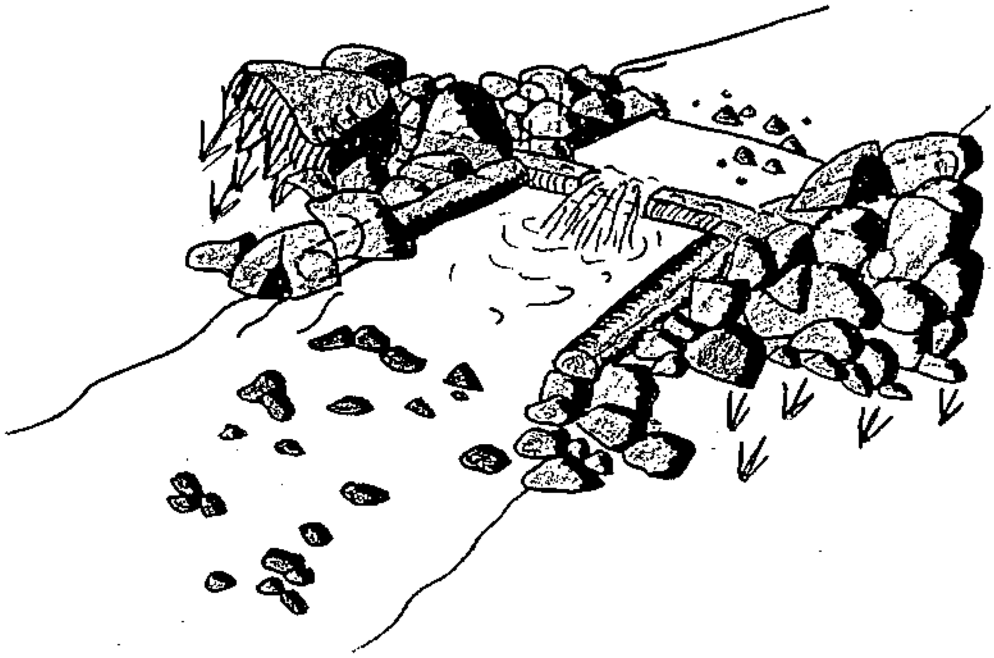

A WORKING GUIDE TO THE ASSESSMENT, IMPLIMENTATION AND POST PROJECT MONITORING OF FISHERIES HABITAT IMPROVEMENT SCHEMES

Report Nos NRA/NW/FTR/95/7

A WORKING GUIDE TO THE ASSESSMENT, IMPLEMENTATION AND POST PROJECT MONITORING OF FISHERIES HABITAT IMPROVEMENT SCHEMES IN SOUTH CUMBRIA

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FORWARD

This working document is split into three sections. They offer information on;

1) How to decide whether a habitat improvement scheme is a suitable management option at a chosen site.

2) Where habitat improvement is selected as a management option, the guide shows how to determine what will be most effective habitat improvement measures and how to implement them.

3) What factors require monitoring following a schemes implementation.

SECTION

1)	**The determination of suitability for habitat improvement, choice of schemes and post project appraisals.**
2)	**A manual of habitat improvement works.**
3)	**Worked examples using the guide.**

SECTION 1 DETERMINATION OF SUITABILITY FOR HABITAT IMPROVEMENT, CHOICE OF SCHEMES AND POST PROJECT APPRAISALS

INDEX

1.0 PURPOSE AND SCOPE

Due to changes in land use over the last century, the physical nature of many streams and rivers in the British Isles has probably changed. In some cases this change may be large for example as a result of flood defence schemes and is easily observed, whilst in other cases altered land use, farming, forestry or urbanization may have resulted in more subtle changes to river features.

This working guide draws together a way of assessing habitat in any stream or river and determine sites or reaches on the assessed watercourse that may benefit from habitat improvement schemes. It will determine a method of measuring existing habitat in a broad sense, whilst referring to R&D studies currently being undertaken in this area. A method of prioritising any proposed habitat restoration work will be suggested.

The limitations of fisheries improvement schemes in terms of cross functional acceptance (flood defence and conservation) will be examined along with suggested proposals for some example watercourses.

The need for pre and post enhancement monitoring will be discussed as will the requirement for maintenance programs on schemes.

Finally methods for determining the cost benefits of small schemes will be examined, compared to other currently used enhancement strategies. This will allow small scale revenue schemes to be used to back up pre project cost benefit analysis as required in future capital submissions.

2.0 INTRODUCTION

2.1 Habitat Requirements

Under conditions of adequate water quality and quantity, the capacity of a water body to support fish depends on the amount of usable space, food and cover. The specific requirements will vary from species to species, from life stage to life stage and from season to season. Cover includes physical features such as stones, boulders, overhangs and deep pools as well as emergent and bankside vegetation. Cover provides protection against predators, reduces the necessary territory size of individual fish and provides protection from displacement by currents. Vegetation provides a source of food for invertebrates on which fish feed and is an important source of those invertebrates when they fall into the water or are blown in by the wind, Black et al 1994.

Adult fish have additional requirements. All species require spawning substrate - either gravel or weed as appropriate. Many fish species migrate either within rivers or from rivers to estuaries and then open sea and for this they need open passage.

Where habitat is assessed as degraded or lacks diversity, schemes to increase the diversity and extent of cover for either one or a variety of life stages can be instigated. Such habitat improvement schemes (HIS) have been used extensively in North America and Canada for the last decade as largely natural and cost effective way of improving stocks of juvenile salmonids within nursery areas. For example, Hunt 1976, 1988, Binns et al 1979, Duff et al 1988 and Binns 1994.

Studies include the building of weirs, boulder clusters, wooden instream structures, bank overhangs and pool construction, along with tree planting and fencing. Adding such artificial structures to a stream can significantly increase it's carrying capacity over the medium term, although maintenance may be required to avoid a return to pre enhancement conditions. The use of fences to create buffer zones has been well documented both in Scotland (Espie 1995) and now on a trial bases in the Ribble catchment, in the North West NRA region (Walsingham per comm).

3.0 SCHEME DESIGN

A pre-requisite in any project of proposed enhancement is to be able to determine what the aims of the project are and whether they justify the cost incurred. A requirement of habitat improvement schemes is the ability to first demonstrate the lack of available habitat and therefore need for a scheme. This will not always result in the need for enhancement work as in many cases habitat may not be limiting production or may not be the primary limiting factor. If a scheme is required then alterations to the existing habitat should demonstrate that the improvements have resulted in appreciable and sustainable increases in fish population biomass. For this reason all schemes require detailed planning prior to implementation. This planning should include three overall phases. They are;

1) **PRE PROJECT ASSESSMENT AND PLANNING**

2) **PROJECT DESIGN AND IMPLEMENTATION**

3) **POST PROJECT APPRAISAL**

Within these three broad areas of the project, the following areas should be covered in detail;

Stream and/or site selection	
Habitat assessment - pre scheme	*PRE PROJECT*
Population Estimates - pre study.	*APPRAISAL*
Biological Production assessment	
Prioritization of projects	
Scheme Design	*DESIGN AND*
Consultation	
Implementation of scheme	*IMPLEMENTATION*
Habitat assessment - post scheme	
Population estimates - post scheme	*POST PROJECT*
Development of a maintenance plan	*APPRAISAL*
Cost Benefit Analysis	

3.1. PRE PROJECT ASSESSMENT AND PLANNING

3.1.1. Stream and/or site selection

In many cases streams that may benefit from habitat improvements are initially selected because of observations from field staff. These observations may relate to a perceived change in stream or river physical structure, or to an lack of observed fish (either visually or by rod catch.). These sites should be listed and where possible visited to select areas suitable for habitat assessment.

Additionally there may be rivers due for flood defence work or land drainage work, where a HIS may be added to the proposed works at the planning stage.

Finally, areas where low juvenile densities were recorded through the NRA's Strategic Stock Assessment Program, should be examined as habitat may be an important limiting factor in fish production.

3.1.2 Habitat Assessment.

No formally accepted national basis for habitat assessment currently exists within the NRA although current R&D projects looking at habitat include "Habscore", and "PHabSim". Neither of which have currently produced models for field analysis. Other habitat studies relate largely to American and Canadian research, Binns et al 1979, Bovee 1978, 1982, Raleigh et al 1986, Wesche et al 1987. In many cases these studies have endeavoured to determine habitat carrying capacity by using a number of determinants, for example flow velocity, cover, altitude, water depth, gradient. The complexity of these models with large numbers of variables requiring measurement (as in Habscore) and the assumption that the model will contain a linear relationship between these factors and fish populations can be questioned, Elliot 1994. Furthermore the time required for such detailed assessments may limit the cost effectiveness of HIS.

Thus, as the field of habitat assessment is clearly complex, this working document uses some of the ideas and models already published but in their broadest sense. The hope is to use a rough model which will allow for real improvements without perhaps the requirement for scientifically proven methodology. Following National R&D outputs there may be scope to "bolt on" more sophisticated models for assessing habitat and thus strengthen the confidence in choosing Habitat Assessment Schemes as a way of improving fish productivity.

Accordingly a proposed method of assessing habitat is given in Appendix 1, along with test data from a number of sites with known biological and fish production. In these 20 test cases, sites with observed high biological productivity were chosen. This will limit the effect that biological productivity as a variable will play in the determining salmonid production.

From the test data a set of equations were produced to score each type of cover and flow regime. Ideally sites scoring high in cover and/or flow patterns that suit juvenile salmonids should have high total salmonid production. This can be seen from the test sites as the model produced broadly shows increasing fish production with increasing habitat quality as assessed by the model.

Effects such as local land use and shading appeared to be important but not to the same magnitude as cover and flow. These should thus be addressed independently after limiting cover or suitable flow has been rectified.

3.1.3. Salmonid Population estimates

Prior to the implementation of any planned enhancements, it is essential that the current production of the stream reach in question is known. Where the reach has not been identified through the strategic stock assessment program an investigation should be undertaken by standard electrofishing methodology to determine the total productivity, species diversity and age class densities currently resident at the site.

