Habitat Surveys

Training Course Manual

Scottish Fisheries Co-ordination Centre

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Disclaimer

Under no circumstances will the Scottish Fisheries Co-ordination Centre (SFCC) and/or its members be held responsible for death or any form of injury, damage or loss occurring during or as a result of the use of the protocol.

Health and safety issues relating to habitat surveying are entirely the responsibility of parties who intend to use or are using the protocol. Users should bear in mind that riverine environments are potentially dangerous. Points which should be considered in order to minimise risks are suggested in Appendix 1. However the suggestions are not exhaustive and SFCC stresses that it is the responsibility of parties using or intending to use the protocol to inform staff of potential dangers and to establish procedures to minimise risks. SFCC strongly recommends that habitat surveys are carried out by two people, particularly when working in remote areas.

In addition to the risks associated with habitat surveys *per se*, personnel working in the vicinity of rivers should be made aware of Weil's Disease (*Leptospirosis*) and other potential hazards and the steps to take to minimise exposure (Appendix 2).

Acknowledgements

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This habitat survey training manual was revised and expanded in 2007 in line with SFCC members' requirements, and a Bibliography was added with relevant sources of information. The SFCC would like to thank all those who contributed to the review: SFCC member biologists and FRS Freshwater Laboratory staff, and in particular Galloway Fisheries Trust for assistance with completing the revised manual and course material.

Legislation

Surveyors should be aware of legislation relating to Health and Safety, protected freshwater species and pollution of fresh waters, and should operate within the appropriate guidelines or requirements.

In particular surveyors should avoid damaging any salmon spawning or freshwater pearl mussel beds. The former is an offence under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act (2003), while both species are protected under the EU Habitats Directive. In Scotland Scottish Natural Heritage (SNH) should be consulted regarding freshwater mussel locations, and the Scottish Environment Protection Agency (SEPA) or the Police should be informed immediately of any serious pollution found while surveying. References and contact links for SNH and SEPA can be found in Section 8.

1. Introduction

Catchment-wide fish habitat surveys are an integral part of fisheries management and research. However, many of the habitat survey methodologies existing in the 1990s were developed to characterise and assess the physical structure of freshwater rivers rather than to collect information about rivers with specific reference to fish habitat. The Scottish Fisheries Co-ordination Centre developed a habitat survey method in 1998 to address the needs of fisheries managers and researchers, making use of relevant categories from the Environment Agency's River Habitat Survey (RHS). The SFCC method was specifically developed to assess habitat for juvenile salmon and trout and represents a consensus view by SFCC members.

In 2004, following comment from SFCC members that the time and cost of collecting detailed river habitat information might not be justifiable in all cases, a review was begun to examine the existing SFCC habitat survey protocol and identify other survey and data recording methods. In 2006 a UK-wide workshop described and compared the various habitat survey, classification and modelling methods currently in use. The workshop concluded that there are valid reasons behind the differences in methods and data definitions for the various methods and that it was unlikely to be possible to produce a single definitive habitat survey or classification method to suit the purposes of all the organisations concerned. It is beyond the scope of this manual to give details of these other UK methods but references can be found within those listed in Section 8.

The SFCC review concluded that the original detailed SFCC habitat survey method would be retained and that information on an alternative 'walk-over' method should be included with the SFCC protocol. Other areas of interest included the use of aerial photography to map specific features of river habitat. Each of the three method types - SFCC detailed habitat survey, shorter walk-over survey and aerial photography survey - has advantages and limitations which are given in Sections 3 and 7.

This manual was prepared as a supporting document for SFCC habitat survey training and has been revised to take into account the various requirements of SFCC members. The manual now includes the reviewed SFCC habitat survey method, and information on a walk-over method and the use of aerial photography. However both of the latter methods require additional skills and experience and a single course cannot fully cover all three areas. The purpose of the present habitat survey course is therefore to give participants the necessary theoretical background and practical experience to apply the detailed SFCC method successfully in the field.

2. Salmonid Habitats

A basic understanding of salmon and trout habitat requirements, within complex river environments, is essential to complete a successful habitat survey. This section gives a brief description of salmonid habitat requirements in terms of water quality, shelter and territoriality, food and availability of spawning habitat, all of which are highly inter-related. More detailed information can be found in particular in Armstrong et al (2003), Hendry et al (2003), Hendry & Cragg-Hine (1997) and Hendry & Cragg-Hine (2003).

2.1 Water Quality

Salmonids require clean, well-oxygenated water to breed, feed and survive. In terms of water quality, most streams in Scotland are able to sustain healthy salmonid populations. There are, however, many reasons why water quality may not be optimal for salmonids. Most obviously point pollution, such as an unauthorised release of toxic material from an industrial site, can result in a large fish kill. Less obvious influences, though not necessarily less important, include catchment landuse, geology, altitude and flow type.

2.1.1 Catchment Landuse

Landuse may affect water quality through acidification and diffuse pollution, both of which can result in reducing the quality of instream habitat and causing harm to fish. Afforestation with conifers can acidify surface waters by enhancing deposition of airborne acid pollutants while runoff from agricultural land can produce overgrowth of instream vegetation and highly enriched water.

2.1.2 Geology

Geology has a natural effect on water quality. A stream flowing over granite will be less productive and usually contain more elements that are harmful to salmonids than one flowing over limestone. Geomorphology and hydrology together help to determine the local instream habitat for fish with the mix of substrate and water conditions.

2.1.3 Altitude

Altitude has an effect on water temperature, which, amongst other things, influences dissolved oxygen levels in the water. Water temperature directly affects the survival of salmonid eggs and the feeding and growth rate of young fish.

2.1.4 Flow Type

Both in terms of speed and depth, flow type has a direct effect on water quality: fast-flowing, turbulent streams tend to have higher dissolved oxygen levels than slow lowland streams.

2.2 Shelter and Feeding Territory

2.2.1 Shelter

Availability of shelter, both in terms of protection from predators and from adverse environmental conditions, such as excessive heat, is of primary importance in determining the suitability of a stream for juvenile salmonids. At different stages of development, the preferred shelter provided by substrate, cover and water flow varies with fish size and swimming capacity.

In the middle of a stream, physical shelter is most commonly provided by stream substrate and aquatic vegetation, but items like old rusting oil barrels or shopping trolleys can also act as good hiding places. At the river banks, undercut banks and marginal vegetation (e.g. reeds) are the main sources of shelter. Draped riparian plants can also provide good shelter, as can any root systems of larger bushes and trees that grow on the river bank.

Water flow type is an important aspect of shelter. Deep pools and fast, turbulent water flow provide more protection than shallower slow flowing areas.

2.2.2 Territory

Juvenile salmonids, in particular salmon parr, are very territorial. They prefer to live in an environment where they can feed without interference from other fish living in the same area. Besides acting as shelter, stream substrate and aquatic vegetation are crucial in terms of increasing available territory in a stream, as they help isolate individual fish living in the same area.

2.2.3 Natural and Human Factors

The precise physical nature of a stream is directly influenced by natural factors such as altitude, stream gradient, catchment area, catchment shape, amount of rainfall, underlying geology and underlying soils. Humans tend to have little control over these factors, and given the wrong combinations a stream can be naturally unsuitable for fish. Other natural factors relating to water flow can in some cases, be highly controlled by human activity. More information on the geomorphological processes relating to rivers in Scotland is given in Werritty & Hoey (2004).

There are many factors directly linked to human activity that can have a profound influence on the physical stream habitat. In Scotland, overgrazing is arguably the most important of these. Overgrazing by sheep and deer increases bank instability, resulting in bankside erosion and collapse. This not only reduces the amount of bankside shelter available, but also increases the input of finer sediment particles into river systems, which can have the effect of 'clogging up' shelter provided by larger instream substrate.

Activities in the catchment area, such as large scale commercial forestry, can have similar effects on streams, with silting after planting, dense shading from mature trees and phosphorus release during tree harvesting. Other important sources of human interference include hydroelectric dams, canalisation in urban and agricultural areas, and instream and bankside modifications aimed at enhancing angling potential. The impact of all these activities is highly variable, depending not only on the precise type of intervention but also on the nature of the stream prior to intervention.

2.2.4 Life Stages and Typical Habitats

Typical habitats for different life stages of salmon and trout are given in Table 1 below. It is important to emphasise here that the precise habitat requirements of each species and each life stage are often extremely complex, and that successful populations of fish have established themselves throughout Scotland in a very wide variety of habitats. In practice salmonids of all species and age classes often co-habit in the same environment.

	Salmon	Trout
Eggs / alevins	Golf ball to tennis ball sized substrate.	Dependent on fish size: Golf ball to tennis ball sized substrate for large brown trout and sea-trout. Pea to golf ball sized material for smaller trout.
Fry (<1 year old)	Golf ball to tennis ball sized substrate, fast flowing, shallow broken water.	Golf ball to tennis ball sized substrate, slow to medium flowing shallow water, often concentrated at stream margins.
Parr (=>1 year old)	Tennis ball to football sized substrate, fast flowing broken water, often slightly deeper than fry.	Variety of substrate, undercut banks, tree roots, big rocks, deeper slower water.
Smolts	Unknown	Unknown
Adults	Deep pools	Deeper areas, sustained flow but not too fast, undercut banks, tree roots, good instream vegetation and large rocks.

Table 1: Typical habitats for different life stages of salmon and trout.

2.3 Availability of Food

Juvenile salmonids feed primarily on invertebrates. Although the dominant source of invertebrates tends to be aquatic, it has been found that terrestrial invertebrates can be an important component of the diet of salmonids (particularly trout) in certain circumstances and at certain times of the year.

Abundance of aquatic invertebrates are influenced by a large variety of different factors, including the water quality, water depth, substrate, water flow type, instream vegetation and so on. On the other hand, abundance of terrestrial invertebrates is primarily dependent on the riparian vegetation, with lush and diverse vegetation likely to be a better source of invertebrates than short uniform vegetation. Branches and grasses overhanging the river bank are likely to be particularly important in this respect.

Absence of trees in the riparian vegetation will increase the water temperature in the river and reduce invertebrate numbers, many of which feed on leaf litter. However too much shade from riparian vegetation, from either coniferous or some deciduous trees, results in the herbaceous layer being lost and an increase in bank erosion as well as a reduction in invertebrates.

2.4 Availability of Spawning Habitat

2.4.1 Stream Size

Adequate spawning habitat must be available for a successful population of salmon and/or trout to establish itself. Salmon tend to spawn in wider streams and trout in narrower ones. In smaller river systems, especially on the west coast of Scotland and in the Hebrides, the two species often share very small streams to spawn, and these also act as nursery habitats. On the Western Isles, for example, salmon have been recorded to spawn commonly in streams that are less than 1 metre wide. It is therefore extremely important to include small streams when carrying out a habitat survey.

2.4.2 Substrate and Flow

The main spawning habitat requirements for salmon and trout are fairly well defined. Salmon require an uncompacted and well-oxygenated stream substrate of golf ball (pebble) to tennis ball (small cobble) size. Trout require smaller sized substrate right down to gravel size.

Spawning often takes place in the tails of holding pools where there is moderately fast water, a smooth, yet sustained, flow through the substrate, and a substrate size which can be moved by the adult fish to cover deposited eggs.

Emerging fry disperse from the area of the nest to within 100 metres and generally prefer shallower and slower flowing water. The spatial distribution of spawning areas and the availability of adjacent suitable habitat for each of the early life stages is therefore crucial.

Unfortunately, it is often extremely difficult to identify spawning areas with any degree of accuracy in the field. This is mainly because, if 'typical' spawning areas are not available within a stream, adults tend to spawn anywhere they possibly can.

2.4.3 Accessibility

For both species, and in particular for salmon, accessibility of spawning habitat is a crucial consideration in terms of determining the spread of the species throughout a catchment. It is therefore important to carefully record any obstacles to fish movements during a habitat survey.

In many cases it is difficult to tell whether a particular obstacle can be negotiated by a particular species without electrofishing to see whether juveniles are present above the obstacle. Accessibility will depend, among other things, on the flow conditions and the fish species and size. It is therefore wise to document all obstacles, even apparently insignificant ones, during a habitat survey so that these can be investigated further if required.

3. Habitat Survey Methods

The habitat requirements and the complex inter-relationship of habitat features outlined in Section 2, highlight a number of implications and difficulties for recording and assessing salmonid habitat. This section briefly covers three types of method available for habitat surveying, with some information on the benefits and limitations of each.

3.1 Choice of Method

The choice of survey method and the precise habitat data collected will depend on a number of factors, including

- the exact purpose of the survey,
- the habitat features and level of detail required,
- the extent of the area being surveyed,
- the resources and time available, and
- the technical skills available.

Depending on the purpose of the survey, it may not be necessary to record all the detailed habitat information along a river stretch, tributary or catchment. Surveys using aerial photography can produce good results in answer to some specific questions but the saving in survey time may be offset by the cost of obtaining suitable photography and the need for technically skilled staff to process and interpret the data collected.

Similarly a walk-over method may in some cases be appropriate and may produce time savings. However it requires a high level of skill, based on experience and knowledge, for example, to assess spawning habitat across a catchment. The SFCC strongly recommends that surveyors are familiar with the detailed SFCC habitat survey method and participate in electrofishing surveys before attempting to carry out a walk-over habitat survey of this type.

3.2 SFCC Habitat Survey

The SFCC Habitat survey provides a method of recording detailed information relating to salmonid habitat in a standardised way. Depending on the purpose of the survey, a choice can be made between collecting data for the full range of variables or selecting appropriate groups of variables.

In the light of the habitat requirements of salmonids outlined in Section 2 and to obtain a full overview of the suitability of fish habitat along a river system, using the SFCC Habitat Survey, consider collecting the following data:

- Water depth
- Water flow type
- Instream characteristics
- Bankside characteristics
- Riparian vegetation
- Surrounding landuse

It is also important to collect information on potential causes of unsuitable habitat or lack of fish, particularly with a view to taking action against further degradation:

- Bankside fencing and grazing
- Bankside erosion and collapse
- Obstacles to fish movement
- Pollution sources
- Bankside and channel modifications

In practice the two categories of information are inextricably linked and should be recorded together to obtain the best overview of the factors impacting on fish habitat suitability in a particular river system. Where the survey is intended to answer a specific question, it may be appropriate to record only the relevant information and to leave other data unrecorded.

Information recorded during habitat surveys is entered into a customised SFCC Habitat database which stores and displays survey records and exports information to spreadsheet. Since all the survey records include grid references, survey stretches and associated features can be imported, as lines and points, into a Geographical Information System (GIS) to display with other datasets and produce maps of the survey information. Both spreadsheets and GIS can be used to investigate relationships between variables at the same site (e.g. substrate, flow and depth), between survey sites on the same or different rivers, or between datasets (e.g. electrofishing data with habitat survey data).

The benefits of this type of survey include standardised recording and data storage, the ability to compare data within and between survey stretches and rivers, and the ability to combine data with other datasets in GIS. The detail recorded for habitat variables potentially allows data to be analysed in many different ways.

The limitations of a detailed survey method are largely related to cost. It requires substantial time and resources to complete a habitat survey for a full catchment. In some cases there may also be difficulties due to the inaccessibility or remoteness of the river, and in the lower reaches of rivers a full instream survey may not be possible due to water depth. Mapping the patterns of instream habitat within a survey stretch, in terms of areas of suitable spawning or juvenile habitat, ideally requires large scale 1:10,000 maps which may be expensive to obtain.

Sections 4 - 6 give details of the SFCC habitat survey method and data collection.

3.3 Walk-over Surveys

Where resources are more limited, large areas are to be surveyed, or information is required only on certain features, a walk-over survey may be more suitable. Again the amount and exact nature of data recorded will vary depending on the survey purpose and, as with other methods, on the available resources. Some of the features which can be recorded using a walk-over habitat survey method include:

- Obstacles to fish movement
- Bankside erosion and fencing
- With experience, assessment of instream habitat types

A number of walk-over methods are available in the UK but the most widely used is the Hendry & Cragg-Hine method, which was developed for the Environment Agency (Hendry & Cragg-Hine, 1997). The benefits of the method are relative speed, and an output that can produce detailed maps of local instream habitat and inform catchment scale management decisions. The main limitations are the need for experienced surveyors and for access to detailed digital map data.

Section 7.1 gives further information on the Hendry & Cragg-Hine method and some of the benefits and limitations of walk-over methods.

3.4 Aerial Photography Surveys

Depending mainly on the type of feature and the scale of the photography, certain aspects of river habitat can be identified and quantified from aerial photographs across whole catchments or within smaller river sections.

