver damming	1-18
Previous use	Note previous use, if possible, in the same manner as for the variable Current use.	1-18
Cultural heritage, barrier	Note if the construction may be of interest from a cultural heritage point of view. Stated as No (code 0), Uncertain (1), or Yes (2).	0-2
Cultural heritage, building	State if adjacent buildings may be of interest from a cultural heritage point of view. Stated as No (code 0), Uncertain (1), or Yes (2).	0-2
Owner	If possible, state name, address, mail address, and phone number to the owner or other contact, (tenant, company).	Free text, max. 255 characters
D7-MEASURES		
Possibilities	An assessment of the possibility to make the barrier passable is made and noted as one of the alternatives below. "Other measure" should be commented under the variable Comments. In many projects the ambition is not to create complete measure proposals, then it is not necessary to fill out the measure proposal. Make a note of possible measures to be carried out under Comments. **0** Difficult to improve passability **1** Demolition **2** Fishway/ladder **3** Fauna passage **4** Half-culvert instead of culvert **5** Placing a pool downstream (usually with terracing) **6** Natural gully in the stream (inlet) **7** Terracing **8** Demolition in combination with restoration of natural thresholds **9** Demolition in combination with construction of an artificial terrace or riffle reach **10** Other measure	0-10
Roads	Note if there is a road to the migration barrier.	Yes/No
D8-FISHWAYS		
Fishway	Note if there is a fishway around the barrier.	Yes/No
Type of fishway	Note the type of fishway, if any.	Free text, max. 255 characters
Function	Note the function of the fishway.	Free text, max. 255 characters
D8-Other		
Comment	Note other information, e.g. Biological information or other comments about the barrier.	Free text, max. 8,000 characters
D9-SKETCH		
Sketch	A sketch may be drawn, and the ambition level should be at a suitable level for the inventory project.	

7 Appendix 3-Hydromorphologic types – Flowchart



Amendments to be noted if applicable.

M	**Multichannel streams**
A	**Anastomosing**
LWD	**Morphology forced by large woody debris**
BMC	**Beaver meadow complex**

8 Appendix 4-Hydromorphologic types - general characteristics

Code	Hydromorphologic type (base type, subtype)	The stream slope (%)	Sinuosity	Quotient width/ depth	Valley confinement	Typical soil types	Dominating bed material
A	Bedrock streams						
Aa	Bedrock stream above 10% slope	> 10	< 1.3	< 12	High	Bedrock	Bedrock
Ab	Bedrock stream below 10% slope	< 10	< 1.3	< 12	High	Bedrock	Bedrock with loose boulders to gravel
B	Turbulent steep streams with stones and boulders						
Bc	Cascade streams	5-15	< 1.1	> 12	High to moderate	Moraine and ice age river sediment	Boulders and stones
Bs	Step-pool stream	2-8	< 1.3	> 12	High to moderate	Moraine and ice age river sediment	Boulders and stones
Bp	Plane bed stream	0.5-3	< 1.3	> 12	High to moderate	Moraine and ice age river sediment	Stones
Bl	Stream with blocks and stones with a low slope	< 0.5	< 1.3	> 12	High to moderate	Moraine and ice age river sediment	Boulders and stones
C	Riffle-pool streams						
Ct	Transversal riffle-pool stream	< 2	< 1.3	> 12	Moderate to low	Moraine and ice age river sediment	Boulders to gravel
Cr	Riffle-pool streams	< 2	< 1.3	> 12	Moderate to low	Moraine and ice age river sediment	Stones to gravel
D	Braided streams						
Dx	Braided streams	< 3	-	> 40	Low	Ice age river sediment	Stones and gravel
E	Meandering alluvial streams						
Ex	Meandering alluvial streams	< 0.5	1.05-3	< 12	Moderate to low	Clay to sand, flood sediment and ice-age river material	Clay to gravel
F	Incised alluvial streams						
Fx	Incised alluvial streams	< 0.5			High to moderate	Clay to sand, flood sediment and ice-age river material	Clay to gravel
P	Streams in peat soils						
Px	Peat streams	< 0.1	Variable	< 12	Low	Peat	Peat, sand

After Montgomery & Buffington, 1997, with some modifications.

9 Appendix 5-Indicators for fluvial processes

Indicators of erosion, sedimentation, and stable conditions. After Galli (1996), Kondolf & Piégay (2003) Schumm et al, (1984), Sear et al, (2010b), Ontario Ministry of the Environment (1999), Vermont Agency of Natural Resources (2009a, 2009b).