For the benefit of prioritising sites that might benefit from an HIS it is proposed that two five class tables are used for scoring salmonid productivity. These are the standard classes (for salmon) as proposed from the National R&D project on fisheries classifications. The classes and the scores attributed to them for prioritization are set out in Table 1. (They are also found in, Appendix 3a, along with a justification of the total productivity score system.)

Table 1 Salmonid Productivity and Scores Attributed to them for the Prioritisation of Habitat Improvement Works

TOTAL PRODUCTIVITY DENSITY			CLASS	SCORE
SALMONID FRY				
0			F	0
0.01	-	9.0	E	1
9.01	-	23.0	D	2
23.01	-	45.0	C	3
45.01	-	86.0	B	4
>86.01			A	5
SALMONID PARR				
0			F	0
0.01	-	2.0	E	1
2.01	-	5.0	D	2
5.01	-	12.0	C	3
12.01	-	21.0	B	4
>21.01			A	5

Prior to scoring all salmon and trout fry are added together to create a combined salmonid fry production. The same procedure is used for salmon and trout parr.

3.1.4. Biological Production of Invertebrates

A method to simply assess the production of a reach of stream in terms of available fish food has been proposed, as in many cases this may prove an important limiting factor. Currently this methodology is in a test phase, although it should be robust enough for prioritization.

The methodology addresses the following points;

1) Easily undertaken by field staff with basic training in invertebrate biology.

2) Quick and repeatable.

3) Robust in assessing the available food for all juvenile salmonid age classes and species.

4) Able to be scored over a range of Low to High.

An example field sheet is enclosed in appendix 3b. Training will be given to staff involved using, An illustrated guide to the invertebrates of the North West region, B.Ingersent 1994 as a guide.

All samples will be based on a one minute kick sample and should be bank sorted and scored wherever possible.

Sites will be scored as follows;

Food Resources	Score
Abundant	100
Good	75
Moderate	50
Poor	25
Very Poor	0

Should a site be deemed suitable for habitat improvement work, a full biological investigation by Ecology staff should be considered prior to scheme implementation.

3.1.5. Prioritization

Priority should be given to habitat schemes where there is demonstrably good water quality and quantity and where current habitat is deemed low in quality as scored by the HQS index. This priority may be calculated by the following equation;

$$\text{Priority} = \frac{(BPS/HQS)}{TPS}$$

BPS Biological Productivity Score
HQS Habitat Quality Score
TPS Total Productivity

Scores may range from 0.1 to 100.

PRIORITY SCORE <2

Scores less than two are either limited by biological productivity and are unsuitable for habitat improvement works without first increasing invertebrate productivity or currently support a good total salmonid productivity.

PRIORITY SCORE 2-10

Scores above two but below 10 may already have good habitat but may have other factors limiting production. This could be limited resources of adult spawners or a lack of suitable spawning medium in the area. Alternatively medium to low biological production may be limiting fish production. Examination of the individual scores will determine what is the case.

PRIORITY SCORE 10-100

Scores greater than 10 have increasing merit for habitat improvements works, with the priority for work lying with the highest scoring sites.

In summary HIS will only initially be a suggestion for sites or reaches where the Priority score is greater than 10. All other sites have either contributing factors that may also effect production or are currently sites producing good densities of juvenile salmonids with no interference.

3.2. IMPLEMENTATION

3.2.1. Scheme design and implementation

The design of any habitat improvement scheme should take into account the stream width and gradient as these play an important part in defining the likely species and age class of fish that may colonize the area, National Fisheries Classification Scheme, Mainstone C.P et al 1994.

For this purpose the range of stream widths and associated gradients best suited to each age class and species of salmonid is enclosed in appendix 3.

Having established that there is scope to improve habitat and the species and age class targeted would benefit, the next step is to determine what improvement measures could be taken. A manual of possible enhancement works is enclosed along with a ready reckoner that shows which are most suited to each age class and species of salmonid. This manual will be expanded as further improvement measures are proved successful and functional.

There are some aspects of this work that would benefit all species, for example the 'fencing off' of areas subjects to livestock grazing and trampling. This type of improvement should be considered and where possible implemented at all sites prior to other measures.

When a scheme has been designed and accepted by all parties, photographic evidence of the site prior to implementation should be collected. This should be filed with the assessment data and the HIS design.

Following HIS implementation further post scheme photographs should be taken and added to this filed data.

3.2.2. Consultation

The actual choice of habitat improvement measures chosen will rely on a number of factors. These are likely to be financial and physical in nature and very site specific.

Financially some improvements may be beyond the funding available, although a suitable cost benefit analysis may aid their justification as a capital project, provided smaller schemes have been proved effective.

Physical constraints may be imposed to prevent increased flood risk from the habitat features proposed. Bank stabilisation may be required in many cases which whilst not directly improving fish habitat would stop deterioration of the new structures. The water services section of the NRA should be consulted at an early stage of any designs to ensure flood risk is not compromised.

Conservation interests also need identification and these should be addressed at the design stage.

In summary, the following persons will have to be notified of the intent to undertake habitat improvement works and their approval to designs sought prior to works commencing;

1 Fishery Owner
2 Land Owner
3 Flood Defence Staff
4 Conservation Staff
5 Financial Approval

3.2.3. Application and Timing

In general the best period for work to commence will be between the end of April and the end of June. In some smaller streams localised bank work could be undertaken through the summer months if 'in-river' work is kept to a minimum.

Under no circumstances should work be undertaken between October and March within the river/stream as downstream siltation may adversely effect localised natural production.

A timescale for each project should be drawn up prior to work commencing. If works are incomplete by the end of the allotted timescale, a review should be undertaken to determine if the timescale may be extended. This should take into account the likely effects of leaving the work unfinished through winter flood events against any damage caused by works outside the original timescale.

3.3. POST PROJECT APPRAISAL

3.3.1. Monitoring

It is essential that there is a post project appraisal of the effects of the habitat improvement scheme on fish densities and species diversity at all sites. This is required over a minimum of a four years post scheme implementation. Ideally this should be undertaken with controls, Keeley et al 1994.

The appraisal should be a minimum of one electrofishing survey within the scheme area and one site outside the area but on the same river (as a partial control) every year for a minimum of four years. Any sites failing to produce increased fish densities may require reappraisal to determine the reasons for a lack of improvement.

Ideally, there also should be a one off survey every five years on 10% of successful schemes to determine whether improvements have maintained the initial improved densities or if long term improvements have occurred.

The relationship between sites sampled, numbers of years monitored and the confidence that can be placed on survey results is shown in Appendix 4, adapted from Walters 1994. In theory schemes on some 8-16 paired (the paired site acts as a control) streams or large sites should be undertaken and monitored over 4-8 years, if assessment of this methodology is to be robust. Such a system of post project monitoring allows for a seasonal variation coefficient of up to 3.0. This is greater than may be expected on many streams and increasing the number of years post monitoring above 8 has little increased improvement in the likelihood of being wrong in the final assumption of this scheme.

Without such analysis it is possible that this type of habitat improvement works could be expanded with little improvement in overall fish production.

3.3.2. Maintenance plan

As with all natural environments, there will be a change or deterioration of structures/habitat within each scheme in the years following it's completion, Hunt 1976, Binns 1994. This will often have knock-on effects on fish productivity. It is therefore important that all HIS are visited at least yearly by field staff and any observed deterioration in habitat reported to the office. Maintenance may then be undertaken on a small scale to avoid the need for periodic large scale works.

It is possible that catastrophic flood events may remove or radically alter the HIS. If this occurs photographic evidence should be collected of the results and the suitability of the HIS discussed prior to it's reconstruction.

3.3.3. Cost benefit analysis

It should be a requirement of all schemes that a cost benefit analysis is undertaken to determine if the scheme has been worthwhile. This does not automatically result even if significant increases in fish production are observed in the Post Project Monitoring.

Cost benefit analysis should include wherever possible the following information;

Pre Project Assessment Costs

HQS Design and Implementation Costs

Maintenance Costs

Loss of river corridor.

Benefits in terms of juvenile and adult fish

Benefits on conservation grounds

Timescale of benefits.

Where a scheme is large and may require approval from PAB, this cost benefit analysis (CBA) will have to take place prior to scheme implementation. It should be possible from smaller revenue schemes already completed and subjected to CBA to undertake such a desk study.

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APPENDICES

HABITAT IMPROVEMENT FIELD SHEET

SITE NO. CATCHMENT U/S NGR

DATE RIVER D/S NGR

LENGTH OF RIVER FOR PROPOSED HABITAT IMPROVEMENT -

RIVER WIDTH (10 measurements equally spaced along length)

1) 2) 3) 4) 5) Mean = [ ]

6) 7) 8) 9) 10) Gradient = [ ]

1) SUBSTRATE (as a % of wetted area)

Bedrock [ ] Cobbles [ ] Fine Sand/Silt [ ]

Gravel [ ] Boulders & Rocks [ ]

2) COVER (as a % of wetted area)

Express each type of cover as a percentage of the total available.

Boulders [ ] Undercut Banks [ ] Branches & Logs [ ]

Tree Roots [ ] Overhanging Vegetation [ ] Other Eg. Walls Please Specify [ ]

Total cover as a percentage of total section area = [ ]
(See Table I)

3) FLOW

Pools [ ] Shallow Riffle [ ] Shallow Glides [ ]

Deep Riffle [ ] Deep Glides (>30cm) [ ]

4) What Percentage of the River is Shaded? [ ]

5) Is the River Fenced? [ ]
(Please Tick)

No [ ] One Bank [ ] Both Banks [ ]

Effective [ ] Not effective [ ] Grazed inside [ ]

6) Is the river prone to drying up? [ ]

7) LAND-USE : What is the land-use immediately surrounding the reach?