Obtaining new, suitable aerial photography may be too costly for many small organisations. However in some cases larger, usually governmental, organisations may make existing current or historical photography available if requested, or other local organisations may hold suitable photography. One of the major benefits of aerial photography is that the same photographs can be used for different purposes. There is therefore scope for establishing a consortium of smaller organisations to cover the cost of obtaining new photography.

Some factors to bear in mind regarding aerial photography for habitat survey:

- Time of year and time of day that photographs are taken
  (differences in vegetation growth and soil moisture content; shadow in areas of high relief; cloud, tree canopy or sunlight on water obscuring features)
- Scale of photographs
  (differences in size, texture and tone of features; extent of area covered by the image)

These factors affect the success of subsequent photo-interpretation and the ability to identify features, and/or the number of photographs required to cover the survey area. For river and instream features, scale (and therefore detail on the image), river conditions (including depth, flow speed and water clarity) and time of year (before full leaf cover but after the poorer light of winter) are likely to be crucial to the successful use of photographs.

Section 7.2 gives further information on aerial photography methods with some of the benefits and limitations.

4. SFCC Habitat Survey Method

4.1 Applications

The SFCC detailed habitat survey method has been developed with specific reference to juvenile Atlantic salmon (*Salmo salar* L.) and brown/sea trout (*Salmo trutta* L.), and therefore its application to evaluate habitat for other fish species is limited.

The method takes into account all the recording requirements listed in Section 3.2. Information gathered about river stretches using the SFCC fish habitat survey protocol can be used by trained interpreters and within reason to:

- Evaluate quality of habitat for juvenile salmon and trout.
- Identify stream stretches that may benefit from habitat improvements.
- Target areas for stocking.
- Identify and classify point pollution sources.
- Identify and grade obstacles to fish migration.
- Identify location and type of past or existing channel/bank modifications.
- Identify the potential location of salmon and trout spawning gravels.

4.2 Equipment

Surveyors should be aware of Health and Safety issues at all times (see Appendices 1 and 2). Waders should be disinfected before use each day and at any time if moving survey work between river tributaries or catchments.

The SFCC recommends that a **lifejacket is always worn** and a **mobile phone** and small **first aid kit** are carried. In order to carry out a habitat survey according to the SFCC method the surveyor also requires:

- A 30 metre tape measure or range finder
- A depth measuring stick, graduated in centimetres
- Waders
- 1:25,000 or 1:50,000 scale Ordnance Survey maps of the survey area
- Polarising sunglasses, to improve substrate visibility in sunny conditions
- A camera, preferably digital
- An A3 white board and black marker pen for photographs
- A clip board, if possible with waterproof cover
- A pencil, rubber, pencil sharpener and pen
- Optionally a GPS, to identify survey stretch or point data grid references

4.3 Planning the Survey

A detailed survey plan should always be drawn up before commencing a habitat survey. Determining the precise survey purpose is one of the most important parts of developing a good survey plan. The survey purpose influences the type of information to be collected, the timing of the survey, the length of survey stretches to be surveyed, and the permissions required to access the stretches of stream targeted for survey. The following should be considered when drawing up this plan:

4.3.1 Information Collection

The type of information to be collected during a habitat survey obviously depends on the precise aim of the survey. The two examples below illustrate this point:

Survey aim 1: to determine the suitability of physical habitat for salmonid fry and parr.
This survey aim requires collection of information on physical instream and bankside characteristics (e.g. substrate, flow, widths, depths, and bankside cover). However, the survey does not necessarily require collection of other information such as fencing and grazing; these factors may be a cause of degraded habitat but are not direct measures of habitat quality.

Survey aim 2: to determine locations where banks are degraded due to overgrazing.
This survey aim requires collection of information about bankside vegetation, fencing, erosion and collapse. However, it is not necessary to collect information on instream characteristics; instream habitat may be degraded due to overgrazing on the banks, but recording of instream information will not necessarily help to remedy bankside problems.

For both of the examples above, it may not be necessary to record obstacles to migration, pollution points, spawning areas or channel/bankside modifications.

4.3.2 Survey Timing

As with all surveying, timing is linked to purpose. Particular things to consider are weather and water flow conditions and the extent of vegetation growth. Mid-May to the end of September is the main growing season for juvenile salmonids and the time when instream and bankside vegetation is fully developed. Rivers are also most likely to be at consistently low flows and weather generally more favourable during this period. These are essential for accurate and comparable recording of flow, bankside and instream features. The SFCC therefore recommends that habitat surveys are carried out from mid-May to the end of September.

However note that, although surveying from both the river and the bank normally produces most accurate recording, health and safety must always remain a priority and full habitat surveys should never be carried out in high or spate flows. Additionally instream or bankside vegetation can obscure some channel features when fully grown. Where this is likely to be the case, generally in more lowland rivers, May or June may be more suitable for surveying. Some surveys, such as recording bankside erosion, fencing, obstacles and bankside modifications can be undertaken outside the main survey period.

4.3.3 Survey Stretch Lengths

Always use a 1:50,000 or 1:25,000 scale Ordnance Survey map when delineating survey stretch lengths. Length of survey stretches is primarily determined by a combination of the survey purpose and the resources available to carry out the survey. The SFCC recommends use in most cases of short survey stretches which should be:

- No more than **100 metres** long for rivers of **0 to 4 metres wide**.
- No more than **250 metres** long for rivers of **>4 to 10 metres wide**.
- No more than **500 metres** long for rivers of **>10 metres wide**.

There are two main restrictions on the selection of survey stretches:

1. All survey stretches MUST be broken at ALL river intersections marked on the 1:50,000 or 1:25,000 scale Ordnance Survey map so that data can easily be entered into a GIS, and because there are often differences in conditions (and thus data to be recorded) where tributaries meet. In other words, a point where two or more rivers join must always correspond to the beginning and/or end of a survey stretch; a survey stretch should never span across a river intersection.

   AND
2. When recording bankside fencing, dominant grazers, grazing exclusion, exclusion(%), grazing intensity, predominant bankface vegetation, predominant banktop vegetation AND/OR trampling(%), survey sections MUST also be broken at fence boundaries marked on 1:25,000 scale maps.

Apart from the two restrictions described above, surveyors have the freedom to start and end survey stretches where they wish.

It may be useful to plan the survey out prior to going out into the field, with appropriate survey lengths on a paper map. Noting the recommended survey lengths and restrictions above, use a pencil to mark the beginning and end of each survey stretch on your survey map. Give each survey stretch a unique identification number and write this on the map.

In the field, areas with uniform river habitat may allow longer survey stretches to be set, while for very varied habitat shorter sections are likely to be more appropriate. While planning the survey it may be possible to tell in some cases, from a large scale OS map, the general form of the river and the riparian land, indicated by the river shape and contour lines.

However the map alone may not provide sufficient information to allocate the exact dividing points between your survey stretches. You may therefore have to alter the survey plan when you are out in the field by amalgamating adjacent survey stretches or subdividing a single survey stretch. Habitat may be more variable than was obvious from the map you are working with, or bankside fencing may have changed since the publication of the map.

4.3.4 Access Permissions

Always ensure that you have the required permissions to access the survey streams. In practice this means contacting the landowners and also the owners of the fishing rights. Access permissions should always be obtained before starting the survey. Surveyors should carry identification at all times when working in the field.

4.3.5 Freshwater Mussels

Surveyors should be able to identify the Freshwater Pearl Mussel (*Margaritifera margaritifera)* and take care not to damage mussel beds where they are found. Mussels cannot show an escape response and there is the possibility of them being crushed underfoot. In Scotland liaise with Scottish Natural Heritage (SNH) locally regarding the location of mussel beds before carrying out habitat surveys. Any previously unknown mussel populations found during surveying should also be reported to SNH. References and a contact link for SNH can be found in Section 8.

4.4 Collecting Survey Data

The full SFCC fish habitat survey involves a combination of a linear survey and a point survey. Data definitions are given in Section 5, the suggested survey method in Section 6 and habitat survey record sheets in Appendix 4.

In the linear survey the relative proportions of different fish habitat characteristics, such as substrate and flow types, are estimated within the selected river stretch.

The point survey is used to record features that lie at a particular location, or ‘point’, within each river stretch, such as obstacles to migration and pollution sources.

In total nine categories of information can be recorded for each river stretch surveyed. These are divided into sections on the record sheets:

PART A: General locational and context information about the survey stretch.
Linear survey:
PART B: Information on the channel characteristics
PART C: Information on the characteristics of the left river bank
PART D: Information on the characteristics of the right river bank
PART E: Photographic information for the survey stretch
Point survey:
PART F: Information on point pollution sources
PART G: Information on obstacles to migration
PART H: Information on channel and bank modifications
PART I: Information on spawning locations

As already noted, surveyors do not necessarily have to record all the above information. Depending on the purpose of the habitat survey, it may only be necessary to collect sub-sets of information.

5. SFCC Habitat Definitions and Recording

Data definitions and recording rules are given below for each of the data fields or variables on the SFCC habitat survey recording sheets (Appendix 4). Note that the Environment Agency's River Habitat Survey (RHS) was the basis for many of the categories and definitions. RHS was subsequently revised, resulting in changes to some categories. However the RHS Field Survey Guidance Manual (Environment Agency, 2003) contains many useful photographs illustrating some of the variables below.

In a few cases the definition or categories of SFCC habitat survey variables have been revised. In these cases the differences are indicated in this section and the changes listed in Appendix 3. Users of the survey method prior to this time should note that for these variables, comparison with survey data collected at an earlier date may not be appropriate.

5.1 Part A: General Information

ID

Any combination of letters or numbers that gives a unique ID to the survey stretch.

A combination of letters and numbers to denote the location and order of the stretch on the river system is suggested. It is recommended that only alphanumeric characters are used, that underscore is used rather than spaces and that leading zeros for numbers less than 9 are included. This facilitates sorting records by *ID* value and helps to avoid spreadsheet format problems.

Example:

Fifth stretch surveyed on the River Garry (a main tributary on the Tay system): TG05

River

Description of the location of the survey stretch on the river system.

Example:

A stretch surveyed on the River Garry on the Tay system: 'River Garry, River Tay'.

Altitude (m)

Approximate altitude in metres of the survey stretch, from Ordnance Survey map or GPS.

Date

Full date of the survey including the day, month and year.

DownstE (m), DownstN (m)

Full six figure metre resolution easting and northing of the <u>downstream</u> end of the survey stretch derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (See Figure 1).

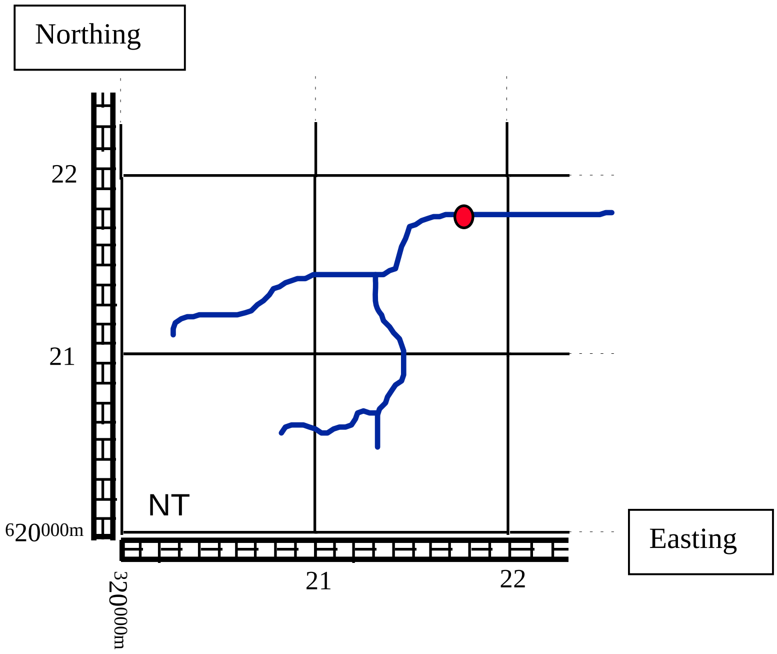
UpstE (m), UpstN (m)

Full six figure metre resolution easting and northing of the <u>upstream</u> end of the survey stretch derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (See Figure 1).

Ordnance Survey British National Grid

Co-ordinates are given as the number of metres east and north from the point of origin of the Ordnance Survey British National Grid. (This point 0 0 is to the south-west of the Scilly Isles.) The National Grid is divided into 100 kilometre squares, each of which can be represented by two letters. Each 100 kilometre square is further sub-divided into 10 and 1 kilometre squares. The smallest squares on a 1:50,000 or 1:25,000 map are 1 kilometre (or 1000 metres). Calibrations around the edge of 1:25,000 maps divide the 1 kilometre square into 10 sections of 100 metres.

Co-ordinates can be given either as a combination of the 100 kilometre square letters with numbers, or as full numbers. Full number co-ordinates are always shown at the corners of Ordnance Survey maps and 100 kilometre letters are shown at the corners of each 100 kilometre square. For the purposes of habitat survey grid references, the full number co-ordinates are required.



Example (1:25,000 map):
The map corner co-ordinates are Easting: 320000 and Northing: 620000.
The point lies within the 1 kilometre square Easting: 321000 and Northing: 621000.
The map calibrations indicate that the point is 800 metres east of 321000 and
800 metres north of 621000.
The full grid co-ordinate of the point is therefore **321800 621800**
(Easting: 321000 + 800 = 321800 Northing: 621000 + 800 = 621800)

Important:
Take care when calculating grid references if there are several 100 kilometre squares on the map. The first number for the easting or northing of the required point may then be different from that at the bottom left hand corner of the map.

Hand held GPS units are useful for determining the location of survey stretches or point features when there are few distinguishing landscape features. GPS accuracy should be checked at known map locations.

Figure 1: Reading grid references.

Length (m)

The length of the survey stretch in metres.

Length should theoretically be measured along the midline of the river and following any curves, but this is not always possible. The SFCC Habitat database accepts length values to two decimal places.

Distances along river stretches are often established by pacing and therefore the approximate pace length of each surveyor must be determined before commencing the survey. Remember that pace length varies according to the type of terrain encountered: it is essential that different pace lengths are established for smooth and rough terrain.

Water level

Water level at the time of survey. Circle ONE of the following:

Dry - no water in stream / dispersed pools with no perceptible flow between.
Low - summer level or below.
Medium - slightly higher than summer level due to rain.
High - substantially higher than summer level but not bursting banks.
Spate - flood conditions, bursting banks.

A stream should in general not be surveyed if the water level is in the 'High' or 'Spate' categories.

Surveyor

Full name and surname of the surveyor and accreditation code (shown on your SFCC accreditation certificate). Always include the surname to avoid any future confusion.

Proprietors

Name(s) of the proprietor(s) of the survey stretch. If there is more than one proprietor (e.g. different proprietors for different banks and/or part of one bank belonging to one proprietor and the other part to another) record all proprietors. Record phone numbers and addresses if possible.

Survey notes ***(See Appendix 3 - 1. New field)***

Record any notes about the survey stretch you wish to add, for example, the general state of the survey stretch, if the stretch could only be recorded from one bank due to water depth or if a rangefinder was used for channel measurements. You may want to add your notes after you have completed the survey stretch.

General Definitions

Left and right bank: Always determine bank side by facing DOWNSTREAM with the direction of water flow.

River bed: The part of the river channel that is submerged by water at low and medium flows including any side or point bars which are only submerged during high and spate flows. Exposed bed can usually be recognised by presence of aquatic/marginal macrophytes and/or a lack of soil development and established terrestrial vegetation.

Banktop: Ignoring side bars, point bars and other bed types exposed due to low flow, the banktop is the first distinct break in slope away from the water, often but not always coinciding with the 'bankfull' point where the river spills on to the flood plain. Where no distinct break in slope occurs the banktop is defined as the winter flood level, often marked by a trash line. If the land on either side of the river is of different heights, extrapolate level with the height of the lower banktop to find the corresponding point on the other bank, i.e the bankfull level.

Bankface: The exposed land area between the water boundary and the banktop. The amount of bankface will vary with flow height. At low flows where the river bed is exposed, the bankface is the land area between the river bed boundary and the banktop, i.e. do not include side or point bars as part of the bankface.

Wet width: The width across the wetted part of the river channel, including wetted areas beneath any visibly overhanging banks and excluding any exposed river bed or bars.

Bed width: The width of the river bed between the bottom of the two bank faces, including the bed beneath any visibly overhanging banks and including any exposed river bed or bars.