Erosion
Old channels in the floodplain
Undermined structures
Exposed tree roots
Thin and deep stream (note, not always valid, use with caution on, e.g. meadows)
Erosion on both sides of the stream
Reinforced/compact bed
A layer of gravel (or stones, depending on the type of stream), overlayered with finer material visible in the bank
No signs of flooding in the floodplain
Trees have fallen from both sides, or are leaning into the stream from both sides
The stream is lower compared to connecting tributaries
Drainage and other pipes are laying in a straight line on the bed
Gravel and stones on the bed have a light colour (not to be mistaken for sedimented material)
Parts of the bed or larger areas in the bed consist of post-glacial clay
The area downstream is cleared (or lowered base level by other means)
Secondary floodplains
Species that belong in the floodplain grows on an elevation that is lower than the floodplain
Erosion occurs in parts of the stream that is not normally eroding, e.g. erosion of river embankments
A lack of sediment banks in the areas where they would have occurred naturally
Erosion, primarily on the lower parts of the sediment banks
Post-glacial clay is visible in the shore bank
There is a knickpoint, alternately other types of environments with higher flows than expected for the stream type
Most of the stream have steep banks
Erosion (particularly undermining) occurs on both sides at the inflexion point or at riffle reaches
Erosion along more the 50% of the banks
Cracks close to the stream, with the same direction as the stream
J-shaped trees
Leaning trees, (straight leaning trees may indicate a higher changing rate compared to J-shaped trees
Entrenchment ratio <2.2
Incision ratio >1 (particularly if the ratio is >1.3)
The slope has increased

Sedimentation
Buried structures (buried bridge foundations, logs, larger boulders, etc.)
Buried sediment
A lot of or large non-compacted sediment banks
Heavy erosion in upstream areas
Unnatural narrowing in the stream (situated downstream)
Deep sediment layers above coarser materials in the bed substrate
Many sediment banks lacking vegetation
Drainage flow under the bed
Pale gravel and pale stones
Floodplain is flooded but plants belonging in the floodplain growing at a lower level (indicating previous dominant erosion)
Erosion occurs in not normally eroding parts of the stream
Lateral sediment banks occurring beside the stream, (not to be mistaken for natural middle banks or river embankments)
Sedimentation in pools (concerns new sediment, can be checked by looking for leaves, branches under the sediment)
Presence of middle banks that are not reaching over the stream's width, lacking vegetation and of a dark colour
Depositions on the river banks (new sediment can be checked by looking for leaves, branches under the sediment and through checking if the sediment is compact)
Badly sorted bed substrate
Deposition on the floodplain (not normal deposition on the floodplain)
The slope is reduced
Stable
There is vegetation on the sediment banks (also gravel banks with algae)
The bed substrate is compact and overgrown with water plants
Bank erosion is unusual
Older structures, (e.g. bridge foundations) are located in the right positions in relation to the stream
No significant differences in the reaches compared to older maps
Well-established forestation on the shores
Natural separation of riffle and pool reaches
The bed substrate consists of dark gravel and dark stones
The area downstream is not cleared
The floodplain is flooded to an extent that is expected (can be difficult to assess)
Entrenchment ratio >2.2
Incision ratio =1

10 Appendix 6-Example of interpretation of indicators for fluvial processes

Erosion indicators
Exposed tree roots (often more severe than in these pictures)
Erosion on both sides of the stream
A layer of gravel (or stones, depending on the type of stream), overlayered with finer material visible in the bank
No signs of flooding in the floodplain
The downstream area is cleared
Erosion occurs along more than 50% of the banks
J-shaped trees
Incision ratio >1

Sedimentation indicators
Heavy erosion in upstream areas
Erosion occurs in parts of the stream not normally eroding

Signs of stability
The bed substrate consists of dark gravel and dark stones

Interpretation
Bed erosion in common with bank erosion dominates, but the bed erosion is not severe. The clearing of the area downstream together with changed land used on the floodplain are possible causes for the appearance.

Erosion indicators
Erosion on both sides of the stream (not visible in the picture)
Trees have fallen from both sides, or are leaning into the stream from both sides (not visible in the picture)
The downstream area is cleared
Erosion along more the 50% of the banks
J-shaped trees
Leaning trees

Sedimentation indicators
Buried sediment
Sedimentation in the pools (the pools are eradicated since they are completely filled)
Middle banks are occurring, not reaching over the width of the stream, without vegetation and with a dark colour.
Many sediment banks lack vegetation (doubtful if this is to be included, vegetation is beginning to establish)
The upstream areas are heavily eroded (doubtful if this is to be included, previously there was a lot of erosion, but it has begun to decrease)

Signs of stability
There is vegetation on the sediment banks (also gravel banks with algae)
The bed substrate consists of dark gravel and dark stones

Interpretation
Bank erosion dominates on both sides. In the photo, banks of gravel and stones are visible, emerging in connection to heavy erosion in the upstream area (re-digging in the 1980s). The sediment banks' appearance and the disappearance of pools shows a heavy impact from sedimentation on the reach. Though the dark colour of the substrate shows that the bed is beginning to stabilise, and that the sedimentation process isn't as active as before. The right side of the picture shows J-shaped trees, leaning trees, and trees that are partly or completely fallen down into the water, indicating shore erosion. Shore erosion is common with this type of sediment impact. Shore erosion is noted as a dominant fluvial process in this reach, but had the visit occurred earlier, when the sedimentation process was more active, “sedimentation/aggradation in common with shore erosion” had been noted. Noteworthy is that the indicator “The downstream area is cleared” has been noted. It entails that the reach might turn into being dominated by bed erosion in the long term.