Woodland
Deciduous [ ] Coniferous with buffer zone [ ] Coniferous without buffer [ ]

Agriculture
Arable [ ] Intensive [ ] Improved Pasture [ ]

Moorland
High Altitude (>200m) [ ] Low Altitude (<200m) [ ]

Other
Residential [ ] Recreational [ ]

8) Bank State

Eroding banks Length (m) Nos of Sites [ ]

9) Channel State

Braiding Shoulders [ ]

10) Bank/In river Works

Please Specify

11) Note all downstream obstacles near site

Type and height

12) Other Observations

OFFICE USE ONLY HQS [ ]

Notes on Habitat Improvement Sheet

Sites chosen for habitat improvement should be a minimum of 50m in length but not exceed 200m. Habitat can be varied across this length but within reason.

At each site please fill in the field sheet as follows:-

Take 10 width measurements equally spaced along the length. Measure the gradient from a 1:50 000 Ordanance Survey map.

1) Substrate.

Record each substrate type as a percentage of the total. Areas of the river bed which have become concreted or areas of artificial river bed, should be classified as bedrock.

a) Bed-rock
b) Boulders & Rocks : > 25cm
c) Cobbles : 6 - 25cm
d) Gravel : 0.2 - 6cm
e) Fine Sand/Silt : <0.2cm

2) Cover.

Cover is defined as the area (expressed as a percentage of the section stream bed area) providing refuge for a >10cm trout. Determine each type of cover in the stream and express as a percentage of the whole reach. This requires wading for assessment, as overhangs, cover under boulders etc. can only be assessed by probing.
It is strongly recommended that measurements are taken in conjunction with Table I. Realistically 20% total cover is a maximum for any stream with an abundance of cover. Figure 1 shows examples of what 1% and 10% cover looks like.

a) Undercut Banks
   Areas where water has eroded away the material under a stream bank, but the upper portion has not slipped into the water.

b) Boulders
   Rocks, stones and boulders found in streams providing protection to fish.

c) Tree Roots
   Bank gets eroded away to leave a dense root system.

d) Overhanging Vegetation
   Overhead vegetation should be less than 30cm above the water surface.

e) Branches
Log and branch debris present in the stream.

f) Other
Anything else which is present in the river which can provide instream cover. Eg. walls, or weed

3) Flow.

Record the flow type throughout the reach as a percentage, using Table I as a guide.

a) Shallow Riffle (<30cm)
Shallow swift flowing section of stream where the water surface is broken. In many cases gravel, rubble or boulders break the surface.

b) Deep Riffle (>30cm)
Same as above with water depth greater than 30cm.

c) Pools
Slow or still water with a velocitiy of less than about $10cms^{-1}$. It will not form eddies behind a metre rule held vertically against the flow.

d) Deep Glides (>30cm)
Section of stream where the water velocities are greater than $10cms^{-1}$, (so form eddies behind a metre rule), but the surface is smooth.

e) Shallow Glides (<30cm)
Same as above with water depth less than 30 cm.

4) Shading.

Record the percentage of river shaded by woodland.

5) Fencing.

Record whether the river is fenced or not. Record whether this fencing is effective at excluding stock. Are the banks deliberatly grazed inside the fencing?

6) Drying Up

Record if the river is prone to drying up.

7) Land-use.

Record the land-use immediately surrounding the reach. If there is more than one, determine the percentage composition.

8) Bank State

Record the amount of eroding bank in meters of length. Also note the nos of seperate isolated eroding bank lengths.

9) Channel State

Record the Length of braided river channel. Braided refers to where the channel is broken up by in river gravel shoals to form several small streams. Record these even if they are dry at low water.

Record the number of gravel shoulders present as a percentage of the high flow bed area.

10) Bank/In river Works

Record the number and condition of any bankside or in-river works, For example, revetment, armour stone, gravel removal etc.

11) Note all downstream obstacles to fish migration. These may be small wiers, bridge aprons, gravel shoals at beck mouths, bridge aprons, or fallen trees etc. Please walk the entire beck from it's downstream confluence to the site being scored if not already done for a downstream site.

12) Other observations.
Any additional information which you think may be useful in assessing the river for habitat and possible suggestions for habitat improvement, if needed.

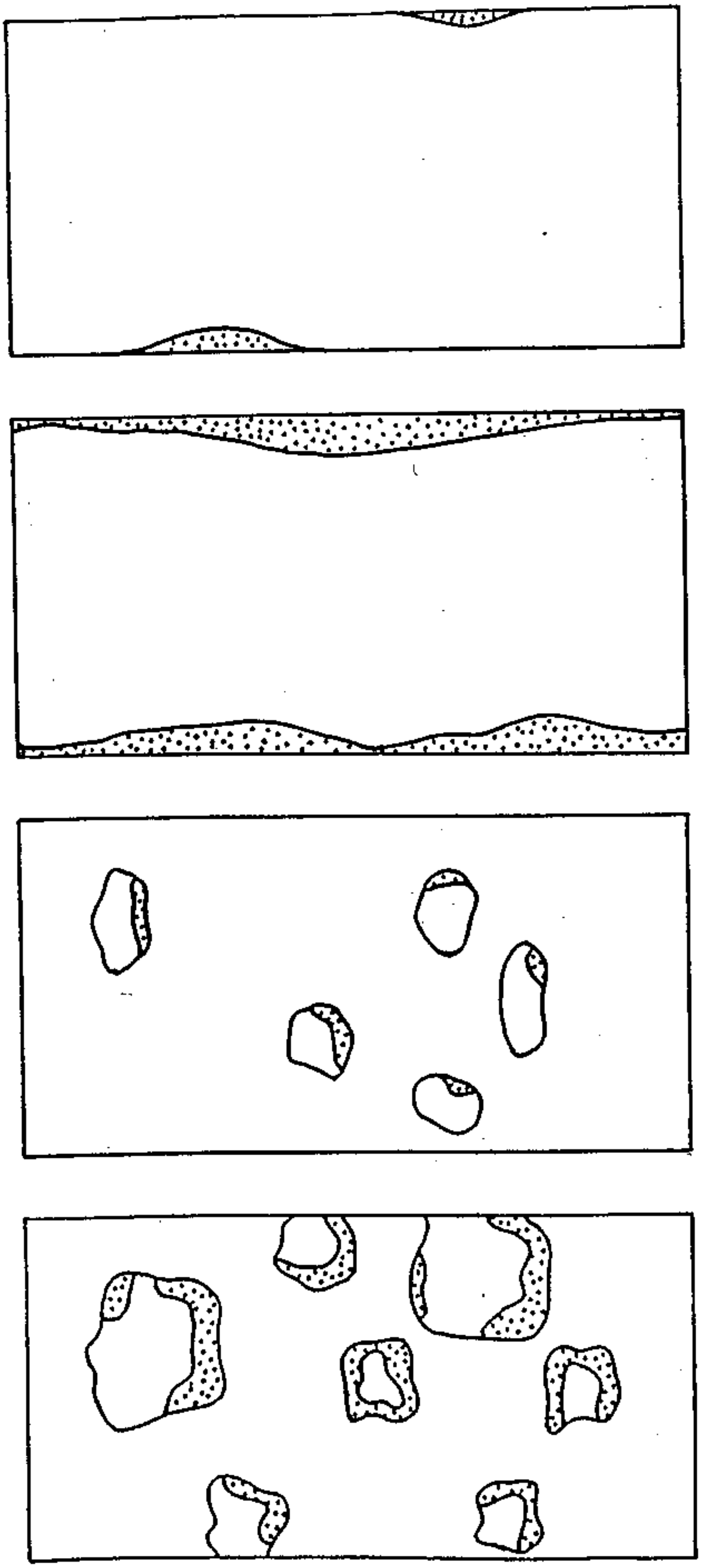
13) Photographs

Please take slide photographs of all sites. Preferably date stamped.

Table 1 : Minimum Areas of Abundance
(Assuming 10m section length)

Section Width m	1% m^2	5% m^2	10% m^2	20% m^2
1	0.1	0.5	1.0	2.0
1.2	0.12	0.60	1.2	2.4
1.4	0.14	0.70	1.4	2.8
1.6	0.16	0.80	1.6	3.2
1.8	0.18	0.90	1.8	3.6
2	0.20	1.0	2.0	4.0
2.5	0.25	1.25	2.5	5.0
3	0.30	1.5	3.0	6.0
3.5	0.35	1.75	3.5	7.0
4	0.40	2.0	4.0	8.0
4.5	0.45	2.25	4.5	9.0
5	0.50	2.5	5.0	10.0
5.5	0.55	2.75	5.5	11.0
6	0.60	3.0	6.0	12.0
6.5	0.65	3.25	6.5	13.0
7	0.70	3.5	7.0	14.0
7.5	0.75	3.75	7.5	15.0
8	0.80	4.0	8.0	16.0
8.5	0.85	4.25	8.5	17.0
9	0.90	4.5	9.0	18.0
9.5	0.95	4.75	9.5	19.0
10	1.0	5.0	10.0	20.0