Bank width: The width between the top of the two banks, taken at bankfull level, where the river spills on to the floodplain. If the banks are of uneven height, 'bankfull' is level with the banktop of the lower bank.

Side, point and mid-channel bars: Depositional features composed of river bed material, transported from upstream and exposed during low flows. Side and point bars occur along the river bank while mid-channel bars create a 'braided' river with more than one water channel.

Figure 2: Definitions of banktop, bankface, width measurements and river bars.

5.2 Part B: Channel Data

Bed visible (%) ***(See Appendix 3 - 2. & 4.)***

Record the percentage of river bed in the survey stretch wetted area that is visible. Bed may not be visible because the water is too deep, coloured or turbulent, or covered by overhanging tree branches. Bed may also be obscured by roots, wood, sheets of iron, barrels etc that cannot be physically moved. *Bed visible* and *Substrate* 'Obscured' values must ALWAYS add up to 100%.

Wet width (m)

Record the representative width across the wetted part of the survey stretch, in metres with up to two decimal places. *Wet width* is measured from the water/land boundary on one side of the river to the water/land boundary on the other side of the river. It includes wetted areas beneath any visibly overhanging banks and excludes any exposed river bed or bars.

Bed width (m) ***(See Appendix 3 - 3. Bank Base Width)***

Record the representative width of the river bed for the survey stretch, in metres with up to two decimal places. *Bed width* is measured from the base of the bankface on one side of the river to the base of the bankface on the other side of the river, and includes any bed beneath visibly overhanging banks and any exposed bed or bars.

For both *Wet width* and *Bed width*, whether overhangs are visible may depend on water level. The surveyor should probe the base of the bank below the water level.

Bank Width (m) ***(See Appendix 3 - 3.)***

Record the representative width between the two bank tops for the survey stretch, in metres with up to two decimal places. *Bank width* is measured at the 'bankfull' level, where the river spills over on to the floodplain. If the banks are of uneven height 'bankfull' is level with the banktop of the lower bank.

Wet width, *Bed width* and *Bank width* should be measured at right angles to the midline of the river, if possible on straight sections of the survey stretch. It is recommended that four or five measurements are taken for each variable at representative points along the survey stretch. Measurements can be averaged to obtain representative wet, bed and bank widths. Estimate wet, bed and bank widths if the channel is too deep, wide or unstable to cross safely.

Mature islands (n)

Record the number of mature islands in the survey stretch. Islands are classed as mature when they are stable, permanently vegetated and feature some developed soil.

Mature islands are in most cases erosional features, where the river has cut into the surrounding bank to create a second channel, leaving behind an island. As a result the bank height of mature islands is generally the same as that of the main river banks.

Do NOT count mature islands in the *Braided channels* value (see page 21). However mature islands can be found in the middle of mid-channel braids, side or point bars, if in the past the river has cut itself a new channel which has subsequently been filled, or partially filled, with river deposits.

The river channels on both sides of mature islands must be included in channel assessments of the survey stretch (Part B: Channel Data). The island banks should be ignored for bankside assessments (Parts C and D: Left and Right Bank Data). In other words, if you wish to include island banks in bankside assessments, river channels on either side of a mature island must be surveyed as separate survey stretches.

Water depths (% of survey stretch wetted area)

Record the percentage of the survey stretch wetted area in four depth categories:

0 - 20 centimetres
21 - 40 centimetres
41 - 80 centimetres
> 80 centimetres

Important: Accurately estimating depth by eye is notoriously difficult. Always use a depth measuring stick to ‘calibrate’ your visual estimates before recording overall percentages.

Substrate (% of survey stretch wetted area) ***(See Appendix 3 – 2. & 4.)***

Record the percentages of each substrate type in the survey stretch wetted area.
When estimating percentages, recorded substrate categories MUST add up to 100%. Substrate sizes are always measured along the longest axis:

HO - High organic: Very fine organic matter.
Includes peat substrate and thick leaf cover on stream bed.
SI - Silt: Fine, sticky, mostly inorganic material, individual particles invisible.
SA - Sand: Fine, inorganic particles, < 2mm diameter, individual particles visible
GR - Gravel: Inorganic particles 2-16mm diameter.
PE - Pebble: Inorganic particles 16-64mm diameter.
CO - Cobble: Inorganic particles 64-256mm diameter.
BO - Boulder: Inorganic particles >256mm diameter.
BE - Bedrock: Continuous rock surface.
OB - Obscured: Roots, wood, sheets of iron, barrels etc. that obscure the river bed and cannot physically be moved for inspection. (If it is possible to move a feature that obscures the river bed, the area covered by the feature should not be included in the ‘Obscured’ value.)
For instream vegetation, only the root coverage on the stream bed should be included in the ‘Obscured’ category as this can truly not be moved. Remaining instream vegetation can generally be moved and should therefore not be included.
INCLUDE in this category any substrate that cannot be seen because of water depth, colour or turbulence, or due to overhanging tree branches.
‘Obscured’ and *Bed Visible* values must ALWAYS add up to 100 %.

Note that there is always a tendency to over-estimate the percentages of prominent and highly visible features i.e. the larger substrate types, especially boulders.

Important: Always record substrate from the point of view of cover for fish, not spawning suitability. Substrate estimates should therefore specifically refer to the substrate on the bed surface and the first few centimetres below it (i.e. the part of the bed matrix available for use by juveniles), and not to bed composition at depth.

Instream veg (%)

Record the percentage of the bed in the visible survey stretch which is covered by instream vegetation (i.e within the *Bed visible* area). Include ALL types of vegetation (including algae) in this category providing the vegetation serves as cover for fish. A thin layer of algae/mosses that just cover the surface of rocks does not count as cover in this case.

Silted?

Record whether the bed in the visible survey stretch is covered by a thin layer of silt (**Y/N**). This does not refer to silt in the stream bed matrix but rather to silt covering the surface of the bed. Silted streams typically indicate disturbance in the catchment area (e.g. forestry and agricultural operations).

Iron deposits (%)

Record the percentage of the bed in the visible survey stretch that is covered by iron deposits. In colour terms iron deposits can range from bright red to dark rusty brown. Deposits can take a variety of physical forms, ranging from fine loose particles that have settled on the stream bed to encrusted/solidified material which is concreted into river bed itself. These deposits are often found in coal mining areas but can also occur naturally.

Substrate

Record the degree of substrate stability and compactness. Select ONE category from EACH of the two variables:

Stable / Unstable - All stream beds are to some extent unstable. This variable is used to identify stretches where stream mobility is extreme and where one might expect the entire bed to move during floods. This is often indicated by braided channels and large bars of loose clean gravel and cobbles washed onto the banks.

Compacted / Partly / Uncompacted - Evaluate compaction by digging into the stream bed with your feet. If you are able to move the bed around, record it as ‘Uncompacted’. Only describe the bed as ‘Compacted’ if it is obviously cemented by fine particles and you find it very difficult or impossible to move with your feet. Note that a fully ‘Compacted’ stream bed is unlikely to be ‘Unstable’. Define a bed as ‘Partly’ compacted if it contains both uncompacted and obviously compacted patches. Bedrock, which cannot be moved due to its nature and size, should never be recorded as compacted.

Substrate notes

Record any comments you wish to make about the substrate in the survey stretch. It is useful to record any distinctive features about the substrate, such as the presence of large boulders. Details should always be recorded if

- a large area of the bed is obscured or covered by instream vegetation and/or
- a bed has been described as being silted, unstable and/or compacted.

These may be an indication of potentially unsuitable conditions for juvenile salmonids.

Braided channels (% of survey stretch length)

Record the percentage of the survey stretch length where there is more than one channel within the river banks (Figure 3). Remember that braided channels may be dry.

In mobile braided rivers, the height of the mid-channel bars are normally lower than the height of the adjacent river banks and bars are usually, but not always, unvegetated. During low flows the wetted area of the river may be substantially less than the full area of the river bed for the survey stretch.

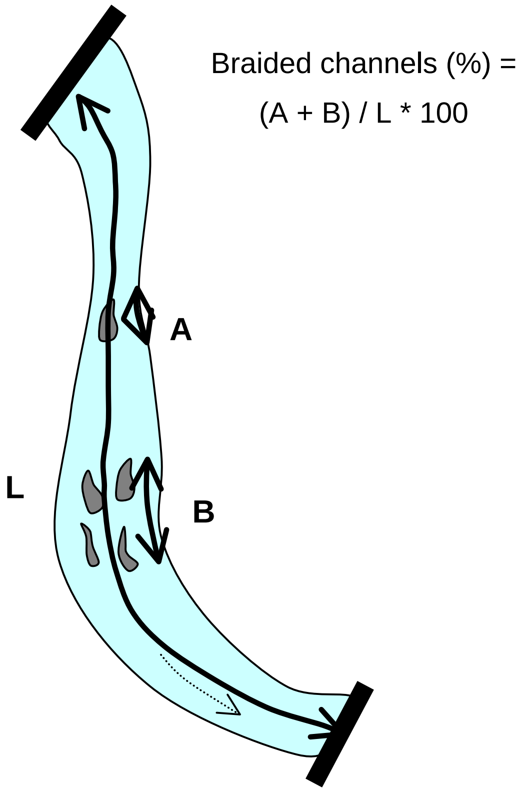


Figure 3: Recording braided channels.

Braids stable?

Record whether the braided channels appear to be predominantly stable (**Y / N / NA**).

Remember that all braids are to some extent unstable. This variable is used to identify those stretches where braid instability is extreme.

- Use 'Yes' (Y) only where the braid shows signs that it has been in its current position for more than one or two years. Vegetation may include established bushes or small trees, as well as mosses and/or grasses.
- Use 'No' (N) only if braid instability is severe. A good indicator of instability is lack of terrestrial vegetation or mosses growing on the mid-channel bars.
- Use 'Not applicable' (NA) where there are no braided channels in the survey stretch (i.e. *Braided channels* = 0%).

Channel feature notes

Record any comments you wish to make about the channel features in the survey stretch. Notes should always be taken if there are braided channels, or side or point bars in the survey stretch, especially if these are recorded as unstable.

Flow percentages (% of survey stretch wetted area)

Record the percentages in the survey stretch wetted area of each flow type. When estimating percentages, recorded flow categories MUST add up to 100%.

SM	**- Still marginal**	< 10cm deep, water still or eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
DP	**- Deep pool**	> =30 cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
SP	**- Shallow pool**	< 30cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
DG	**- Deep glide**	> =30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
SG	**- Shallow glide**	< 30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule is placed in the current, smooth surface appearance, water flow is silent.
RU	**- Run**	water flow fast, unbroken standing waves at surface; water flow is silent.
RI	**- Riffle**	water flow fast, broken standing waves at surface; water flow is audible.
TO	**- Torrent**	white water, chaotic and turbulent flow, water flow is noisy, difficult to distinguish substrate.

Flow type is determined by a combination of water depth, surface appearance, speed of flow and sound. Note that wind can mislead by creating surface ripples and the surface of deep pools can be affected by upwelling water. Sound can also cause faster flow types to appear more prominent and lead to over-estimating percentages of noisy flow categories.

Classification into different flow types involves depth estimates which can be notoriously difficult to judge by eye. Always use a gauging stick to 'calibrate' your visual estimates.

Flow notes

Record any comments you wish to make about the flow in the survey stretch. It is always useful to record a general statement on the flow types or patterns.

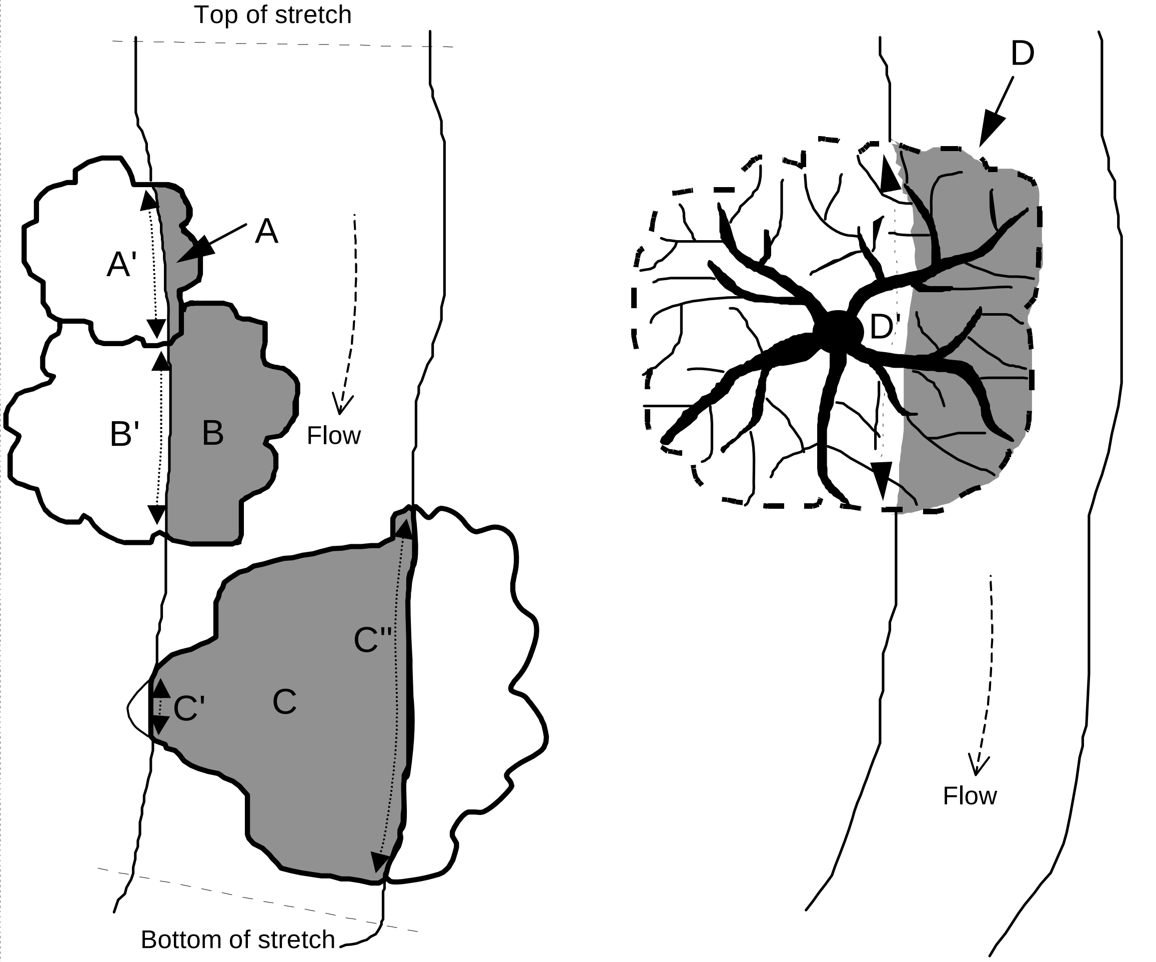
Canopy cover (% of survey stretch wetted area)

Estimate the percentage of the survey stretch wetted area covered by overhanging branches from trees or shrubs. Canopy cover must be greater than 0% if 'Overhanging boughs' is greater than 0%. Figure 4 gives examples and see *Overhanging boughs* on page 29).

Note that the *Canopy cover* value will vary with river width and flow height. For a narrow stream with trees along both banks, *Canopy cover* could be 100% i.e. the full water area of the survey stretch is covered by the tree canopy. For the same length of survey stretch with the same number and size of trees on the banks, a wider river would have a *Canopy cover* value <100%, i.e. the width of the river prevents the tree canopy from each bank closing over the full water surface of the stretch. Similarly, except where the river channel is fully covered by the tree canopy, the *Canopy cover* value for a survey stretch is likely to be lower during low flows than when the full bed area is covered by water.

Canopy cover notes

Record any comments about canopy cover in the survey stretch. Notes should always be taken if there is excessive shading of the channel due to dense canopy cover. It can also be useful to record the main species of tree or shrub present and how these are distributed along the bank, for example whether scattered or continuous.



Canopy cover: Percentage of survey stretch wetted area covered by tree and shrub canopies. In the example given above:

Canopy cover (%) = ((A + B + C) / [Total area between top & bottom of stretch]) * 100

When leaves are not present on trees and shrubs (spring and autumn surveys), determine canopy cover by taking an outline around overhanging tree branches (D).