11 Appendix 7-Examples of measures

The table contains examples of issues or different types of impact that can be attended to. Note that the table is not possible to use as a template. Every proposal of measures during a river habitat survey must be adapted to each separate case.

Hydro-morpho-logical type	Issue/Impact/Scenario	Example of measure
Bx	The stream is cleared out of boulders and stone.	Placing boulders and stone and re-creation of prior typical morphological units.
Ex, Cx	The flooding frequency of the floodplain is reduced, the stream is cutting down into the floodplain after boulders and stone being cleared out from a controlling section.	Placing boulders and stone at the controlling section (restoring the local base level).
Ex, Cx, (Bp)	The flooding frequency of the floodplain is reduced, the stream is cutting down into the floodplain after the land use has been changed from grazed and mowed land to 1st generation forest.	Increased continuity in the land usage. Accelerated development to forest phase. Resumed grazing or mowing.
Px	The flooding frequency and/or the ground water level is reduced in surrounding peat land after clearing of boulders and stone from a controlling section.	Placing boulders and stone at the controlling section (restoring the local base level).
Ex, Cx, (Bx)	The stream's width is increasing due to disturbed hydrology.	Measures in the river basin, for example dams delaying the water inflow from impermeable surfaces or arable land.
Ax, Bx, Ex, Cx	The local environment is dominated by homogeneous spruce forest.	Spruce is thinned out.
Ax, Bx, Ex, Cx, (Px)	Occurrence of large woody debris is low, and the local environment consists of forest, (the reference environment is forest in the local environment).	Large woody debris is added. Agreement with land owners to let the alluvial forest develop freely.
-	The stream is straightened, and the water level significantly lowered, with an increased confinement.	Restoring the water level and restoration of the river planform, alternatively creating a new river.
-	The stream is culverted.	Removing the culvert, recreating the stream.
-	The local environment is drained.	In-filling of ditches.
Px	Overgrowth in the local environment or the stream of common reed, due to disturbed hydromorphology, (caused by water regulation or a lowered water level).	Hydrological restorations, for example adjusted regulation or raising the water level. Increased/resumed grazing or mowing in combination with hydrological restoration. Mowing reeds in spring, in combination with hydrological restoration.

Ex, Cx, (Px)	A clearing or similar impact downstream, for example a “head cut erosion” or a lowered water level. There is no controlling section to restore.	Installation of a “grade control structure”, (a terrace working as an artificial controlling section).
Ex, Cx, (Bx, Px)	Sediment impact leading to a raising of the bed.	Measures at the river basin level, for example measures against erosion on reaches upstream.
Ex, Cx	The stream is reformed to a ditch, but not cleared out for a long time and has regained its natural character. The stream is stable. Restoration to natural condition is impossible.	Adjusted maintenance of ditch, avoiding unnecessary clearings.
Ex, Cx	The stream is reformed to a ditch and unstable. Restoration to natural condition is impossible.	The stream’s banks are reformed to an artificial floodplain or a two-step ditch.
Ex, Cx	Erosion upstream a lowered lake, caused by lowering of the lake (base level drop).	Restoration of the lake level if possible. Otherwise “grade control structure” in a suitable location upstream of the lake inlet.
Cx	Redug reach through gravel and stone. There is a thin floodplain.	Restoration of controlling sections, restoration of riffle-pool system.
Bs	The stream is cleared out of boulders and stones.	Placing out blocks and stones, formation of terraces and other prior typical morphological units.
Bp	The stream is cleared out of stones.	Placing out stones and recreation of floodplain, plane bed and other typical morphological units characterising the Bp type. Pools can be created through large woody debris (if the stream runs in a forest), and not by block terraces (if those were not occurring naturally, e.g. At controlling sections).
Bx, Cx	Gravel banks are missing due to human impact.	Recreation of processes for creating and maintaining gravel banks. The most important process is different for different objects. E.g. recreation of a forced pool or riffle pool system.
Ex, Cx, Tt	A dam has been built on a controlling section and the original controlling section is cleared.	Demolition of the dam and recreation of the controlling section (restored local basic level).
Bx, Cx	The stream is cleared out and consists of a mixture of short sections dominated by either fine-grained sediment or stones and boulders.	Restoration from clearing, restoration of controlling sections and recreation of typical morphological units, for example pools, if these occurred naturally.
Cx	No controlling sections are affected, and no visible clearing exists, but the topography of the stream is smoothed out due to log driving.	Restoration of undulating bed and riffle-pool system. The flow of the river must be right for the measure to work.