Figure 1 : Examples of 1% and 10% submerged overhang



1% undercut bank

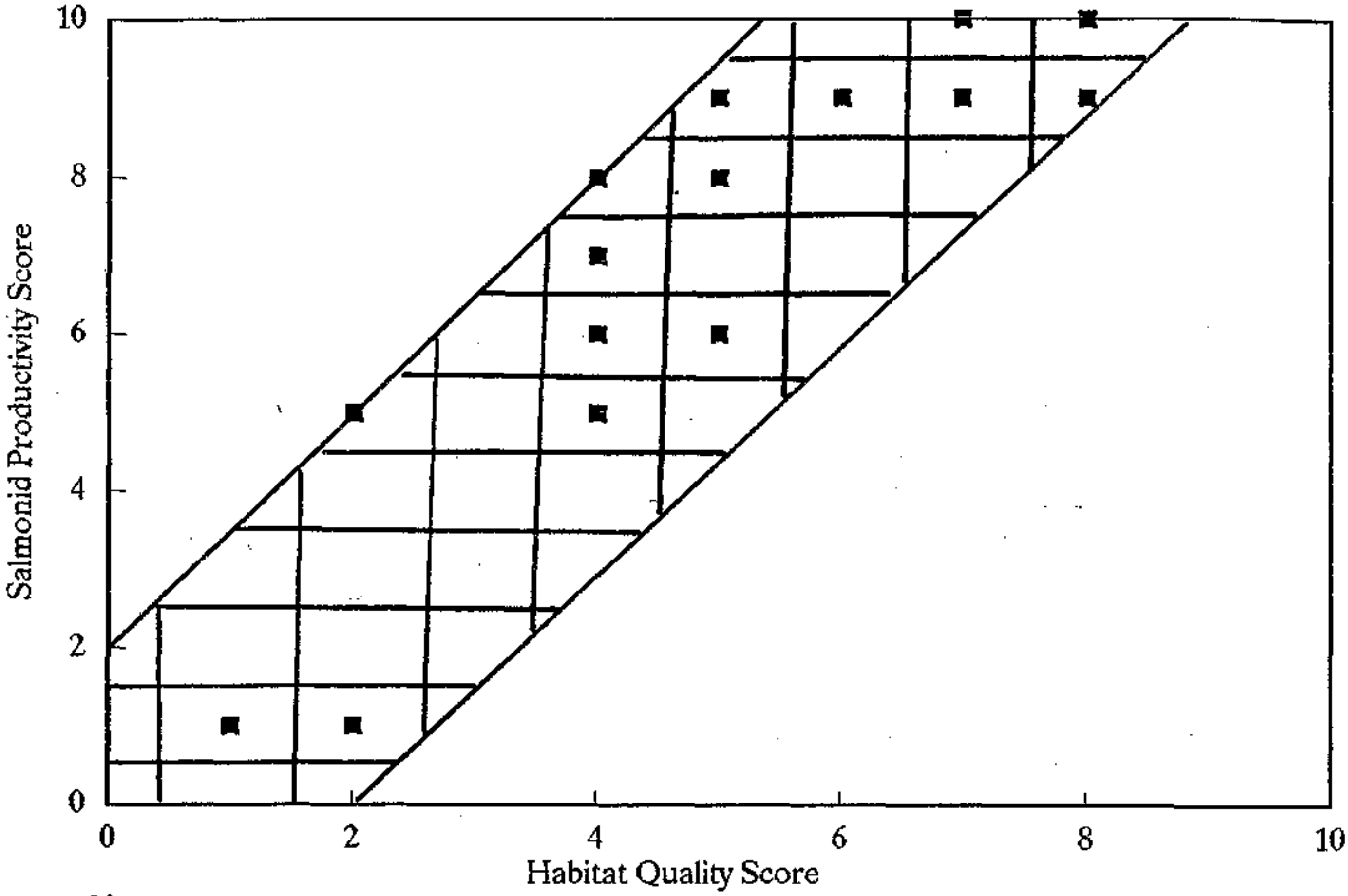
10% undercut bank

1% boulder overhang

10% boulder overhang

APPENDIX 2

HABITAT SCORE SYSTEM



n = 20

Appendix 3a Justification of using salmon density classes as a method for attributing a total salmonid score.

The score attributed to either fry or parr salmonid densities is taken from the density classes as derived for salmon in the National classification system. It uses elements of fry and parr classes to give higher scores to sites that produce a diversity of age classes rather than just high densities of one age class of salmonid. Sites with high production and diversity of age class are deemed to be of the best quality.

This system works well for parr as the density class splits for trout and salmon are similar. It works less well with fry where there is around a three fold difference between the numbers of salmon fry required to score any particular density class compared to trout. For ease of application of this score system both species of fry are added together before scoring a salmonid fry density score. Sites dominated by salmon fry will thus tend to score better than those dominated by trout fry. There is no easy way to overcome this situation and as in the North West region we have historically scored salmon and trout fry on a density class system close to the National scheme for salmon, it is proposed that the results will be acceptable and that sites scoring low because of dominance by trout fry only should be treated with caution when planning the need for habitat improvement works.

Table 2 National Classification Classes for Salmonids

Class	Salmon Fry	Trout Fry
A	>86.01	>38
B	45.0 - 86.0	17.01 - 86.0
C	23.01 - 45.0	8.01 - 17.0
D	9.01 - 23.0	3.01 - 8.0
E	0.01 - 9.0	0.01 - 3.0
F	0.00	0.00

Class	>0+ Salmon	>0+ Trout
A	>19.01	>21
B	10.0 - 19.0	12.01 - 21.0
C	5.01 - 10.0	5.01 - 12.0
D	3.01 - 5.0	2.01 - 5.0
E	0.01 - 3.0	0.01 - 2.0
F	0.00	0.00

Appendix 3b

BIOLOGICAL ASSESSMENT - HABITAT IMPROVEMENT SCHEMES

ONE MINUTE KICK SAMPLE

SAMPLE DATE	
SITE	
SITE NOS	
SAMPLER	

NOS OF INDIVIDUALS

	0	1-10	10-50	50-100	100+
STONEFLIES					
MAYFLIES					
BAETIS					
CADDIS					
GAMMARUS					
ASELLUS					
OTHER					

ASSESSMENT

SCORE	
0	
25	
50	
75	
100	

COMMENTS

Appendix 3c Biological Assessment Methodology

The following information should be used to assist scoring a site for biological production.

1) Chose a riffle section if possible.

2) Undertake a one minute kick sample

3) Empty the contents of the net into a white sorting tray.

4) Assess the quantities of each of the main groups of invertebrates and tick the appropriate box on the pro-forma.

5) Fill in the other required details and any comments.

SCORING

The following scheme is proposed for scoring a site (this is subject to review).

100pts

Either	Any named group scoring 100+ with any other named group present.
OR	Any two or more named groups scoring 50-100
OR	Any three or more named groups scoring 10-50

75pts

Either	Any named group scoring 100+
OR	Any named group scoring 50-100 + Any named group scoring 10-50
OR	Any two or more named groups scoring 10-50

50pts

Either	Any one named group scoring 50-100
OR	Any group scoring 10-50 + three or more groups scoring 1-10
OR	All groups scoring 1-10

25pts

Either	Any named group scoring 10-50
OR	Less than three groups scoring a maximum of 1-10

0pts

None of the named groups present

APPENDIX 4

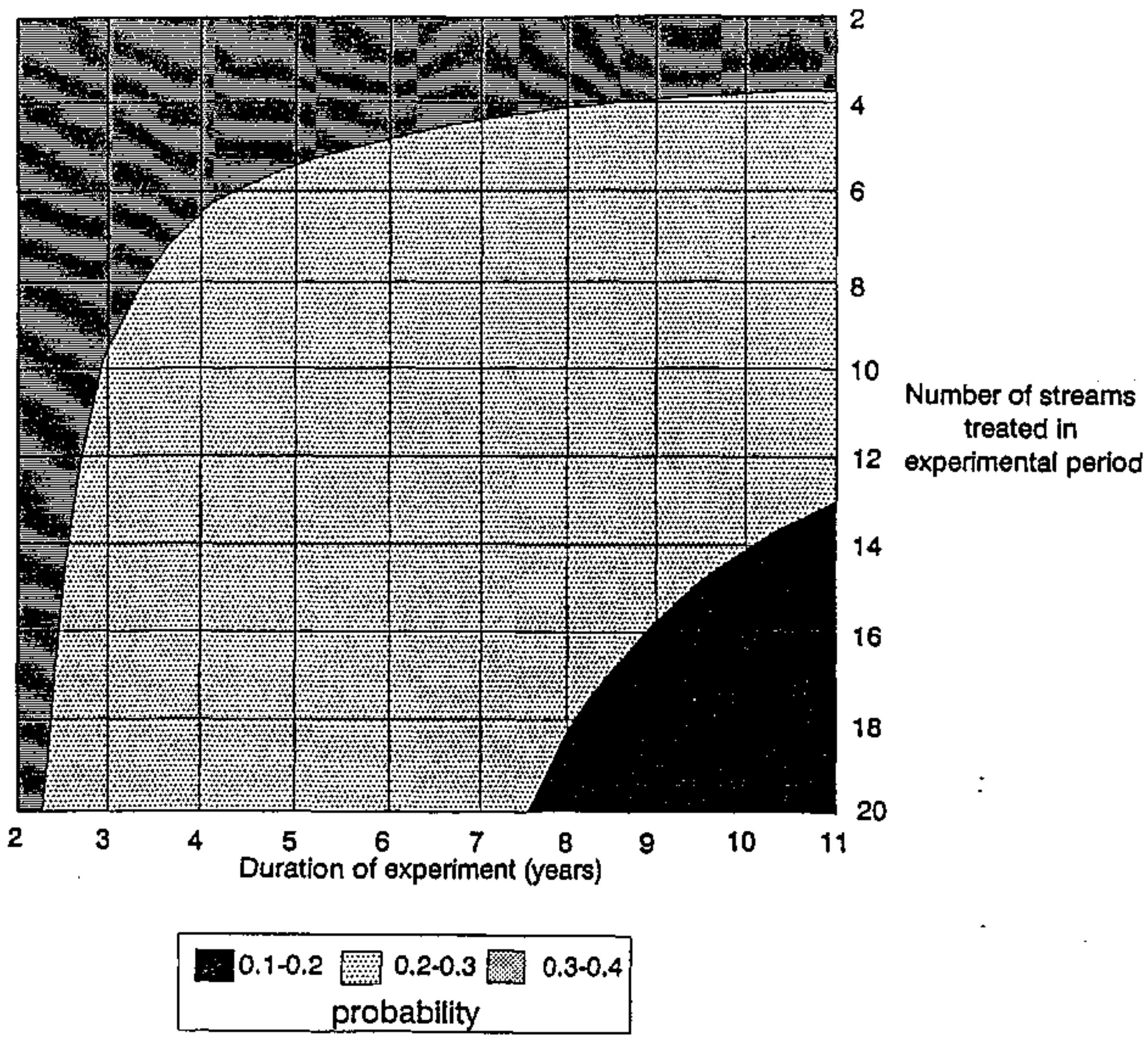
River Width

Gradient (mKm^{-1})	0 - 3.9m	4 - 5.9m	6 - 8.9m	> 9m
0.0 - 1.9				
2.0 - 3.9	T.P		S.F	S.F
4.0 - 5.9	T.F	T.F T.P S.F S.P	S.F S.P	S.F S.P
6.0 - 7.9	T.F T.P	T.F T.P S.F S.P	T.F T.P S.F S.P	T.F S.F S.P
8.0 - 9.9	T.F T.P S.P	T.F T.P S.P	T.F T.P S.F S.P	T.F S.F S.P
10.0- 11.9	T.F T.P S.F S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
12.0- 13.9	T.F T.P S.F S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
14.0- 15.9	T.F T.P S.F S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
16.0- 17.9	T.F T.P S.F S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
18.0- 19.9	T.F T.P S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
20.0- 24.9	T.F T.P S.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
25.0- 29.9	T.F T.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
30.0- 39.9	T.F T.P	T.F T.P S.P	T.F T.P S.P	T.F S.P
> 39.9	T.F T.P	T.F T.P	T.F T.P	T.F

T.F = Trout Fry   S.F = Salmon Fry

T.P = Trout Parr   S.P = Salmon Parr

Appendix 5 : The Probability of making a false decision at the end of an experimental period based on the duration and the number of the number of streams in the experiment.