Overhanging boughs: Percentage of survey stretch bank length with overhanging tree and shrub branches. In the example given above:

Left bank (%) = (C'' / Bank length between top & bottom of stretch) * 100
Right bank (%) = ((A' + B' + C') / Bank length between top & bottom of stretch)) * 100

When leaves are not present on trees and shrubs (spring and autumn surveys), determine overhanging boughs & canopy cover based on outline around overhanging tree branches (D & D').

Figure 4: Recording canopy cover and overhanging boughs.

5.3 Parts C & D: Left and Right Bank Data

Where required, record each of the following variables for each bank. Cross check Right bank with Left bank values to confirm that the balance between the two banks is correct.

Fish cover (% of bank length)

Record the percentage of the survey bank length (the water/land boundary) that, at the time of survey, provides cover for fish.

Important: In this case 'cover' means physical cover for fish, not just secondary cover related to shading of the stream bed. It is often difficult to determine whether draped vegetation and undercut banks are sufficiently deep to provide cover for fish: always probe the depth using a stick before recording.

Type

Record the type of bankside fish cover by circling ONE OR MORE of the following:

UC	**- Undercut**:	Cover provided from undercut banks.
DR	**- Draped**:	Cover from vegetation rooted on the river bank and draping on to the water surface.
MA	**- Marginal**:	Cover provided by plants rooted in the stream bed. Exclude fully aquatic vegetation from this category.
RT	**- Roots**:	Cover provided by exposed roots of trees or shrubs growing on the bank. Trees and shrubs can be alive or dead.
RK	**- Rocks**:	Cover provided by rocks forming part of the bank. Do NOT confuse with instream cover provided by the bed substrate.
OTH	**- Other cover**:	Cover provided by any other bankside features. If circling OTH, give details in the space provided.

OR circle:

NONE - No fish cover: If there is no cover for fish OR fish cannot get to cover due to lack of water, i.e. only circle NONE if *Fish Cover* = 0%.

Cover notes

Record any comments you wish to make about fish cover for the bank. Where there is more than one Fish cover *Type*, note the more dominant type(s) for the bank.

Riparian buffer zone (m)

The buffer zone distance from the banktop, in metres with up to two decimal places.

The buffer zone distance is set to the approximate average distance from the banktop of

- an existing stock exclusion feature (fence, wall etc), if this feature is effective or can within reason be upgraded to provide effective protection to the river bank and is not too distant from the bank that upgrading would not be sensible (i.e. no more than 15-20 metres from the banktop, OR
- a major obvious change in riparian vegetation, such as forestry.

If there is an exclusion feature that is both ineffective and not upgradeable or there is no major obvious change in vegetation, the surveyor has the freedom to determine the buffer zone distance. It is recommended that this should be at least 5-10 metres.

Grazing intensity (bankface & buffer zone)

Record the degree of grazing on the bankface and within the riparian buffer zone. Select ONE of the following:

None - Bank not grazed. (Select only if *Grazers* is 'None').

Light - Ground vegetation apparently grazed but impact is negligible AND/OR existing trees and shrubs show very slight damage only.

Moderate - Ground vegetation is shorter than normal in patches or throughout AND/OR existing trees and shrubs are moderately damaged.

Intense - Ground vegetation grazing is heavy to the roots of the bankside vegetation AND/OR existing trees and shrubs are extensively damaged.

Grazers (bankface & buffer zone)

This variable is used to highlight the predominant animals that actually graze the survey bank. Select ANY of the categories OR 'None' to record which animals, if any, graze the bankface and the buffer zone:

Deer **-** Grazed by any kind of deer.

Livestock **-** Grazed by goats, sheep and cattle.

Rabbits **-** Grazed by rabbits

OR

None **-** No apparent grazing to the river bank.
(Select only if *Grazing intensity* is 'None')

Grazing does not have to occur actively at the time of survey. Remember that grazers can come from both banks, so presence of an effective fence along the survey banktop does not necessarily preclude grazers from accessing that bank. Access from opposite banks is particularly problematic in very shallow rivers. It is important to only include grazers that you suspect are significantly contributing towards the recorded *Grazing intensity*.

For both *Grazing intensity* and *Grazers*, if the riparian buffer zone coincides with an exclusion feature, then record *Grazing intensity* and *Grazers* relating to the block of land between the river banktop and the exclusion feature, regardless of whether some of the exclusion feature is sometimes closer to the river than the buffer zone set for the stretch.

Grazing exclusion feature(s) present

Record what kind of exclusion features(s) are present, if any. Select ANY of the categories OR 'None' :

Deer fence

Stock fence

Wall

Hedge

Rabbit mesh

Other - Other exclusion type. Give details in the space provided.

OR

None - No exclusion features

Only record exclusion features on the bankface, in the buffer zone and/or along the outer edge of the buffer zone. In all cases record features that provide effective protection to the bank.

Also record exclusion features that are ineffective (e.g. a broken fence, gap in fence or collapsed wall), but only if the features can within reason be upgraded to provide effective protection. In other words, if there is an old collapsed wall 30cm high along the survey stretch, this wall should not be recorded because it would be completely uneconomical to upgrade it to provide full protection to the bank.

Exclusion upgrade required (m)

Estimate, in metres, the total length of grazing exclusion feature that would be beneficial within the survey stretch to effectively prevent recorded grazers from accessing the bankface and buffer zone for the bank. The surveyor will need to consider presence of grazers and grazing intensity as well as bank erosion and trampling.

Upgrading may include setting in place a completely new exclusion feature, repairing damaged sections of existing exclusion features, linking an existing exclusion feature to the bank so that animals cannot get around it, and so on. If the entire bank is unfenced then the exclusion upgrade required will be equal to the length of the survey bank plus, if required, the length of any connections to the bank itself (upstream and/or downstream).

Predominant bankface vegetation

Record the predominant vegetation structure on the bankface. Vegetation must be rooted on the bankface, and/or overhanging the bankface. Select ONE of the following:

Bare - Predominantly bare ground (or buildings / concrete). < 50% vegetation cover.
Uniform - Predominantly one vegetation type, but lacking scrub or trees.
Simple - Predominantly 2-3 vegetation types, with or without scrub or trees, but including tall or short herbs.
Complex - Four or more vegetation types which must include scrub or trees.

Predominant buffer zone vegetation

Record the predominant vegetation structure in the riparian buffer zone. Select ONE of the following:

Bare - Predominantly bare ground (or buildings / concrete). < 50% vegetation cover.
Uniform - Predominantly one vegetation type, but lacking scrub or trees.
Simple - Predominantly 2-3 vegetation types, with or without scrub or trees, but including tall or short herbs.
Complex - Four or more vegetation types which must include scrub or trees.

Important: For both *Predominant bankface vegetation* and *Predominant buffer zone vegetation*, 'vegetation types' does not mean different species. It refers to the structural complexity of the vegetation in terms of the number of different canopy layers (e.g. mosses vs. short grasses vs. tall grasses/herbs vs. shrubs vs. trees).

If the riparian buffer zone coincides with an exclusion feature, record *Predominant buffer zone vegetation* relating to the block of land between the river banktop and the exclusion feature, regardless of whether some of the exclusion feature is sometimes closer to the river than the buffer zone set for the stretch.

Collapse (%)

Record the percentage of <u>bankface length</u> in the survey stretch affected by bankface collapse in the following categories:

Severe - Substantial shifts in bank location due to collapse are likely after each successive flood. Banks highly unstable. Requires immediate attention if channel stabilisation is required.

Moderate - Shifts in bank location due to collapse are likely to be gradual. Banks still fairly stable, but could potentially be problematic in the future.

Light - Small amount of collapse of no major consequence in terms of channel stability.

Erosion (%)

Record the percentage of <u>bankface length</u> in the survey stretch affected by erosion in the following categories:

Severe - Substantial shifts in bank location due to erosion are likely after each successive flood. Banks highly unstable. Requires immediate attention if channel stabilisation is required. Usually difficult to stabilise.

Moderate - Shifts in bank location due to erosion are likely to be gradual. Banks fairly stable, but nevertheless has impact on stream morphology (width and depth). May become more problematic in the future.

Light - Small amount of erosion of no major consequence in terms of channel stability.

<u>Important</u>: In practice collapse is directly caused by erosion undermining the bottom of a bank. In other words, a collapsing bank is almost always also eroding, and an eroding bank often also displays some collapse features. It is important, however, NEVER to classify a section of bank as both collapsing and eroding but to EITHER record it as collapsing OR eroding, depending on the predominant type of instability displayed.

- Collapse takes the form of chunks of bank toppling or slumping into the river channel (usually because the bank is being undermined by erosive forces).
- Erosion is different from collapse in that the bank is generally 'cut back' by strong water current, and most of the displaced sediment is carried away in the river. There is no <u>major</u> bank toppling or slumping visible.

Only record bank *Collapse* or *Erosion* if it evident that the bank is still being actively affected. If it has been affected in the past but has since <u>stabilised</u>, do not record the bank as being affected by collapse or erosion. If the bank has been <u>successfully</u> repaired to stabilise it, again do not record it as collapsing or eroding but remember to record the repair under the bank/channel modification section (Part H).

Trampling (%)

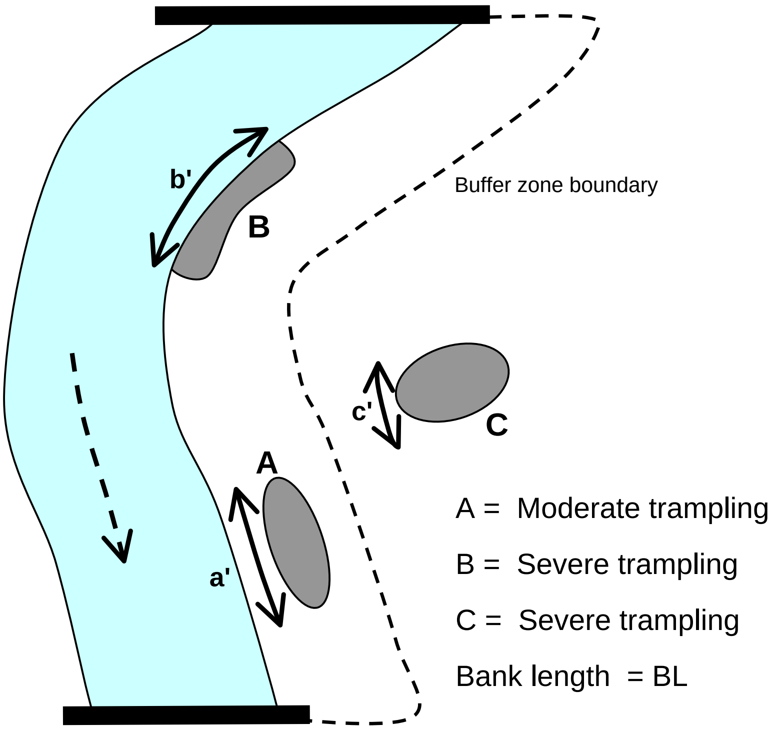
Record the percentage of bankface length in the survey stretch affected by trampling (by animals and/or humans) in the following categories:

Severe - Substantial trampling likely to act as a seed point for further bank instability. Less than 1/3 of original bankside vegetation cover present. Requires immediate attention to remedy problem.

Moderate - Trampling obvious but more than 1/3 of bankside vegetation still present. Could be problematic in the future.

Light - Small amount of trampling of no major consequence in terms of channel stability. Original vegetation cover almost intact.

Important: Trampling can occur anywhere within the riparian buffer zone, and does not necessarily have to be directly on the bankface. Trampling falling outside the riparian buffer zone that you have set should not be recorded.



Left bank severe trampling (%) = (b' / BL) x 100

Left bank moderate trampling (%) = (a' / BL) x 100

Trampling outside the buffer zone (C & c') must never be included

Figure 5: Recording bankside trampling

Bankside notes

Record any comments you wish to make about the bankside status. Notes should always be taken if the bank is severely affected by grazing, collapse, erosion or trampling.

Side bars (%) / Point bars %

Record the percentage of bank length in the survey stretch with side bars or point bars. Bars are sedimentary depositional features between the water/land boundary and the banktop (usually composed of gravel / pebbles / cobbles / boulders).

- Side bars are always found along straight sections of the survey stretch.
- Point bars are always located on the inner bank of a river meander and are associated with erosion of the outer bank of the meander.

Side bars stable? / Point bars stable?

Record whether the side bars or point bars appear to be predominantly stable (**Y / N / NA**).

Remember that all bars are to some extent unstable. These variables are used to identify those stretches where bar instability is extreme.

- Use ‘Yes’ (Y) only where the bas shows signs that it has been in its current position for more than one or two years. Vegetation may include established bushes or small trees as well as mosses and/or grasses.
- Use ‘No’ (N) only where bar instability is severe. A good indicator of instability is lack of terrestrial vegetation or mosses growing on the bar.
- Use ‘Not applicable’ (NA) if there are no side or point bars in the survey stretch (i.e. *Side bars* or *Point bars* = 0%).

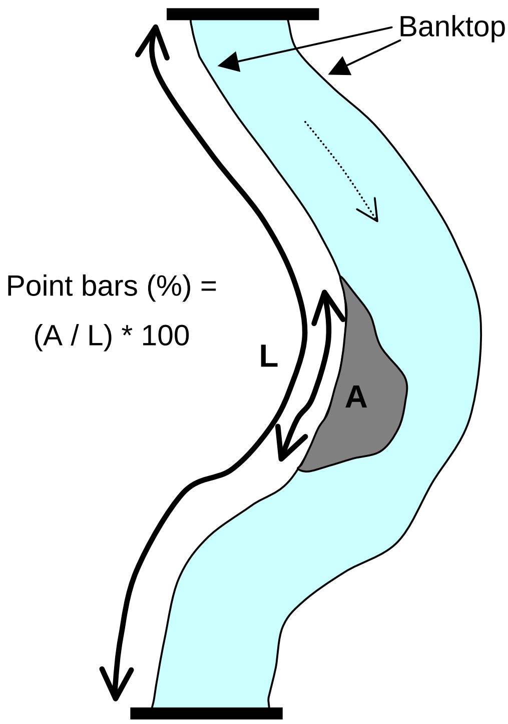


Figure 6: Calculating side or point bar percentages.

Overhanging boughs (% of bank length - trees and shrubs)

Record the percentage of bank length in the survey stretch where there are branches from trees and shrubs rooted in the riparian zone overhanging the water. Remember to include any overhanging boughs from trees rooted on the opposite bank of the river. *Overhanging boughs* must be greater than 0% if *Canopy cover* is greater than 0%. Examples are shown in Figure 4 and see *Canopy cover* on page 22).

Note that the *Overhanging boughs* value will vary with flow height and wider rivers are less likely to include overhangs from trees rooted on the opposite bank. Except where the river channel is fully covered by the tree canopy, the *Overhanging boughs* value for a survey stretch is likely to be lower during low flows than when the full bed area is covered by water.

Predominant overhanging trees

Record the predominant type of tree or shrub overhanging the river. Select ONE of the following:

Deciduous - Mainly deciduous trees or shrubs
Evergreen - Mainly evergreen trees or shrubs
OR
None - No overhanging trees or shrubs.
Only select 'None' if *Overhanging boughs* and *Canopy cover* equal 0%.

Predominant land use (50 m from banktop) ***(See Appendix 3 - 5.)***

Record the most important landuse type within 50 metres of the banktop. Select ONLY ONE of the following:

- **AR** - Arable (agricultural land with growing crops)
- **BL** - Broadleaf / mixed woodland
- **CP** - Conifer plantations
- **FW** - Felled woodland (recently felled only)
- **GP** - Gardens and parkland
- **IG** - Improved / semi-improved grass (agricultural, reseeded or fertilised)
- **IN** - Industrial land / agricultural buildings (including landfill)
- **MH** - Moorland / heath (heather dominated, with / without rough grasses)
- **NC** - Natural / semi-natural conifers
- **OR** - Orchard
- **OW** - Open water (natural lochs and artificial reservoirs)
- **RD** - Road and railway
- **RP** - Rough pasture (unimproved grassland)
- **RS** - Rock and scree
- **SC** - Scrub (including brambles, woody shrubs, gorse)
- **SU** - Suburban / urban development
- **TH** - Tall herbs / rank vegetation (including hogweed, tall thistles, nettles, bracken, and herbs greater than waist high)
- **TL** - Tilled land (agricultural ploughed land)
- **WL** - Wetland (marsh, bog, fen, wet woodland)

Other land uses (50 m from banktop) ***(See Appendix 3 - 5.)***

Record the other land use types found within 50 metres of the banktop. The list of categories is the same as for *Predominant land use* above, with the additional option 'NA'. Select ANY of the categories, EXCEPT the landuse selected as *Predominant land use*:

OR

- **NA** - Not applicable. Select NA if land use within 50 metres of the bank is entirely of one type which has already been recorded under *Predominant land use*.

Presence of young plantations

Record whether there are any young plantations (trees < 2 metres high) planted along the bank. Select ANY of the following:

Deciduous - Deciduous plantation
Coniferous - Conifer plantation
Mixed - Mixed deciduous and conifer plantation
OR
None - No plantations

Important: Natural regeneration following clear felling should NOT be included in this variable. Make sure that you only include areas as *Young plantations* if they have obviously been re-planted.

Conifer planting conforms to F&W guidelines?

Record whether any conifer planting along the bank of the survey stretch conforms with the latest Forests and Water Guidelines (**Y / N / NA**). Use 'NA' if there is no conifer planting along the bank.

The F&W Guidelines (4th Edition) are as follows:

- For channels >2 metres wide:
  trees must be 20 metres from the watercourse
- For channels 1 – 2 metres wide:
  trees must be 10 metres from the watercourse
- For channels <1 metre wide:
  trees must be 5 metres from the watercourse UNLESS the watercourse has been highlighted as important for fish or spawning, when a minimum of 10 metres should apply.

The Forestry Commission's 'Forests and Water Guidelines' is available from their website and is referenced in Section 8.

Riparian notes

Record any comments that you wish to make about the riparian zone for the bank. Add comments particularly when overhanging trees or adjacent landuse are likely to be affecting the instream habitat. Always add notes during low flows if there are bankside trees but *Canopy cover* and *Overhanging boughs* values are zero. Always also comment on felled or replanted woodland.

5.4 Part E: Survey Stretch Photographs

Survey stretch photographs

Record photograph identification numbers relating to the survey stretch.

Take at least two photographs of the survey stretch to illustrate the general character of the stretch, and additional photographs of any unusual features to aid interpretation of their impact on the river channel and fish habitat. (Record photographs for point features separately in Parts F – H below.)

A digital camera with built in time and date facilities is recommended to ensure photographs are correctly assigned to survey stretches. It is suggested that the stretch ID and survey date are marked on an A3 size white board with a thick black pen at the time of survey and the board included in photographs to ensure accurate identification. Photographs are extremely valuable for habitat assessments: it is better to take too many than too few.

5.5 Part F: Pollution Points

Pollution ID

Any combination of letters or numbers that gives a unique ID to the pollution point.

A combination of letters to denote hierarchical location on a river system and numbers to denote the order of the pollution point on a given tributary is recommended.

Example:
First pollution point on fifth survey stretch of River Garry on Tay system: TG05_P01

Easting

Full six figure metre resolution easting of the pollution point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Northing

Full six figure metre resolution northing of the pollution point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Time

Record the time at which the point pollution source was found (24 hour clock).

Pollution Type ***(See Appendix 3 - 6.)***

Record the type of pollution source. Select ONE of the following:

FE - Farm effluent
FR - Fish rearing
IN - Industrial
RD - Road drainage
SE - Sewage effluent
SD - Sheep dip
?? - Don't know
OTH - Other type of pollution. Give details in the space provided.

Status

Record the status of the pollution point at the time of observation. Select ONE of the following:

Potential - Potential risk but not polluting at survey time.
Actual - Polluting at survey time.

Dead fish?

Record whether, at the time of observation**,** dead or distressed fish were found (**Y/ N**).

Important: ALWAYS take samples of dead or distressed fish and immediately inform the relevant authorities of the problem. In Scotland contact the local Scottish Environment Protection Agency (SEPA) office or the Police, or phone the SEPA emergency number: 0800 80 70 60. A contacts link for SEPA is included in Section 8.

Pollution Photos

Record the photograph identification numbers relating to the pollution point.
See *Survey stretch photographs* (page32) for suggested methods.

Take photographs upstream and downstream of the pollution area or source if it appears to be significantly affecting the river.

Pollution Contact

Record the name of the owner of the pollution source, with phone numbers and addresses if possible.

Pollution Notes

Record any comments you wish to make about the pollution point.

5.6 Part G: Obstacles

Obstacle ID

Any combination of letters or numbers that gives a unique ID to the obstacle.

A combination of letters to denote hierarchical location on a river system and numbers to denote the order of the obstacle on a given tributary is recommended.

Example:

Second obstacle on fifth survey stretch of River Garry on Tay system: TG05_Ob02

Easting

Full six figure metre resolution easting of the obstacle point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Northing

Full six figure metre resolution northing of the obstacle point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Obstacle Type ***(See Appendix 3 - 7.)***

Record the type of obstacle. Select ANY of the following:

BR - Bridge apron
CU - Culvert
DA - Dam
FC - Fish counter
FD - Flood debris
FS - Fish pass
FT - Fallen trees
GC - Gravel cones >50 cm high at side burns
WE - Weir
WF - Waterfall
WG - Water gate
OTH - Other type of obstacle. Give details in the space provided.

In general *Obstacle Type* categories should be recorded where they constitute a potential obstacle to fish movement.

Pass?

Record whether the obstacle is passable to fish. Select ONE of the following:

No (U/D) - Not passable to adults in upstream direction (U) and fatalities likely during passage of fish in downstream direction (D).
No (U) - Not passable to adults in upstream direction (U), passable to fish in downstream direction.
Yes (S/F) - Passable, but likely to be species/adult size (S) and flow (F) dependent.
Yes - Passable at all times, but could potentially be problematic.
?? - Unsure whether the obstacle is passable.

Important: Whether an obstacle is passable to adult fish in an upstream direction depends on many factors, including

- the physical nature of the obstacle (height, length, continuity, gradient),
- the depth and area of water at the base of the obstacle,
- the water flow across the obstacle (depth, speed, turbulence),
- the water flow at the top of the obstacle (depth, speed, turbulence),
- the water temperature, and
- the fish species and size.

It is important to note that it is often exceedingly difficult to determine whether fish are successfully able to negotiate an obstacle unless the case is very clear cut. If in doubt always use ‘Unsure’ (**??**) to record whether an obstacle is passable.

Vertical?

Record whether the obstacle is vertical or close to vertical (**Y / N / NA**).

Note that this variable is only applicable to waterfalls (WF), weirs (WE) and dams (DA) and in some cases culverts (CU), i.e. obstacles which typically require fish to jump vertically. Use ‘Not applicable’ (NA) in most other cases.

E-fishing required?

Record whether electrofishing is required to investigate the impact of the obstacle further (**Y / N**).

Obstacle Photos

Record the photograph identification numbers relating to the obstacle.
See *Survey stretch photographs* (page32) for suggested methods.

Important: Take photographs of ALL obstacles, upstream and downstream of the obstacle if it appears to be significantly affecting the river, so that these can be examined by third parties at a later stage. Always place a vertical scale next to the obstacle (a person or 1 metre rule) whilst taking obstacle photographs to allow height evaluation. Beware of underexposure due to turbulent white water, especially when taking photographs of waterfalls.

Obstacle Contact

Record the name of the owner of the obstacle or owner of the land on which the obstacle is found, with phone numbers and addresses if possible.

Obstacle Notes

Record any comments you wish to make about the obstacle.

5.7 Part H: Channel / Bank Modifications

Modification ID

Any combination of letters or numbers that gives a unique ID to the channel/bank modification point.

A combination of letters to denote hierarchical location on a river system and numbers to denote the order of the channel/bank modification point on a given tributary is recommended.

Example:
Third modification on fifth survey stretch of River Garry on Tay system: TG05_M03

Easting

Full six figure metre resolution easting of the modification point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Northing

Full six figure metre resolution northing of the modification point derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Location

Record the location of the channel/bank modification. Select ANY of the following:

Left bk - Left bank
Right bk - Right bank
Bed - River bed

Only select 'Bed' if the works are truly aimed at modifying the nature of the bed (e.g. pool creation). 'Bed' should not be selected if bankside modifications have had a secondary effect on the stream bed.

Modification Type ***(See Appendix 3 - 8.)***

Record the type of channel/bank modification. Select ANY of the following:

CD - Current deflectors
CR - Croys
CW - Concrete wall
FP - Fishing pool
GA - Gabions
HP - Holding pool
PI - Piling, sheet metal or wood
RE - Revetments
RR - Rip-rap
SN - Soft engineering
UC - Under construction / not yet identifiable
OTH - Other type of channel/bank modification. Give details in the space provided.

Effectiveness

Record whether the channel/bank modification has had an impact on the watercourse and is therefore effective. Select ONE of the following:

Effective - The channel/bank modification fulfils the purpose for which it was designed.

Ineffective - The problem still persists and the channel/bank modification does not fulfil the purpose for which it was designed.

Not known - Effectiveness is not clear or it is too early to tell.

Downstream effect?

Record whether the channel/bank modification has any obvious effects on the geomorphology of the stream downstream of the construction. Select ONE of the following:

Y - Obvious problems have been created downstream of the construction/modification (e.g. erosion, bank collapse). Record details in *Modification Notes* if this is the case.

N - There are no obvious downstream effects that can be attributed to the construction/modification.

Approx. age

Estimate the approximate age of the construction, in YEARS. Circle 'Not known' if you cannot tell how old the construction is.

Previous attempts

Record whether there are any signs that this is not the first attempt at channel/bank modification. Select ONE of the following:

0 - No previous attempts evident.

1 - One previous attempt evident.

2 - Two previous attempts evident.

>2 - More than 2 previous attempts evident.

Not known - Cannot tell / unsure how many previous attempts have been made.

Length (m)

Record the length of the channel/bank modification, in metres with up to two decimal places.

Modification Photos

Record the photograph identification numbers relating to the channel/bank modification. See *Survey stretch photographs* (page32) for suggested methods.

Take both upstream and downstream photographs of any major modification. Always take photographs if you are unsure of the nature, purpose or impact of the structure.

Modification Contact

Record the name of the owner of the channel/bank modification or owner of the land on which the channel/bank modification is found, with phone numbers and addresses if possible.

Modification Notes

Record any comments you wish to make about the channel/bank modification.

5.8 Part I: Spawning Locations

Spawning locations are recorded as point features despite the fact that they can sometimes span substantial areas. A grid reference is identified that denotes the centre of a general spawning region. This must lie on the river system.

The surveyor records the area of the spawning region, the percentage of the spawning region that is actually suitable for spawning (the useable percentage), the species for which the spawning region is most suitable, and whether the region is prone to egg washout during major winter floods due to bed instability.

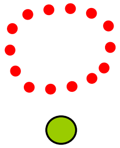
Figure 7 illustrates how this method allows maximum flexibility in recording spawning locations, depending on the precise purpose of the survey.

At one extreme (example a), if a very general assessment is required, the entire survey stretch can be assessed as one spawning region. In this case, unless there is extensive spawning within the survey stretch, the *Useable%* value will be low for the spawning region.

At the other extreme (example c), a highly detailed assessment could be made in which every small pocket of gravel is identified as a separate region (in this case four regions) and recorded on separate sections of the record sheet (Part I). Here the *Useable%* of each region is likely to be high because the boundary of each region corresponds to the actual area suitable for spawning.

An example of recording a medium amount of detail is illustrated in (b) with two separate regions identified for assessment.

Important: General spawning areas that are adjacent to each other must never overlap.



1. Within the survey stretch, select <u>one or more regions</u> to record spawning.

2. Record the <u>central grid reference</u> of each region.

m^2 — 3. Record the <u>area</u> of each region: *Area (m2)*

% — 4. Record the <u>percentage of substrate suitable for spawning</u> within each region: *Useable%*

5. Record other attributes.

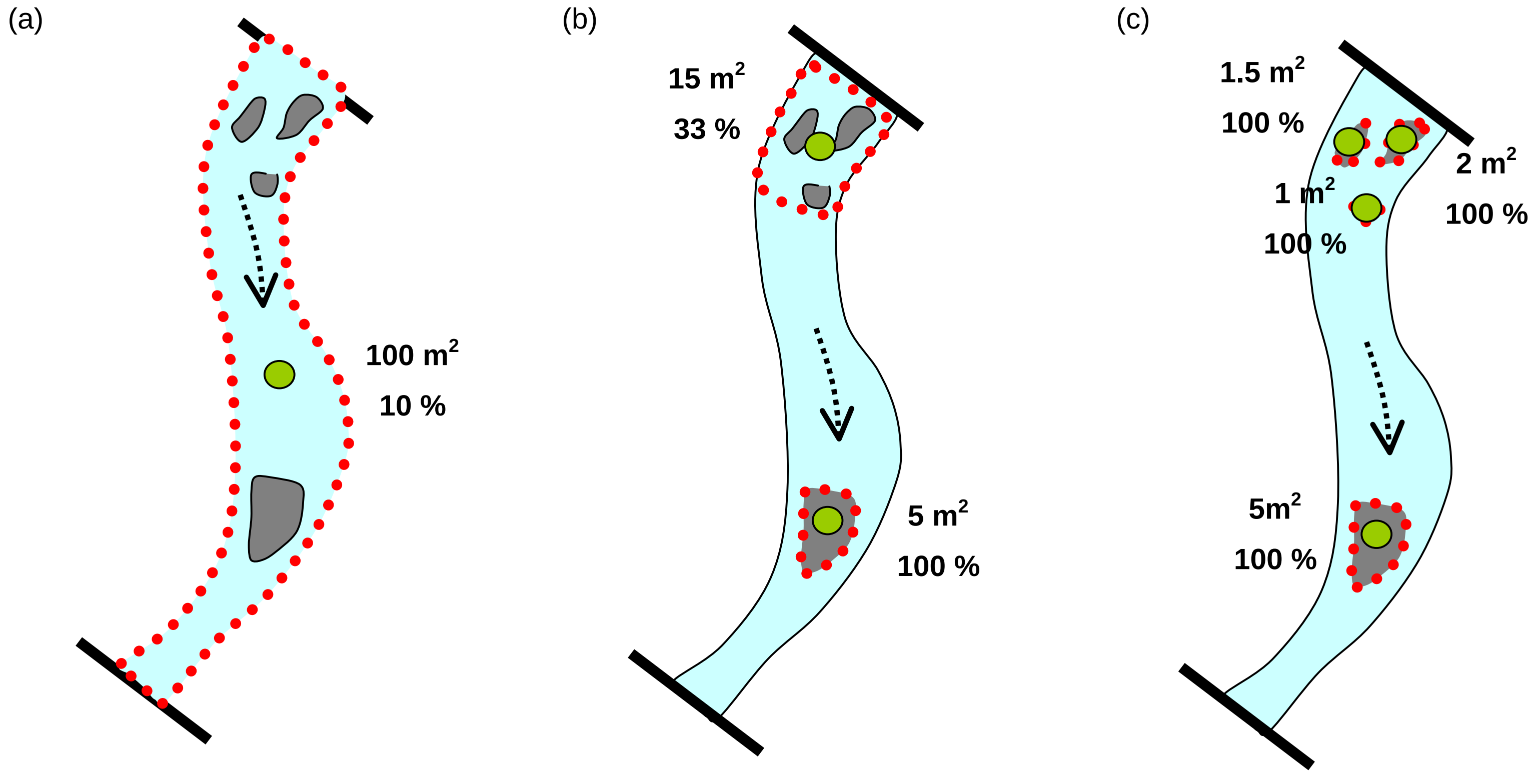


Figure 7: Recording spawning areas: different ways of recording spawning in the same stretch.

Spawning ID

Any combination of letters or numbers that gives a unique ID to the spawning location.

A combination of letters to denote hierarchical location on a river system and numbers to denote the order of the spawning point on a given tributary is recommended.

Example:
Fourth spawning region on fifth survey stretch of River Garry on Tay system:
TG05_S04

Easting

Full six figure metre resolution easting of the central point of the spawning location derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Northing

Full six figure metre resolution northing of the central point of the spawning location derived from a 1:50,000 or 1:25,000 scale Ordnance Survey map or GPS (see Figure 1).

Area (m2)

Record the area, in square metres, of the region over which you are assessing spawning.

If an assessment is made for the entire survey stretch (as in example a), then
Area (m2) = survey stretch *Length* x *Wet width*

Useable (%)

Record the percentage of the substrate within the assessed region that is actually suitable for spawning.

If an assessment is made of the entire survey stretch (example a), then in many cases, the *Useable%* value is likely to be substantially less than 100%. Otherwise the *Useable%* value can be 100%.