SECTION 2 A MANUAL OF HABITAT IMPROVEMENT WORKS

1.0 Selection tables

2.0 Description of works

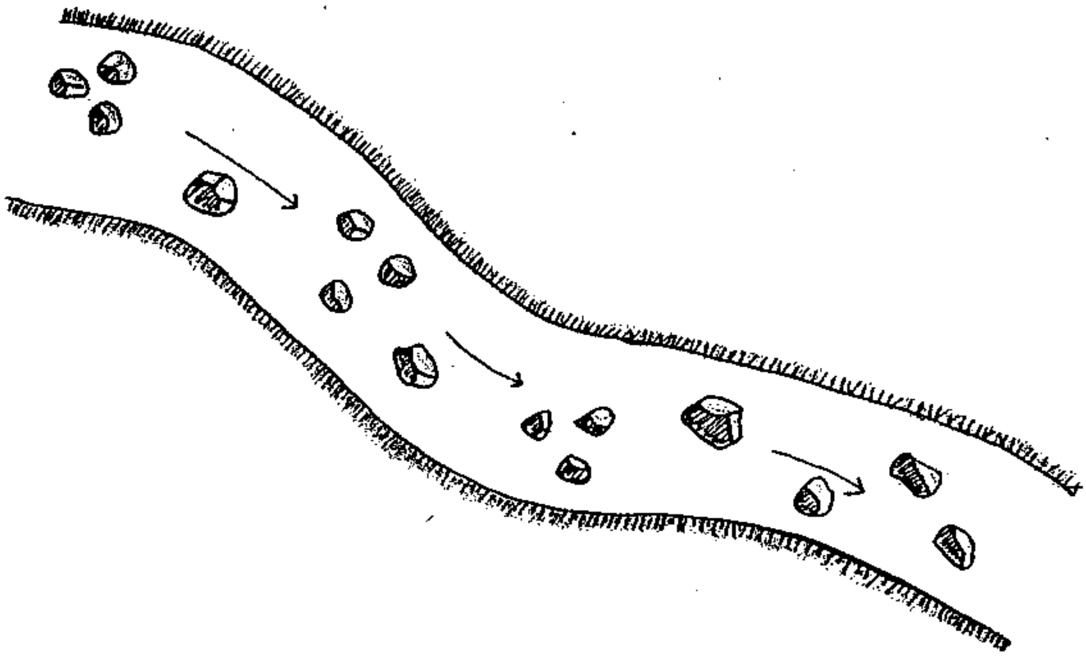
3.0 Implementation steps

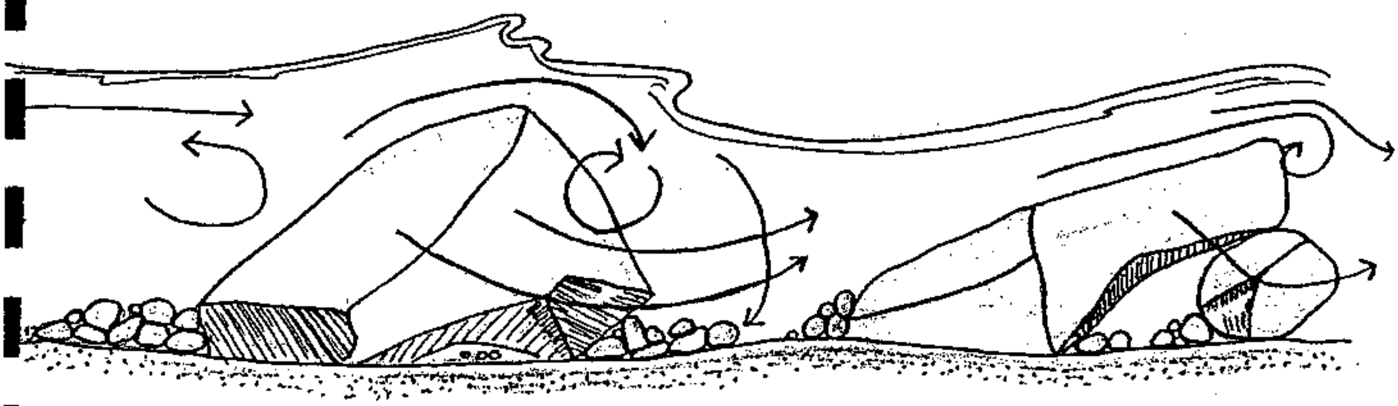
A MANUAL OF HABITAT IMPROVEMENT WORKS

	Trout Fry	Trout Parr	Salmon Fry	Salmon Parr
1. Instream Boulder Placement			x	x
2. Riffle Building			x	x
3. Spawning Gravel Addition	x		x	
4. Submerged Log Bank Cover	x	x		
5. Removal of Woody Bank Vegetation			x	x
6. Instream Debris Removal			x	x
7. Plant Streamside Vegetation	x	x		
8. Tree & Brush Shelters	x	x		
9. Channel Constrictor		x		x
10. Cross-channel Log/Bank Revetment		x		x
11. Log Rip-Rap		x		
12. Streamside Fencing	x	x	x	x
13. Whole Log Cover		x		x
14. Tip Deflector		x		x
15. Wedge Dam		x		
16. K Dam		x	x	x
17. Wing (Current) Deflector & Bank Cover Logs		x		

1. Instream Boulder Placement.

-To provide instream cover in streams where it is lacking and to break a uniform current in a stream to dislodge and relocate fine sediments downstream.





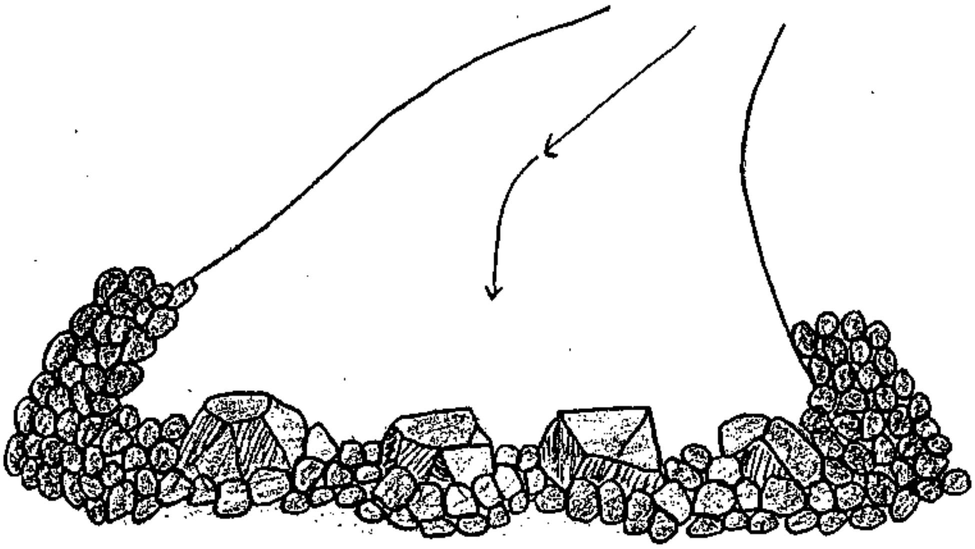
Fry Habitat Creation

To improve fry habitat, dead water pockets can be created by selectively removing a few boulders and stones. Ideally, it should be created immediately downstream of a large boulder so that during moderately high flows, the current is deflected away. If the current in the back eddy is too strong, place boulders and stones along the edge of the eddy and main current to reduce the water speed.

2. Riffle Building

In a stream of moderate flow which is not prone to flooding and where stream channel is of roughly uniform depth. Riffles should be created at areas where they would naturally occur in the river.

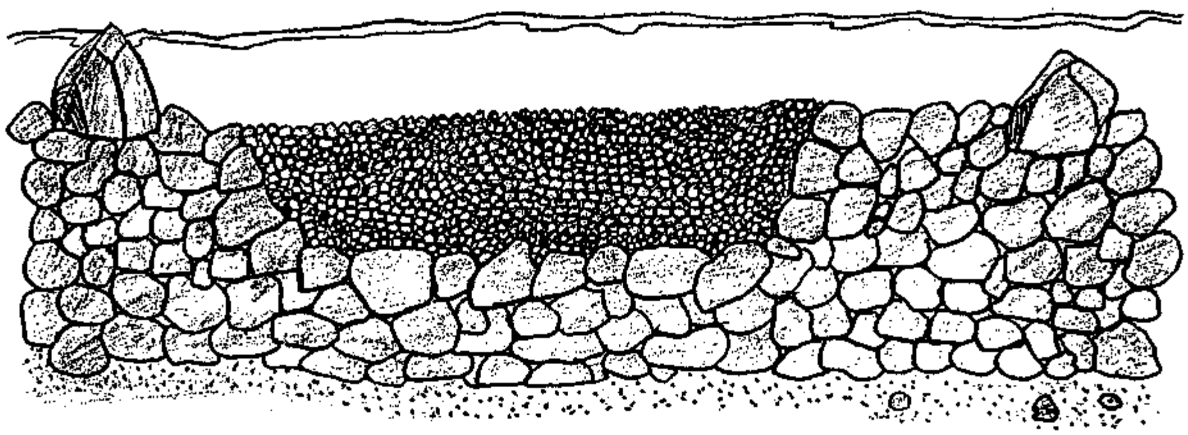
Large irregular shaped boudlers are used to create a solid core base for the structure. Both banks require strengthening to reduce the risk of erosion.