Suitability (G/P)

Record the suitability of the spawning area for salmon (**SA**) and for trout (**TR**). Insert ONE of the following in EACH of the spaces provided:

G - Good: Spawning is predominantly good.
P - Poor: Spawning is predominantly poor.

You may select ‘Good’ spawning for both species if this appears to be the case.

Washout?

Record whether the spawning area is prone to egg washout during winter floods. Insert ONE of the following in the space provided:

Y - Spawning is prone to washout
N - Spawning is not prone to washout
? - Don't know

Spawning Notes

Record any notes you wish to make about the spawning region or more generally about spawning areas within the survey stretch.

6. SFCC Habitat Field Methodology

6.1 Important Recording Points

It is ESSENTIAL that all required sections of the recording sheets are FULLY completed for each survey stretch in order to avoid confusion when the habitat data are analysed. Five important points should be kept in mind in this respect:

1. Record sheets should be completed neatly and legibly. Remember that data entry to the SFCC Habitat database may be completed some time after the field survey and/or by another person. Illegible recording of any data values can invalidate the whole survey and at the least require a revisit.

2. NEVER omit to record the ***Downstream easting***, ***Downstream northing, Upstream easting*** and ***Upstream northing*** for the recording stretch (Part A: General Information). Without these values it is impossible to enter the data gathered into the database or a GIS.

3. ALWAYS enter the ***ID***, ***River*** and ***Date*** at the top of EACH recording sheet in the spaces provided. This is essential so that recording sheets from different surveys cannot be mixed up. Always also remember to number any additional recording sheets required for pollution points, obstacles, channel/bank modification points or spawning regions in the spaces provided.

4. ALWAYS distinguish between zero values, variables deliberately not recorded and variables that were impossible to record. The following convention must be used:
   - Zero values: When the value of a given variable is zero, write a **0** ('Zero') in that box - NEVER leave blank and NEVER draw a line through the box.
     For example, where a Substrate or Flow category is not present in the survey stretch, the box should be recorded with a zero and not left blank.
   - Variables deliberately not recorded: If you do not wish to record a particular variable, then **draw a diagonal line** through the relevant box. NEVER leave the box blank.
   - Variables that were impossible to record: If you were unable to record a variable for a particular reason, mark **CR** ('Cannot record') in the relevant box. NEVER leave blank or draw a diagonal line through the box.
   - All boxes left blank are interpreted as variables that were mistakenly not completed.

5. ALWAYS take a few minutes to check the record sheets for a survey stretch before moving on to the next stretch. Completeness of each record sheet is essential for subsequent entry to the database and use of the data.
   - Check for items listed in 2 – 4.
   - Check that, where appropriate, values add up to 100%, for example, *Substrate Type* and *Flow Type*.
   - Check values where there is a specific connection, for example, *Canopy cover* and *Overhanging boughs*.
   - Check that grid references recorded for any point features (Parts F – I) relate correctly to the survey stretch grid references, i.e that the features are actually located on the survey stretch.

6.2 Suggested Field Recording Routine

Ultimately the precise field methodology is left up to individual surveyors. It is most important, however, that a logical routine is established and consistently followed for each survey stretch. A suggested routine for field recording is described below. The example given assumes that the survey is begun in an UPSTREAM direction.

1. Whilst standing at the downstream boundary of the survey stretch, start by recording general context information about the stretch (Part A: General Information). Do this BEFORE surveying the stretch. It is essential that this information is FULLY completed. Any omissions could easily result in ambiguities over the location of the survey stretch, making the habitat information useless.
2. Walk along the survey stretch in an upstream direction, pacing out the length of river to the upstream end of the survey stretch. Whilst walking along the stretch observe its general character.
3. After reaching the upstream end of the survey stretch, start recording information on channel characteristics (Part B: Channel Data) while moving back to the downstream end of the survey stretch. Whenever possible *Wet width* and *Bed width* should be measured from the river.
4. Water *Depth* values and *Substrate Type* should also be assessed from the river. Use a depth measuring stick and record tally marks for values found at regular intervals across the stretch. Use the tally marks to calculate estimated values for the categories. Broad *Flow Type* values may be best assessed from the bank but any ‘Glide’ or ‘Pool’ areas should be checked for depth.
5. After reaching the downstream end of the survey stretch again, move back upstream recording information for the left bank (Part C: Left Bank Data) and return recording the right bank (Part D: Right Bank Data). Again whenever safe, record bankside information by walking in the river. This allows a better view of both banks than standing on one of the banks, and will result in more accurate estimates of variables such as *Fish Cover*.
6. After reaching the downstream end of the survey stretch again, return upstream and, as required, record any photographs (Part E: Survey stretch photographs), pollution points (Part F: Pollution Points), obstacles (Part G: Obstacles), channel/bank modifications (Part H: Channel/Bank Modifications) or spawning locations (Part I: Spawning Locations) found in the survey stretch.
7. Check that the recording sheets are complete before starting the next survey stretch at its downstream point.

If the survey is begun in a DOWNSTREAM direction, start surveying the stretch at the upstream boundary and reverse all walking directions given above.

It is strongly recommended that information is recorded in the discrete ‘blocks’ shown on the recording sheets (i.e. general, channel, left bank, right bank and other information). Random recording of different categories of information is likely to lead to omissions and should be avoided.

7. Other Survey Methods

This section briefly covers two alternative methods of collecting river habitat data: a walk-over survey method and using aerial photographs.

7.1 Walk-over Surveys

An alternative to the SFCC Habitat survey is to carry out a 'walk-over' survey. The main walk-over habitat survey method that has been used in Scotland was developed for the Environment Agency's 'Restoration of Riverine Salmon Habitats' guidance manual (Hendry & Cragg-Hine, 1997). The 'Hendry & Cragg-Hine' method has been used to inform habitat restoration, survey site selection and fish population studies.

7.7.1 Hendry & Cragg-Hine Walk-over Method

The main objective of the Hendry & Cragg-Hine walk-over survey is to obtain a detailed representation of the precise location, extent, condition and juxtaposition of habitat features along and surrounding a river. This is done by walking the riverbank of the selected survey stretch, and entering the river when necessary. The survey aims to collect both general and detailed information on the current status of the instream and bankside habitats. The method allows for much ground to be covered in the least time and it can be applied both to local river and whole catchment studies. A summary of the habitat type classification system used is given below.

Habitat Type	Classification
Spawning habitat and silted spawning habitat	Stable gravel up to 30cm deep that is not compacted or contains excessive silt. Substrate size with a diameter of 1.3 to 10.2cm.
Fry (0+) habitat	Shallow (<20cm) and fast flowing water indicative of riffles and runs with a substrate dominated by gravel and cobbles.
Parr (1+) habitat	Riffle-run habitat that is generally faster and deeper than fry habitat (20-40cm). Substrate consists of boulder, cobbles and gravels.
Glides	Smooth laminar flow with little surface turbulence and generally greater than 30cm deep.
Pools	No perceptible flow and usually greater than 100m deep. Substrate with a high proportion of sand and silt.
Bankside/Tunnel vegetation	Riparian vegetation ideally providing a mixture of open and closed canopy throughout the reach. Tunnel vegetation forms a complete closed canopy for extensive lengths (e.g. >200m).
Macrophyte beds	Submerged and emergent macrophytes providing localised hydraulic diversity.
Flow constrictions	Physical features providing a narrowing of the channel resulting in increased velocity and depth.
Obstructions to migration	Impassable falls, weirs, bridge sills etc. shallow braided river sections preventing upstream migration during low flows.

Table 2. Habitat classification for walk-over survey method

Collecting information is essentially a field mapping exercise. Habitat units are drawn directly on to detailed high-resolution maps (usually 1:10,000 scale), reproduced on A4 sheets from Ordnance Survey data. Boundaries of different habitat features and types are assessed, drawn on the map to represent their actual position in the river, and labelled with symbols or letters in 'lollipops'. Positions of prominent or fixed features (such as bridges, pylons or trees) are recorded via GPS to provide accurate locations within the survey stretch. A good representation of habitat types and features can be recorded as a mosaic of areas and/or points along the whole of the surveyed section(s). Other details, such as bank, riparian and substrate structure, are recorded along with photographs of individual stretches or specific features.

After completion, survey maps are transferred into GIS which allows visual display, mapping and measurement of habitat types, and detailed spatial analysis. The survey data can be used, for example, to calculate the areas or extent of features such as degraded habitat or the amount of habitat inaccessible to migratory fish above obstructions.

7.1.2 Benefits and Limitations

The main benefits of walk-over surveys are speed and coverage of a river system. Walk-over surveys are faster to complete than a more detailed method such as the SFCC Habitat survey, and can provide specific detailed information as well as giving a more generalised overview. This is often very useful if looking at the 'state' of a river system, in a fish sense, or reviewing general catchment-wide issues. Walk-over surveys can provide well-judged information on the potential salmonid use of discrete river habitat types, such as spawning potential, fry habitat or parr habitat. Mapping features in the field allows habitat types to be displayed as coloured areas along a river on survey maps: a very powerful way of visualising and communicating survey information. Information from the walk-over survey can be combined with data from electrofishing surveys and estimates can be made for the carrying capacity and smolt output of a river system or particular survey stretch.

The main limitation of walk-over surveys is that the surveyor must both be experienced in the general application of a habitat survey, and understand the associations and interactions between the fish species and the specific river environment. Often it takes many years before a surveyor has enough field experience in understanding river systems in a general sense, in habitat surveying, and taking part in electrofishing surveys. The latter is most important; it provides the surveyor with a good understanding of how fish species use the different habitats available to them, which is invaluable when undertaking assessments such as carrying capacities or smolt output estimations. Although generally targeted at salmonids, the Hendry & Cragg-Hine method can be adapted for other freshwater species: again the surveyor must be very familiar with the habitat requirements for the species, in order to undertake a survey effectively.

For the Hendry & Cragg-Hine walk-over method, the surveyor requires access to large scale maps and pre- and post survey processing of the mapped data, all of which require appropriate resources. A further disadvantage of walk-over surveys in general is that a relatively small amount of detailed data is collected (such as individual flow combinations, substrates mixes, depths etc.). This may make comparison with any future survey data of the same river system more difficult.

7.2 Aerial Photography Surveys

Rather than field surveys, habitat information can be collected by remote sensing: the acquisition and interpretation of images from space or the air - satellite images and aerial photography. The techniques for producing and processing aerial photography and satellite images developed separately from each other and from GIS, but recent developments in technology increasingly allow their use together. This section gives a brief introduction to what are enormously complex areas in their own right. References in Section 8.3 provide further information on techniques and issues and some examples of applications to habitat investigation and mapping.

7.2.1 Remote Sensing and GIS

Aerial photography has been used for more than 100 years to provide information about the surface of the Earth and is the basis for most cartographic maps. Geographical Information Systems developed from digital cartography and store data mainly in vector format (points, lines and areas or polygons) with attributes attached to each feature. Images from satellites and, more recently, airborne sensors are produced in raster format (a regular grid of squares or 'pixels') with spectral properties attached to each pixel. Identifying features and investigating their spatial relationships within each of these formats requires quite different techniques and processing methods.

Satellite and airborne remote sensing has been widely used to study, map and monitor features on and above the Earth's surface, including terrain, vegetation, hydrology, oceans, weather and climate. Some sensors measure the energy reflected from the earth, e.g. Thematic Mapper (TM) on the Landsat satellite. The spectral reflectance of features varies at different wavelengths. This allows different features, captured in the image as individual pixels, to be identified by 'classifying' or grouping pixels. Healthy green vegetation and stressed vegetation, for example, have different unique reflectance values or 'spectral signatures'.

Other sensors send out a beam of light with a known wavelength and frequency and record the time it takes for the light to return from the Earth's surface to the sensor, e.g. LiDAR (Light Detection and Ranging). The Environment Agency use a LiDAR system, flying at 800 metres above the ground, to produce terrain (height) data suitable for assessing flood risk.

Images produced by satellite or airborne sensors vary in spatial resolution (the smallest distance on the ground distinguishable in the image i.e. the area of the Earth that each pixel represents and therefore the minimum detectable size of features on the ground). Airborne sensors can produce digital images with a much higher resolution than many satellite images and, in some cases, these may be suitable to study very small features such as instream habitats. Lower resolution images are used to study larger areas and are suitable for identifying large features such as lakes and forests. The extent covered by a high-resolution image is generally smaller and more images are required to cover a large area on the ground.

Before images can be used with other data, they must be registered or 'geo-referenced' to an appropriate co-ordinate system and corrected for any distortion. Image analysis techniques usually include automated classification to assign pixels to features, combined with field surveys to 'ground truth' the interpretation or results. Although linear features can be

particularly difficult to classify, the raster format lends itself well to modelling procedures for complex processes like river systems.
Satellite and airborne remote sensing has been applied to many studies of river morphology but there appear to be relatively few studies relating to instream habitat and aquatic species. This reflects the difficulties of remotely studying features that are not only in or under water, but change in complex ways both temporally and spatially. Studies generally require a combination of image interpretation, ground surveys, modelling and GIS in order to reach conclusions. An example of modelling salmon habitat, using airborne digital images with habitat and electrofishing surveys, can be found in Hedger et al (2006) and of analysing and mapping the geomorphology of tidal rivers and estuaries, using airborne sensor images with a walk-over survey, in Gilvear et al (2004).

GIS can support both vector and raster data formats, allowing overlay, display and analysis of data collected by different methods. Creating maps to visualise aspects of habitat data can be a very effective way of communicating information. However the power of GIS is in the ability to relate different data spatially and reveal new information about the relationship. Given suitable datasets, GIS allows complex querying and analysis, providing answers about data to what?, where?, how much? how near?, what if? type of questions. For river networks it can be used, for example, to identify stream types in relation to geology, gradient or landuse or to calculate stream order, distance from the sea or river length and catchment areas above an obstacle or survey site. An example of using GIS to generate catchment information and model the relationship to juvenile salmonid populations can be found in Coley (2003).

7.2.2 Aerial Photographs

Traditional aerial photography, using photographic film, results in images that can be scanned to create a raster image or interpreted and digitised to produce vector data. More recently, digital aerial photography has opened up possibilities for processing and analysing images using techniques similar to those for satellite images.

Aerial photographs are generally obtained using specialist cameras in low flying aircraft or helicopters, and may be taken directly overhead or ‘obliquely’. Images can be created at different scales and resolutions, showing more or less of the ground detail, depending on, among other things, the height of the sensor above the ground and the focal length of the camera. Images may be in black and white or colour but, like satellite and airborne sensors, infra-red can also be used to ‘see’ features not visible to the human eye.

All aerial photographs contain a degree of distortion caused by the Earth being curved, the varying height of surface terrain, atmospheric effects on light, and movement of the aircraft. Distortion may require geometric correction using photogrammetric techniques, but in some cases geo-referencing in GIS is sufficient.

Overhead photographs are normally taken in flight runs of overlapping images, allowing pairs of images to be viewed together, so that features can be seen as a stereoscopic image in three dimensions. Photo interpretation involves the use of tone, texture, pattern, shadow, location, context, size and shape to identify and measure features. Image scale, the season, time of day, weather conditions, cloud cover and shadow can all affect accurate interpretation of features. For river habitats, the riparian tree canopy can obscure features, while the amount of sunshine and water conditions can affect identification and measurement of instream features. Manual photo interpretation can be a lengthy process, and automated interpretation involves similar issues to those for satellite or airborne images.

The Eden Rivers Trust has carried out an assessment of the river and its catchment using visual interpretation of aerial photography and GIS analysis of catchment features. Two useful tables are contained in Dugdale et al (2005): a summary of features typically recorded during walk-over surveys and the alternative approaches for collecting the same data using GIS and remote sensing, and a list of the features identified and recorded for the Eden during interpretation of the photography.

7.2.3 Benefits and Limitations

The main benefits of collecting habitat data remotely are that

- data collection is rapid compared to field surveys,
- area, pattern and distribution measurements of features can be made relatively easily,
- large or remote and inaccessible areas can be covered,
- techniques are consistent and repeatable,
- processing can include sophisticated analysis,
- images can be available at regular intervals, allowing study of change over time, and
- images provide a historical record which can be used for other purposes at a later date.

Limitations will be apparent from the background information above and are mainly related to cost, skills and technical issues in identifying features. The cost of satellite images and of the software required for processing, and the need for skilled operators, makes this method of survey prohibitively expensive for most small organisations. Digital aerial photography and images from airborne remote sensors with improved image resolution, though still expensive to obtain and process, are more feasible at least for specific studies. Costs may in fact be comparable or even cheaper than the time and staff costs of field surveys. However not all habitat features can be identified from remotely sensed images and instream features pose particular difficulties. Section 3.4 lists some of the technical issues that may affect the successful use of aerial photography for habitat investigation.