3. Spawning Gravel Addition.

Material is first removed from the stream bed then replaced with gravel of a suitable size.

To complement this spawning gravel addition, large boulders can be placed in the spawning area to separate spawning pairs

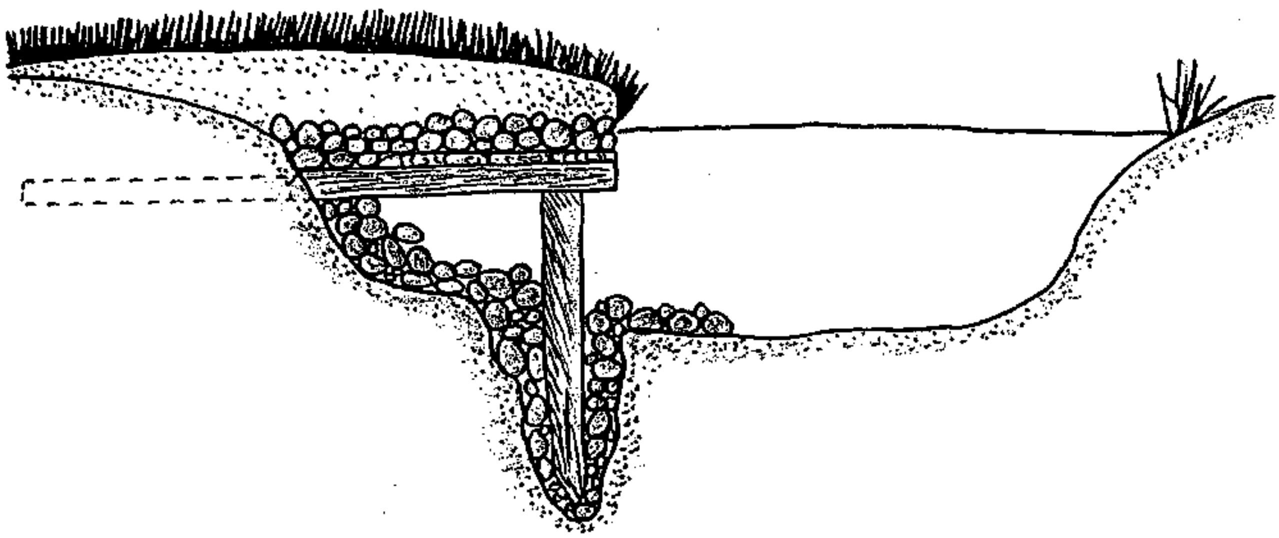


4. Submerged Log Bank Cover.

Consists of an underwater platform supported by wooden pilings.

Provides overhead cover, and some bankside protection. Also increases pool depth and provides more pools.

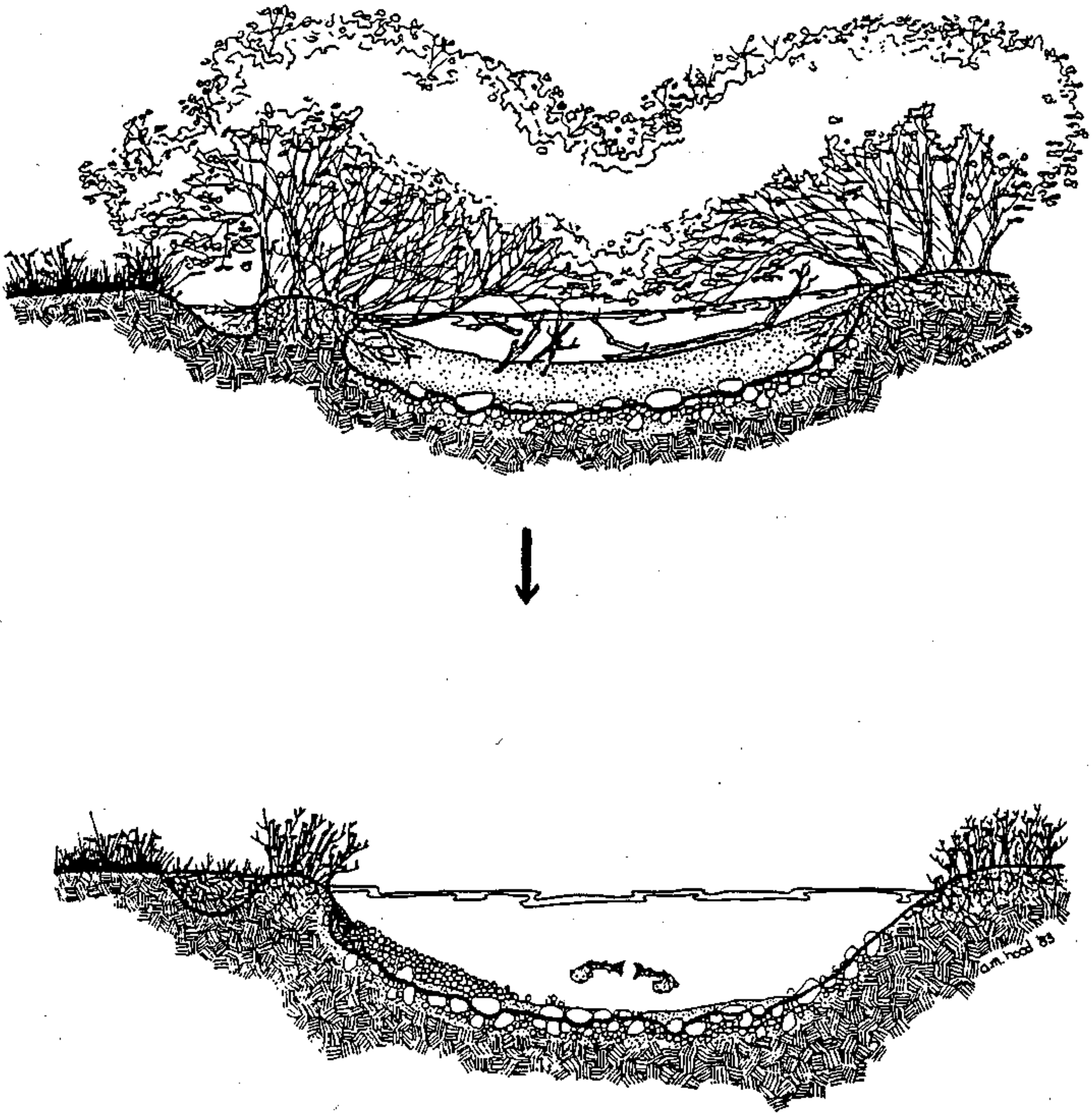
Use in small streams of stable flow with low to moderate gradient.



5. Removal of Woody Bank Vegetation.

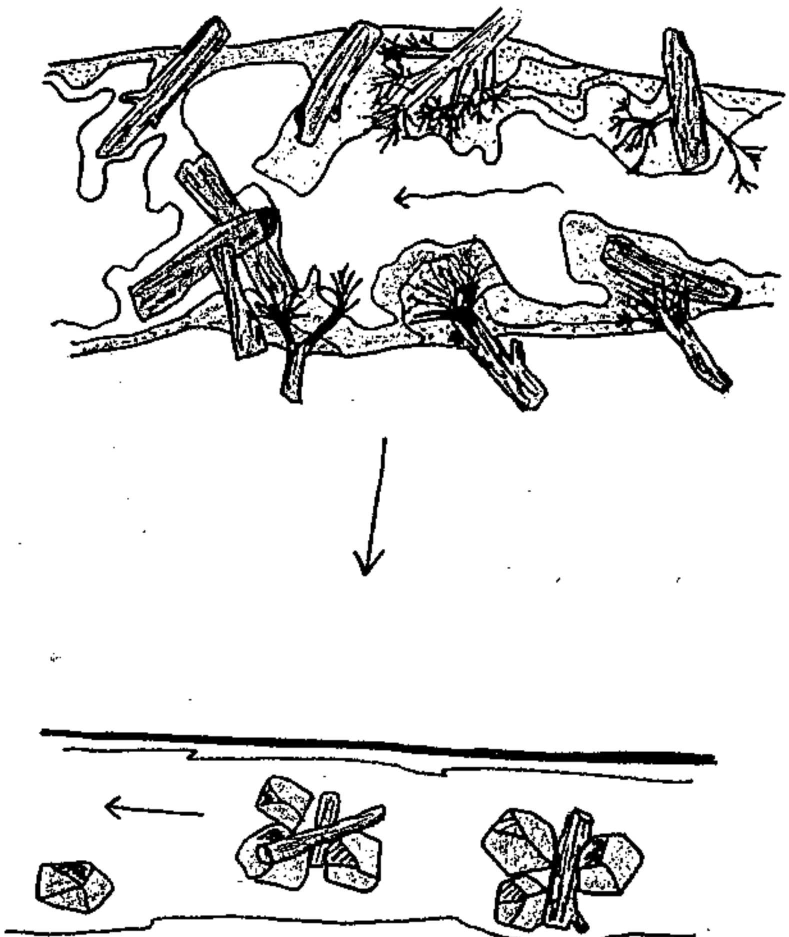
Removal of Woody Bank Vegetation will increase sunlight penetration to the river, and increase the downstream movement of sand and silt.

Removing the woody stems and roots will encourage a new growth of dense shoots and roots to develop. The new root system will provide added anchoring strength to the stream bank. Aquatic plants will also be encouraged.



6. Instream Debris Removal.

By removing instream debris, natural stream currents will be quickened and this will scour accumulated silt and debris deposits. The gravel and rock substrate will then be exposed which will encourage aquatic insects and fish to recolonise the area.



7. Plant Streamside Vegetation.

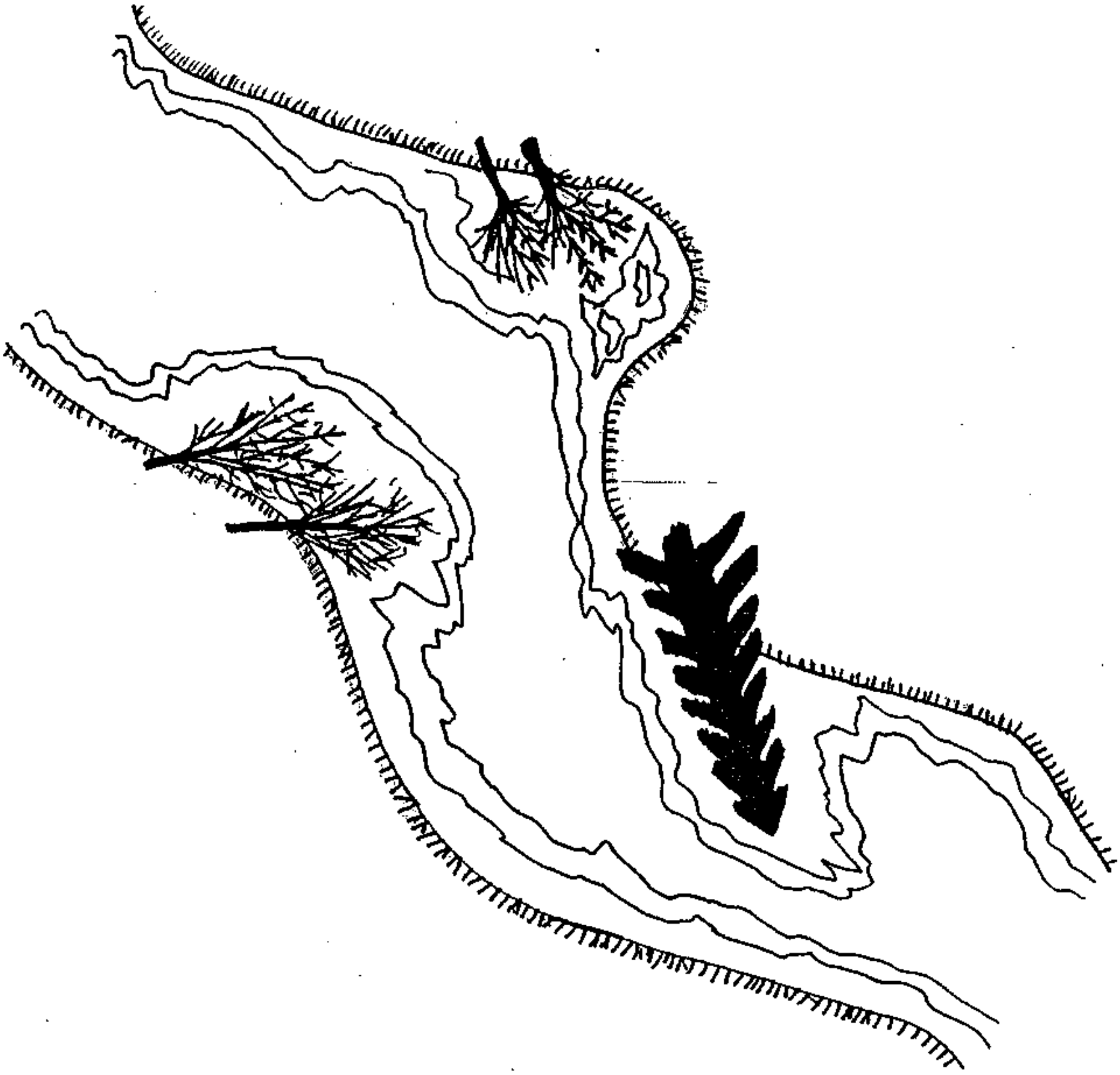
To be used on areas where streamside vegetation has been removed through man's activities or where trampling of stream banks by livestock is severe.

Streamside vegetation should consist of a mixture of grasses, shrubs and trees. In many instances, it may be desirable to have a zone of grass and shrubs close to the stream edge and trees planted further back from the bank. To establish ground cover, plant a mixture of grasses and legumes close to the stream edge. To establish shade as well as bank cover, plant shrubs and trees.

In some cases all that is needed is to erect a fence. A fence will protect the bank from being trampled by livestock, vehicles or pedestrian traffic. This will allow natural vegetation in the area to become established.

8. Tree and Brush Shelters

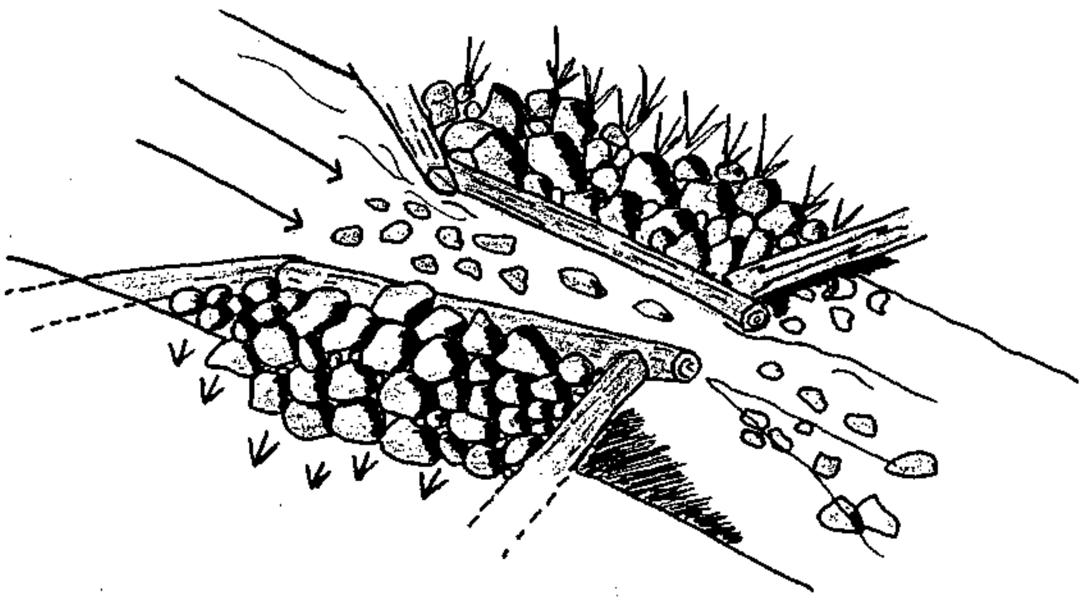
This provides instream cover for all sizes of trout. It is simple and easy to install.



9. Channel Constrictor

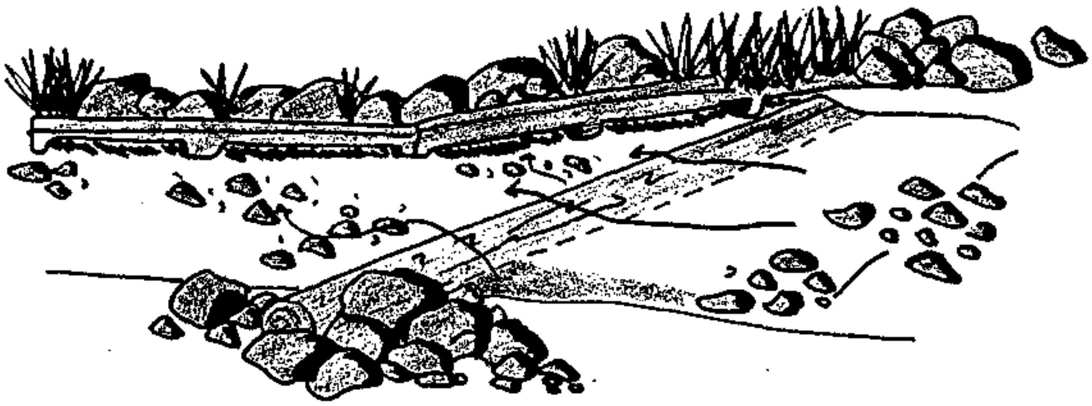
Placed in straight reaches of stream channels to create a partial dam effect and deepen pool depth between the face-logs.

The logs used may be partially notched-out to increase underlog cover for trout.



10. Cross-Channel Log Revetment

This is ideal to install at natural bends that lack underbank cover and/or just at the downstream end of obvious breaks in stream gradient.