SECTION 8

8. Bibliography and Further Information

There is a very large body of published material on salmonid habitat requirements, habitat survey methods, habitat classifications and models, the use of technologies involving remote sensing and geographical information systems, and the legislation relating to fresh waters, and freshwater habitats and species. The references below all include detailed bibliographies for further information.

Unless otherwise stated, most of the papers are available as pdf files from journal websites, from ScienceDirect http://www.sciencedirect.com/science or through the science search engine Scirus http://www.scirus.com/srsapp/.

Books may be available to purchase online from publisher websites or from NHBS http://www.nhbs.com. This site is also a good source for recent books on GIS, remote sensing and spatial analysis relevant to ecology and environmental applications.

Information about relevant environmental legislation can also be found on NetRegs www.netregs.gov.uk/netregs/. Follow links through Environmental Legislation.

8.1 Salmonids and Habitats

Armstrong, J.D., Kemp, P.S., Kennedy, G.J.A., Ladle, M. & Milner, N.J. (2003). Habitat requirements of Atlantic salmon and brown trout in rivers and streams. *Fisheries Research,* **62**, 143–170.

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Cowx, I.G. & Fraser, D. (2003). *Monitoring the Atlantic Salmon.* Conserving Natura 2000 Rivers Monitoring Series No. 7. English Nature, Peterborough. *Pdf available from* http://www.english-nature.org.uk/lifeinukrivers/species/salmon_monitoring.pdf

Crisp, D.T. (2000). *Trout and Salmon – Ecology, Conservation and Rehabilitation*. Blackwells.

Environment Agency (2003). *River Habitat Survey in Britain and Ireland: Field Survey Guidance Manual*. Environment Agency, Bristol.

Hendry, K., & Cragg-Hine, D. (1997). *Restoration of Riverine Salmon Habitats: A Guidance Manual*. R&D Technical Report W44. Environment Agency, Bristol.
Pdf available from publications catalogue http://publications.environment-agency.gov.uk/

Hendry, K. & Cragg-Hine, D. (2003). *Ecology of the Atlantic Salmon.* Conserving Natura 2000 Rivers Ecology Series No. 7. English Nature, Peterborough.
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Hendry, K., Cragg-Hine, D., O'Grady, M., Sambrook, H. & Stephen, A. (2003). Management of habitat for rehabilitation and enhancement of salmonid stocks. *Fisheries Research*, **62**, 171–192.

Maitland, P.S., Boon, P.J. & McLusky, D.S. (eds.) (1994). *The Fresh Waters of Scotland: A National Resource of International Significance.* John Wiley & Sons.
Includes chapters on Geomorphology, Water Chemistry, Fish, Invertebrates and pressures on the resource such as Afforestation and Acidification.

Maitland, P.S. (2004). *Evaluating the ecological and conservation status of freshwater fish communities in the United Kingdom.* Scottish Natural Heritage Commissioned Report No. 001 (ROAME No. F01AC6).
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Maitland, P.S. & Linsell, K. (2006). *Guide to Freshwater Fish of Britain and Europe*. Phillips.

Milner, N.J., Elliott, J.M., Armstrong, J.D., Gardiner, R., Welton, J.S. & Ladle, M. (2003). The natural control of salmon and trout populations in streams. *Fisheries Research*, **62**, 111–125.

O'Grady, M. (2006). *Channels and Challenges: The Enhancement of Salmonid Rivers.* Central Fisheries Board, Dublin.

O'Grady, M., Gargan, P., Delanty, K., Igoe, F., & Byrne, C. (2002). Observations in relation to changes in some physical and biological features of the Glenglosh River following bank stabilisation. *Paper available from 13th International Salmonid Habitat Enhancement Workshop* http://www.cfb.ie/salmonid_workshop/index.htm

Soulsby, C. (2003). *Managing River Habitat for Fisheries: A Guide to Best Practice*.
Pdf available from SEPA publications catalogue http://www.sepa.org.uk

Wentworth, C.E. (1922). A scale of grade and class terms for clastic sediments. *Journal of Ecology*, **30**, 377-392.

Werritty, A. & Hoey, T. (2004). *Geomorphological Changes and Trends in Scotland: River Channels and Processes.* Scottish Natural Heritage Commissioned Report No. 053 (ROAME No. F00AC107B). *Pdf available from publications catalogue* http://www.snh.org.uk/

Youngson, A.F., Jordan, W.C., Verspoor, E., McGinnity, P., Cross, T., & Ferguson, A. (2003). Management of salmonid fisheries in the British Isles: towards a practical approach based on population genetics. *Fisheries Research*, **62**, 193-209.

8.2 GIS and Remote Sensing Applications

Books and papers in this section give background information on remote sensing, including aerial photography, and the use of geographical information systems, with some applications of their use specific to fish and freshwater.

Coley, A. (2003). *Relationship between Juvenile Salmonid Populations and Catchment Features*. R&D Technical Report W2-065/TR. Environment Agency, Bristol.
Pdf available from publication catalogue http://publications.environment-agency.gov.uk/

Congalton, R.G., Birch, K., Jones, R. & Schriever, J. (2002). Evaluating remotely sensing techniques for mapping riparian vegetation. *Computers and Electronics in Agriculture*, **37**, 113-126.

Dugdale, L.J., Lane, S.N., Brown, J., Burt, T.P. & Maltby, A. (2006). Salmonids and scales: investigating the impact of land management on salmonid populations within a hierarchical framework through the use of remote sensing and GIS. *Proceedings of British Hydrological Society Ninth Hydrology Symposium*, **9**, 27-25.
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Dugdale, L.J., Lane, S.N. & Maltby, A. (2005). Achieving a rapid assessment of the river environment: what can remote sensing do to help? *Proceedings of the Institute of Fisheries Management Annual Conference 2005*, 154-173.
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Standard detailed introduction to remote sensing, airphoto interpretation, satellite images and image processing.

Marcus, L. & Lackey, L. (2005). *Prioritizing Restoration Activities for Salmonid Habitat within a Watershed*. Proceedings of the Twenty-Fifth Annual ESRI Use Conference.
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Paine, D.P. & Kiser, J.D. (2003). *Aerial Photography and Image Interpretation.* 2nd ed. John Wiley & Sons.
Up-to-date information on the technology, techniques, processes and methods used to create and interpret aerial photographs and other forms of remote sensing. Also covers GPS and GIS and gives applied examples of environmental monitoring.

Puhr, C.B. & Donoghue, D.N.M. (2000). Remote sensing of upland conifer plantations using Landsat TM data: a case study from Galloway, south-west Scotland. *International Journal of Remote Sensing*, **21(4)**, 633-646.

US Geological Survey, *Geographic Information Systems*.
http://erg.usgs.gov/isb/pubs/gis_poster
Introductory information with illustrations explaining some uses and applications of GIS.

US National Aeronautics and Space Administration, *Remote Sensing Tutorial*.
http://rst.gsfc.nasa.gov/
Tutorial covering remote sensing history to the present, with an introduction to the theory, techniques and applications of aerial photography and satellite images, and their use in GIS.

Wadsworth, R. & Treweek, J. (1999). *Geographical Information Systems for Ecology An Introduction.* Longman.
Readable, non-technical introduction to GIS and its use for ecology based applications.

8.3 <u>Legislation and Contacts</u>

English Nature. *Life in UK Rivers.*
Publications relating to conserving Natura 2000 rivers and protected freshwater species in the UK. http://www.english-nature.org.uk/lifeinukrivers/publications/publications.html
Publications include:
- *Ecology of Species of European Importance (including Atlantic Salmon, Freshwater Pearl Mussel, Lamprey and European Otter),*
- *Monitoring Protocols for these species,*
- *Developing Techniques to Address Key Conservation Issues and*
- *River Conservation Strategies for seven of the SAC rivers in the UK.*

English Nature. *Life in UK Rivers: Freshwater Species and Habitats of European Importance*. http://www.english-nature.org.uk/lifeinukrivers/species/species.html

Forestry Commission (2003). *Forests and Water Guidelines*. 4th ed. Forestry Commission, Edinburgh. *Pdf available from publications catalogue* http://www.forestry.gov.uk/

Fisheries Research Services: *A wide range of reports, leaflets and posters relating to fish and fisheries research in Scotland. Follow links through Information Resources.* http://www.frs-scotland.gov.uk/

Health and Safety Executive (2004). *Your Health, Your Safety: A Guide for Workers.* *Pdf available at* http://www.hse.gov.uk/pubns

Salmon Conservation (Scotland) Act 2001
Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003
Available at www.netregs.gov.uk/netregs/ *Follow links through Current Environmental Legislation / Scottish Legislation / Water Legislation*

Scottish Environment Protection Agency: *Contact details*
http://www.sepa.org.uk/contact/index.htm

Scottish Executive: *Habitats and Birds Directives*
http://www.scotland.gov.uk/library3/nature/habd-00.asp
Information on the EU Habitat and Birds Directives and their implementation in Scotland.

Scottish Executuve: *Publications relating to freshwater fish*
Available from publications catalogue http://www.scotland.gov.uk/Publications/Recent

Scottish Natural Heritage: *Contact details* http://www.snh.org.uk/about/ab-hq.asp

Scottish Natural Heritage: *Special Areas of Conservation and the Habitats and Birds Directive* http://www.snh.org.uk/about/directives/ab-dir07.asp

Skinner, A.,Young, M., & Hastie, L. (2003). *Ecology of the Freshwater Pearl Mussel*. Conserving Natura 2000 Rivers Ecology Series No. 2, English Nature, Peterborough.
Pdf available from http://www.english-nature.org.uk/lifeinukrivers/species/mussel.htm

Appendix 1: Health and Safety

Working in or near rivers, streams or any other body of water is potentially dangerous. Safety should be an integral part of carrying out river habitat surveys. The surveyor's employer is responsible for informing staff of potential dangers and for establishing procedures to minimise risks while carrying out surveys. The surveyor should also make every effort to minimise any risks in the field. SFCC strongly recommends that habitat surveys are carried out by two people, particularly in remote areas.

The following list, based on Environment Agency guidance, gives points that are essential to reduce risks:

- Survey supervisors or employers MUST ensure that the location and route of the surveyor is known each working day.
- A reporting-in and signing-off procedure, linked to a home and/or office base MUST be established and followed. This is especially important for surveyors working alone.
- An agreed system of emergency action MUST be established in case a surveyor does not report in or sign off at the end of the day, or at agreed shorter time intervals.
- A risk assessment procedure should be established and completed before carrying out a survey.
- Surveyors should carry a mobile phone and, if working in remote areas where there is no reliable signal, should establish the location of the nearest telephone or mobile phone signal.
- Surveyors should carry a basic first aid kit and be trained in basic first aid and map reading.
- Surveyors should always wear a lifejacket and wear (not just carry) a whistle.

When in the field surveyors should also:

- consider whether it is safe to work alone: if not work in pairs, especially on large rivers or in remote areas
- avoid steep or unstable banks
- avoid rivers during high and spate conditions
- never enter water where the river bed is not visible
- never enter a culvert
- use a ranging pole while in the water to help maintain balance
- watch out for hazards especially in urban rivers, such as broken glass, sharp metal or decomposing waste
- avoid contact with the water, soil or low vegetation before eating or drinking during field work (and see Appendix 2)
- wear appropriate clothing for the job and weather conditions

Appendix 2: Weil's Disease and Other Health Hazards

Weil's Disease
All personnel involved in working near water should be made aware of the risks of Leptospirosis and the more severe form, Weil's Disease. The disease Leptospirosis is caused by *Leptospira* bacteria and is transmitted to humans by contact with the urine of rats, cattle, foxes, rodents and other wild animals, usually by contact with contaminated soil or water. In the UK the most common *Leptospira* bacteria are those associated with cattle and with rats.

Bacteria from the urine can survive in fresh water for up to a month and infect animals and humans which come into contact with it. Infected water may not appear polluted, but caution should be applied around water draining farmland or areas of human habitation where rats could be present. Areas where signs of pollution or rats are seen should be avoided.

The bacterium enters the human body through cuts in the skin or through the lining of the nose, throat or alimentary tract. To minimise the risk of infection cover cuts with waterproof dressings, wear oversuits and gloves, and do not immerse your head. If an area is thought to be low-risk and diving or snorkelling surveys are being carried out, drysuits are preferred and care should be taken to avoid swallowing water when purging or changing regulators / snorkels. Hands should be washed thoroughly before eating, drinking or smoking, and all equipment and clothing should be disinfected or washed in clean water after use.

Weil's Disease is extremely rare in the UK; however it is a very serious illness and must be swiftly diagnosed and treated.

The incubation period for the disease varies from 3 to 19 days. The initial stages of Weil's Disease resemble a cold or flu, with symptoms including **fever**, **muscular aches and pains**, **loss of appetite** and **nausea.** The fever lasts for approximately **five days** followed by a marked deterioration. Later symptoms include **bruising of the skin**, **sore eyes**, **nose bleeds** and **jaundice**. Treatment with antibiotics needs to begin rapidly after symptoms develop. If left untreated it can cause **liver damage** and even **death**.

Anyone experiencing a fever after working in water should contact their GP immediately and tell them that they suspect Weil's Disease. Weil's Disease is a notifiable illness in the UK and if it is confirmed it will be necessary to inform the local Public Health office where you believe the disease was caught. Pocket cards "Working with sewage" (publication IND(G)197) providing readily accessible information can be obtained from the Health and Safety Executive.

For further information visit:

Health and Safety Executive:	www.hse.gov.uk/pubns Free leaflets: indg84.pdf
NHS Direct:	www.nhsdirect.nhs.uk/encyclopaedia/a-z/
Leptospirosis Information Center:	www.leptospirosis.org

Other Health Hazards
Field workers should also be made aware of other potential health hazards. These include Lyme Disease and contact with toxic plants such as Giant Hogweed.

Lyme Disease is caused by the bacterium *Borrelia burgdorferi* and is transferred to humans by infected ticks. Care should be taken around forests and heathland where the tick's hosts, sheep and deer, are prevalent. Exposure to tick bites can be reduced by covering arms and wearing long trousers (light colours show up the ticks most easily) or wellingtons, and by checking skin carefully at the end of the day. Most ticks are not infected with the *Borrelia* bacterium but it is wise to remove them as soon as possible. Grip the tick as close to the skin as you can with tweezers and gently pull, twisting anti-clockwise at the same time. Specially designed loops for tick removal are often available from pet shops or veterinary surgeries.

The first symptom to be aware of is usually a pink or red spot at the site of the tick bite. This may take 3-30 days to develop and expands steadily, often with an inflamed red border. As the rash spreads the inner skin may return to a more normal appearance, forming an expanding "target pattern" with a flat border, or it may remain more evenly coloured. This rash, the "erythema migrans", may become large (10-70 cm) if left untreated. Additional symptoms in the first few weeks are: tiredness / fatigue, headache, fever, aches in muscles and joints, stiff neck and swollen glands. In rare cases more serious complications affect the nervous system, joints, heart and other tissues.

Anyone experiencing the erythema migrans rash should seek medical treatment. Diagnosis of Lyme Disease can be difficult, especially if you have been unaware of the tick bite: the bacterium does not always trigger the production of antibodies against it as some forms do not have a cell wall and may fail to be recognised as "foreign". Early treatment with antibiotics is usually recommended.

For further information visit:

NHS Direct:	www.nhsdirect.nhs.uk/encyclopaedia/a-z/
British Lyme Disease Foundation	www.wadhurst.demon.co.uk/lyme/

Giant Hogweed has a reddish purple stem and spotted leaf stalks, with fine spines that make it appear furry. The plant can grow to between three and five metres in height, the leaves may expand to 1.5 metres in width with flower heads commonly 250mm in width. The sap of giant hogweed contains an irritant which makes skin sensitive to ultra violet light and which can result in severe burns to the affected areas, with swelling and painful blistering. Large, watery blisters usually appear within 15-20 hours of contact with the sap and exposure to sunlight. Damaged skin will heal very slowly and can leave a residual pigmentation. This can develop into a dermatitis which flares up on exposure to sunlight.

Recognition of giant hogweed plants and avoiding contact with them are the best means of prevention. Long sleeved clothing should be worn in areas where it is present as this will minimise the risk of contact. Should contact occur with the sap, either through brushing against the bristles on the stem or breaking the stem or leaves, the skin should be **covered up** to reduce exposure to sunlight and washed **immediately** and thoroughly with soap and water.

If eradication programmes are to be implemented, in Scotland the Scottish Environment Protection Agency must be consulted about the proper use of herbicides near watercourses.

For further information visit:

NetRegs environmental guidance:	www.netregs.gov.uk/netregs/processes/367839/
SEPA:	www.sepa.org.uk/

Appendix 3: SFCC Habitat Survey Definition Changes

With a few exceptions, the definitions for SFCC Habitat survey variables and categories are the same as for habitat information collected during SFCC Electrofishing surveys. Some of the changes below have been made in order to standardise habitat data collection between the two surveys types, and to reduce any confusion caused by differences, in particular *Bed width* / *Bank base width* and *Substrate* percentages. Other text changes to Section 5 of this manual have been made to clarify definitions: recording values for these variables remains the same.

1. Survey Notes

New notes field for further comments on the survey.

2. Bed Visible%

The *Bed visible* definition was unclear and has been clarified with respect to obscured river bed (*Substrate* type 'OB'). Recording remains unchanged but caution should be used if comparing data with surveys completed at an earlier date for this variable. Revised and previous definitions are given below.

<u>Revised</u>:

Record the percentage of river bed in the <u>survey stretch wetted area</u> that is <u>visible</u>. Bed may not be visible because the water is too deep, coloured or turbulent, or covered by overhanging tree branches. Bed may also be obscured by roots, wood, sheets of iron, barrels etc that cannot be physically moved. <u>*Bed visible* and *Substrate* 'Obscured' values must ALWAYS add up to 100%</u>.

<u>Previous:</u>

Record the percentage of river bed in the survey stretch that is visible. Invisible areas may be covered by overhanging tree branches or may not be visible because the water is too deep and/or coloured.

3. Bank Base width / Bed width

Bank base width has been replaced with *Bed width*. *Bank width* has also been added. The definitions are given below. The important difference is that

- *Bank base width* <u>excludes</u> river bed below any visibly overhanging banks
- *Bed width* <u>includes</u> river bed under any visibly overhanging banks

Both variables include any exposed bed or bars visible at low flows (but this was not specified in the text for the definition of *Bank base width*).

Bank base width (m) - replaced

Record the representative bank base width for the survey stretch, in metres with up to two decimal places. *Bank base width* is measured from the base of the bank face on one side of the river to the base of the bank face on the other side of the river.

Bed width (m) – new

Record the representative width of the river bed for the survey stretch, in metres with up to two decimal places. *Bed width* is measured from the base of the bankface on one side of the river to the base of the bankface on the other side of the river, and <u>includes</u> any bed beneath visibly overhanging banks <u>and</u> any exposed bed or bars.

Bank Width (m) - new

Record the representative width between the two bank tops for the survey stretch, in metres with up to two decimal places. *Bank width* is measured at the 'bankfull' level, where the river spills over on to the floodplain. If the banks are of uneven height 'bankfull' is level with the banktop of the lower bank.

4. Substrate (% survey stretch wetted area)

The percentage calculation for *Substrate type* values has been changed from percentage of the visible bed of the wetted area for the survey stretch, to percentage of the full wetted area bed for the survey stretch. The definition for 'Obscured' (OB) has also been changed to include all areas not in the *Bed visible* area. This standardises *Substrate* calculations with Electrofishing surveys and allows direct comparison of *Substrate type* values between survey stretches. For surveys completed at an earlier date, direct comparisons can be made for *Substrate* values only if the *Bed visible* value is 100%, i.e. no invisible bed. The appropriate parts of the revised and previous definitions for *Substrate* are given below.

Revised:

Record the percentages of each substrate type in the survey stretch wetted area.
When estimating percentages, recorded substrate categories MUST add up to 100%. Substrate sizes are always measured along the longest axis:

OB - Obscured: Roots, wood, sheets of iron, barrels etc. that obscure the river bed and cannot physically be moved for inspection. (If it is possible to move a feature that obscures the river bed, the area covered by the feature should not be included in the 'Obscured' value.)
For instream vegetation, only the root coverage on the stream bed should be included in the 'Obscured' category as this can truly not be moved. Remaining instream vegetation can generally be moved and should therefore not be included.
INCLUDE in this category any substrate that cannot be seen because of water depth, colour or turbulence, or due to overhanging tree branches.
'Obscured' and *Bed Visible* values must ALWAYS add up to 100 %.

Previous:

Record the percentages of each substrate type in the survey stretch. When estimating percentages you should only refer to substrate that is VISIBLE. In other words if you can see 20% of the substrate, then your substrate assessment should be on that 20%, and all categories that you record MUST add up to 100%. Category sizes are always measured along the longest axis:

OB - Obscured: Wood, sheets of iron, barrels etc. that obscure the river bed and that cannot physically be moved for inspection. If it is possible to move a feature that obscures the river bed, the feature should not be included in the obscured percentage category.
For instream vegetation, only the root coverage on the stream bed should be included in the 'Obscured' category as this can truly not be moved. Remaining instream vegetation can generally be moved and should therefore not be included in this category. NEVER include percentage of substrate that cannot be seen because of water depth, colour or turbulence in this category.

5. Predominant land use (50 m from banktop)
Other land uses (50 m from banktop)

Categories have been reordered alphabetically and definitions clarified.

Conifer Plantation:

Code 'CO' changed to 'CP' to remove conflict with *Substrate Type* 'Cobble'.

Gardens and Parkland:

Code 'GA' changed to 'GP' to remove conflict with *Modification Type* 'Gabion'.

6. Pollution Type

Categories have been re-ordered alphabetically. No new categories or other changes.

7. Obstacle Type

Categories have been re-ordered alphabetically. No new categories added.

Fish Pass:

Code 'FP' changed to 'FS' to remove conflict with *Modification Type* 'Fishing Pool'.

8. Channel / Bank Modification Type

Categories have been re-ordered alphabetically and three new categories added:

PI – Piling:	Bank protection, usually constructed of sheet metal or wood, wood may be laid vertically or horizontally.
RR – Rip-rap:	Boulders used as bank protection, tipped or placed, usually non regular boulders or blocks, not cemented but may have earth between the boulders.
SN – Soft engineering:	Bio-degradable bank protection, matting with vegetation planting, brushwood, woven dead stakes and twigs, live willow stakes, 'log and Christmas tree'

Appendix 4: SFCC Habitat Survey Recording Sheets

SFCC HABITAT SURVEY VERSION 2.4

PART A: GENERAL INFORMATION

ID		River		Altitude (m)		Date	
DownstE (m)		DownstN (m)		UpstE (m)		UpstN (m)	
Length (m)		Water level	Circle ONE: Dry / Low / Medium / High / Spate				
Surveyor	Name: ………………………………… Accreditation Code: …………………	Proprietors					
		Survey notes					

PART B: CHANNEL DATA

Bed visible%		Wet width (m)		Bed width (m)		Bank width (m)		Mature islands(n)	

WATER DEPTHS (% OF SURVEY STRETCH WETTED AREA)

0-20 cm		21-40 cm		41-80 cm		>80 cm	

SUBSTRATE (% OF SURVEY STRETCH WETTED AREA)

HO		SI		SA		GR		PE		CO		BO		BE		OB	

Instream veg (%)		Silted?	Y / N	Iron deposits (%)	
Substrate	Circle ONE of EACH: Stable / Unstable **AND** Compacted / Partly / Uncompacted				
Substrate notes					

CHANNEL FEATURES (% OF SURVEY STRETCH LENGTH)

Braided channels (%)		Braids stable?	Y / N / NA
Channel feature notes			

FLOW (% OF SURVEY STRETCH WETTED AREA)

SM		DP		SP		DG		SG		RU		RI		TO	
Flow notes															

CANOPY COVER (% OF SURVEY STRETCH WETTED AREA)

Canopy cover (%)		Canopy cover notes	

PART C: LEFT BANK (looking DOWNSTREAM) DATA

BANKSIDE FISH COVER (% OF BANK LENGTH)

Fish Cover (%)		Type	**Circle ANY:** DR / UC / MA / RT / RK / OTH.. **OR** NONE
Cover Notes			

GENERAL BANKSIDE STATUS (% OF BANK LENGTH)

Riparian buffer zone (m)		Grazing intensity (bankface & buffer zone)	**Circle ONE:** None / Light / Moderate / Intense
Grazers (bankface & buffer zone)	**Circle ANY:** Deer / Livestock / Rabbits **OR** None		
Grazing exclusion feature(s) present	**Circle ANY OR 'None':** Deer fence / Stock fence / Wall / Hedge / Rabbit mesh / Other .... **OR** None	Exclusion upgrade required (m)	
Predominant bankface vegetation	**Circle ONE:** Bare / Uniform / Simple / Complex		
Predominant buffer zone vegetation	**Circle ONE:** Bare / Uniform / Simple / Complex		

Collapse (%)	Severe:……. Moderate:…….. Light:……..			Erosion (%)	Severe:…… Moderate:……… Light:……….		
Trampling (%)	Severe:……. Moderate:…….. Light:……..			Bankside notes			
Side bars (%)		Side bars stable?	Y / N / NA	Point bars (%)		Point bars stable?	Y / N / NA

RIPARIAN ZONE

Overhanging boughs (% of bank length - trees and shrubs)		Predominant overhanging trees	**Circle ONE:** Deciduous / Evergreen / None
Predominant land use (50m from banktop)	**Circle ONE:** AR / BL / CP / FW / GP / IG / IN / MH / NC / OR / OW / RD / RP / RS / SC / SU / TH / TL / WL		
Other land uses (50m from banktop)	**Circle ANY (EXCLUDING category already circled above) OR 'NA':** AR / BL / CP / FW / GP / IG / IN / MH / NC / OR / OW / RD / RP / RS / SC / SU / TH / TL / WL **OR** NA		
Presence of young plantations	**Circle ANY:** Deciduous / Coniferous / Mixed **OR** None		
Conifer planting: F&W guidelines?	Y / N / NA	Riparian notes	

ID		River		Date		V2.4

PART D: RIGHT BANK (looking DOWNSTREAM) DATA

BANKSIDE FISH COVER (% OF BANK LENGTH)

Fish Cover (%)		Type	**Circle ANY:** DR / UC / MA / RT / RK / OTH.. **OR** NONE
Cover Notes			

GENERAL BANKSIDE STATUS (% OF BANK LENGTH)

Riparian buffer zone (m)		Grazing intensity (bankface & buffer zone)	**Circle ONE :** None / Light / Moderate / Intense
Grazers (bankface & buffer zone)	**Circle ANY:** Deer / Livestock / Rabbits **OR** None		
Grazing exclusion feature(s) present	**Circle ANY OR 'None':** Deer fence / Stock fence / Wall / Hedge / Rabbit mesh / Other .... **OR** None	Exclusion upgrade required (m)	
Predominant bankface vegetation	**Circle ONE:** Bare / Uniform / Simple / Complex		
Predominant buffer zone vegetation	**Circle ONE:** Bare / Uniform / Simple / Complex		

Collapse (%)	**Severe**:……. **Moderate**:…….. **Light**:……..	Erosion (%)	**Severe**:…… **Moderate**:……… **Light**:……….
Trampling (%)	**Severe**:……. **Moderate**:…….. **Light**:……..	Bankside notes	

Side bars (%)		Side bars stable?	Y / N / NA	Point bars (%)		Point bars stable?	Y / N / NA

RIPARIAN ZONE

Overhanging boughs (% of bank length - trees and shrubs)		Predominant overhanging trees	**Circle ONE:** Deciduous / Evergreen / None
Predominant land use (50m from banktop)	**Circle ONE:** AR / BL / CP / FW / GP / IG / IN / MH / NC / OR / OW / RD / RP / RS / SC / SU / TH / TL / WL		
Other land uses (50m from banktop)	**Circle ANY (EXCLUDING category already circled above) OR 'NA':** AR / BL / CP / FW / GP / IG / IN / MH / NC / OR / OW / RD / RP / RS / SC / SU / TH / TL / WL **OR** NA		
Presence of young plantations	**Circle ANY:** Deciduous / Coniferous / Mixed **OR** None		
Conifer planting: F&W guidelines?	Y / N / NA	Riparian notes	

PART E: PHOTOGRAPHS

PART F: POLLUTION POINTS

ID		Easting		Northing		Time	
Type	**Circle ONE:** FE / FR / IN / RD / SE / SD / ?? / OTH					Status	Potential / Actual
Dead fish?	Y / N	Photos		Contact			
Notes							

PART G: OBSTACLES

ID		Easting		Northing	
Type	**Circle ANY:** BR / CU / DA / FC / FD / FS / FT / GC / WE / WF/ WG / OTH			Pass?	**Circle ONE:** No (U/D) / No (U) / Yes (S/F) / Yes / ??

Vertical?	Y / N / NA	EF required?	Y / N	Photos		Contact	
Notes							

PART H: CHANNEL / BANK MODIFICATIONS

ID		Easting		Northing		Location	**Circle ANY:** Left Bk / Right Bk / Bed
Type	**Circle ANY:** CD / CR / CW / FP / GA / HP / PI / RE / RR / SN / UC / OTH					Effectiveness	**Circle ONE:** Effective / Ineffective / Not known
Downstream effect ?	Y / N	Approx. age	.... / Not known	Previous attempts	0 / 1 / 2 / > 2 / Not known		
Length (m)		Photos		Contact			
Notes							

PART I: SPAWNING LOCATIONS

ID		Easting		Northing		Area (m2)		Useable (%)	
Suitability (G/P)	**SA**………. **TR**………..	Washout?	**Y / N / ?**	Notes					

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D ON PAGE ....

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D	*PAGE ....*

ID		River		Date		V2.4

PART F: POLLUTION POINTS

ID		Easting		Northing		Time	
Type	**Circle ONE:** FE / FR / IN / RD / SE / SD / ?? / OTH					Status	Potential / Actual
Dead fish?	Y / N	Photos		Contact			
Notes							

ID		Easting		Northing		Time	
Type	**Circle ONE:** FE / FR / IN / RD / SE / SD / ?? / OTH					Status	Potential / Actual
Dead fish?	Y / N	Photos		Contact			
Notes							

PART G: OBSTACLES

ID		Easting		Northing			
Type	**Circle ANY:** BR / CU / DA / FC / FD / FS / FT / GC / WE / WF/ WG / OTH			Pass?	**Circle ONE:** No (U/D) / No (U) / Yes (S/F) / Yes / ??		
Vertical?	Y / N / NA	EF required?	Y / N	Photos		Contact	
Notes							

ID		Easting		Northing			
Type	**Circle ANY:** BR / CU / DA / FC / FD / FS / FT / GC / WE / WF/ WG / OTH			Pass?	**Circle ONE:** No (U/D) / No (U) / Yes (S/F) / Yes / ??		
Vertical?	Y / N / NA	EF required?	Y / N	Photos		Contact	
Notes							

PART H: CHANNEL / BANK MODIFICATIONS

ID		Easting		Northing		Location	**Circle ANY:** Left Bk / Right Bk / Bed
Type	**Circle ANY:** CD / CR / CW / FP / GA / HP / PI / RE / RR / SN / UC / OTH					Effectiveness	**Circle ONE:** Effective / Ineffective / Not known
Downstream effect ?	Y / N	Approx. age	.... / Not known			Previous attempts	0 / 1 / 2 / > 2 / Not known
Length (m)		Photos		Contact			
Notes							

ID		Easting		Northing		Location	**Circle ANY:** Left Bk / Right Bk / Bed
Type	**Circle ANY:** CD / CR / CW / FP / GA / HP / PI / RE / RR / SN / UC / OTH					Effectiveness	**Circle ONE:** Effective / Ineffective / Not known
Downstream effect ?	Y / N	Approx. age	.... / Not known			Previous attempts	0 / 1 / 2 / > 2 / Not known
Length (m)		Photos		Contact			
Notes							

PART I: SPAWNING LOCATIONS

ID		Easting		Northing		Area (m2)		Useable (%)	
Suitability (G/P)	**SA**………. **TR**………..			Washout?	**Y / N / ?**	Notes			
ID		Easting		Northing		Area (m2)		Useable (%)	
Suitability (G/P)	**SA**………. **TR**………..			Washout?	**Y / N / ?**	Notes			
ID		Easting		Northing		Area (m2)		Useable (%)	
Suitability (G/P)	**SA**………. **TR**………..			Washout?	**Y / N / ?**	Notes			

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D ON PAGE ....