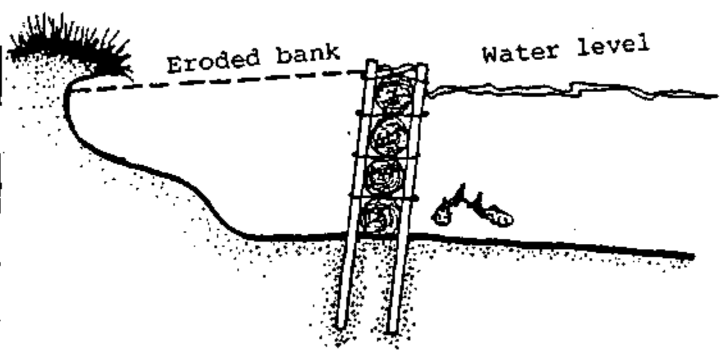


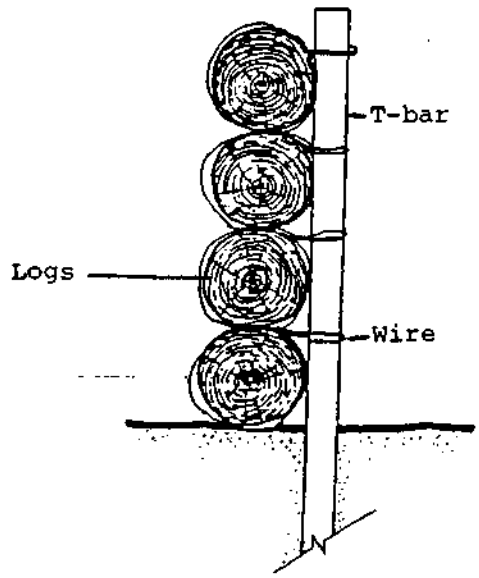
11. Log Rip-Rap

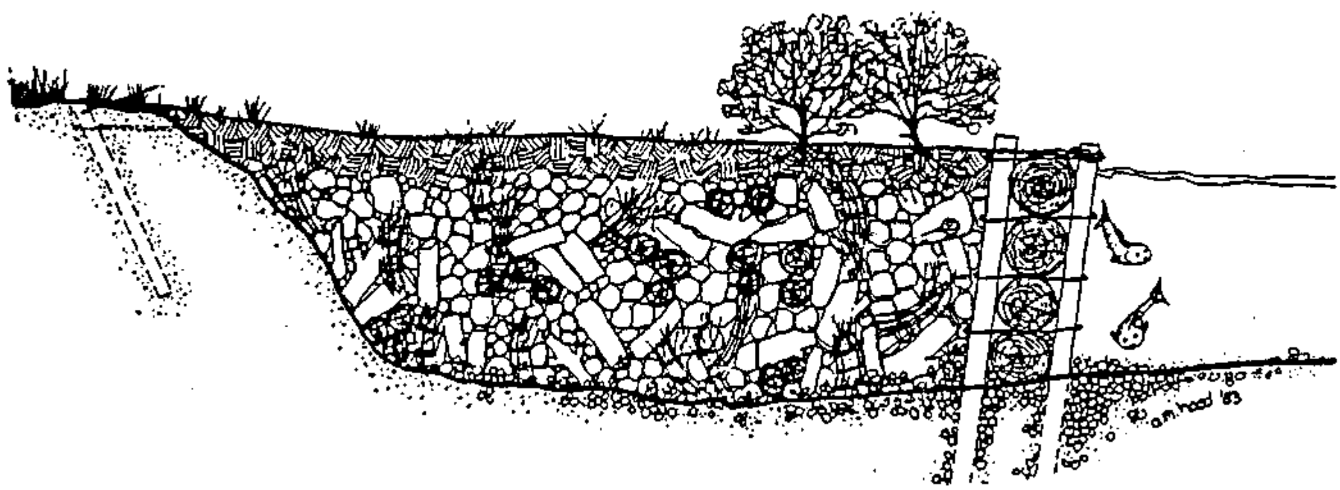
This structure is commonly built on the outside bend of a meander. It Provides bank erosion protection and provides some cover for fish.

Can be used in streams with low to moderate gradient with low to moderately high banks.

If it is built soundly, maintenance is not usually required.

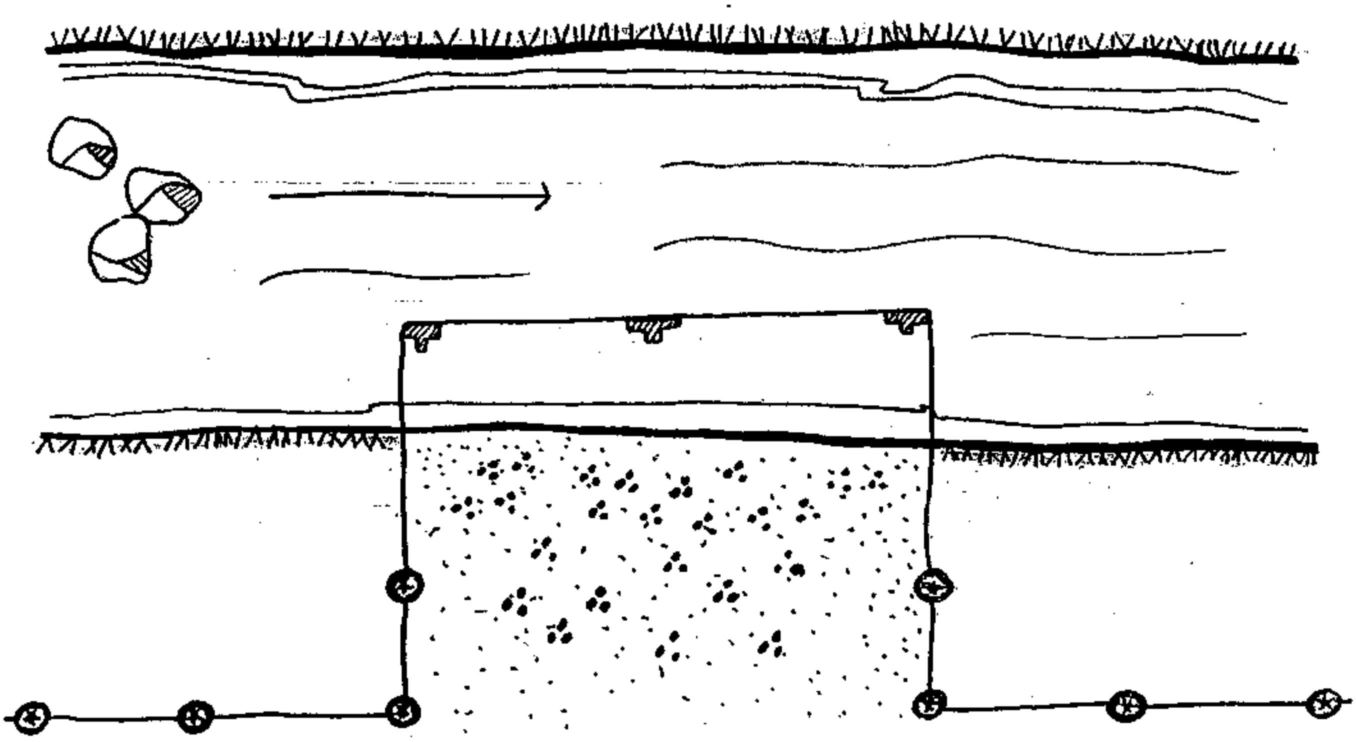






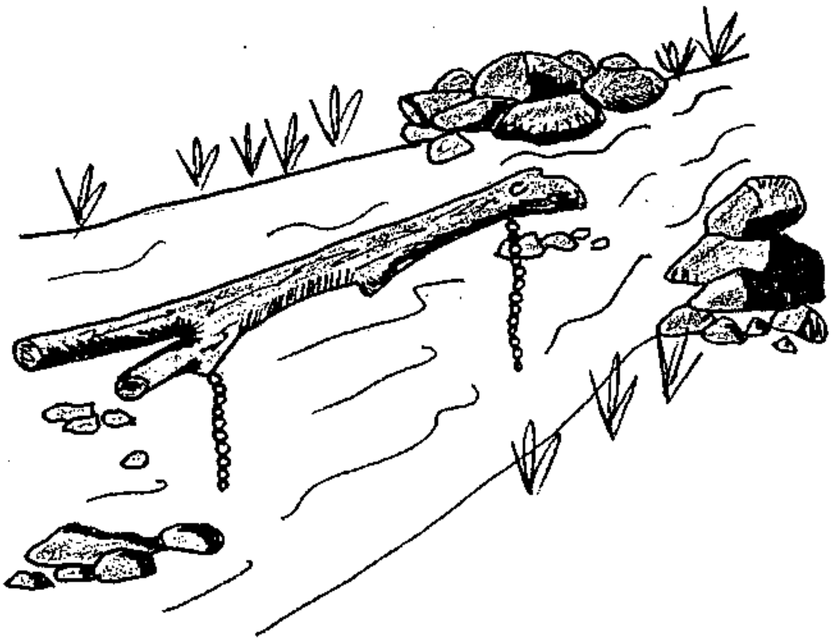
12. Streamside Fencing

Used to protect streamside and stream bank vegetation from grazing and trampling by cattle and other livestock, but still providing a watering point. It will also prevent the impairment of water quality by enrichment from livestock waste products.



13. Whole Log Cover

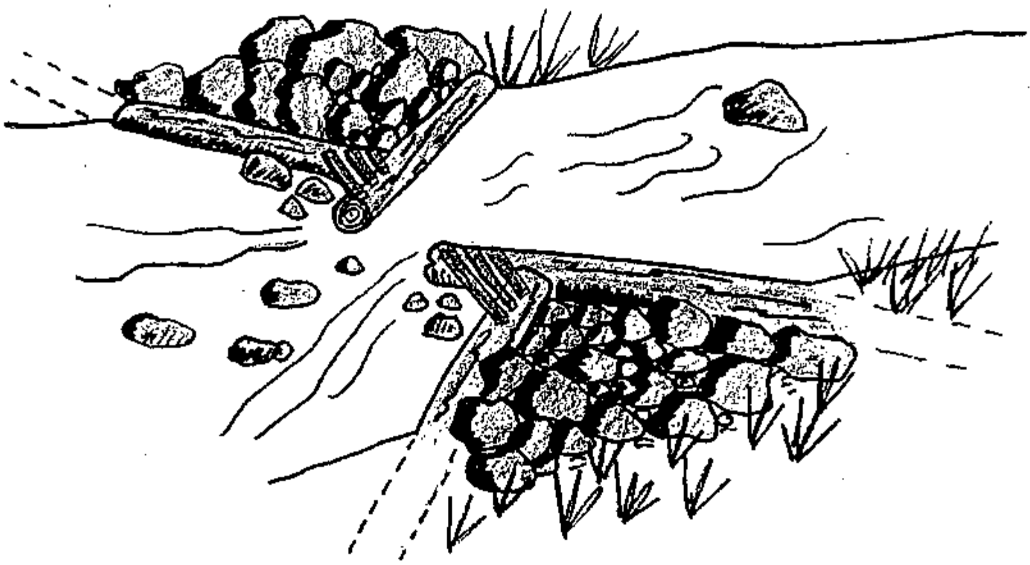
A large crooked log is placed in a stream approximately parallel to the flow. Place in stable gravel/cobble substrate where the water is deep enough to cover the entire log most of the time. It is recommendedto place this structure in or near the tails of pools and in runs of uniformly deep water that lack cover.



14. Tip Deflector

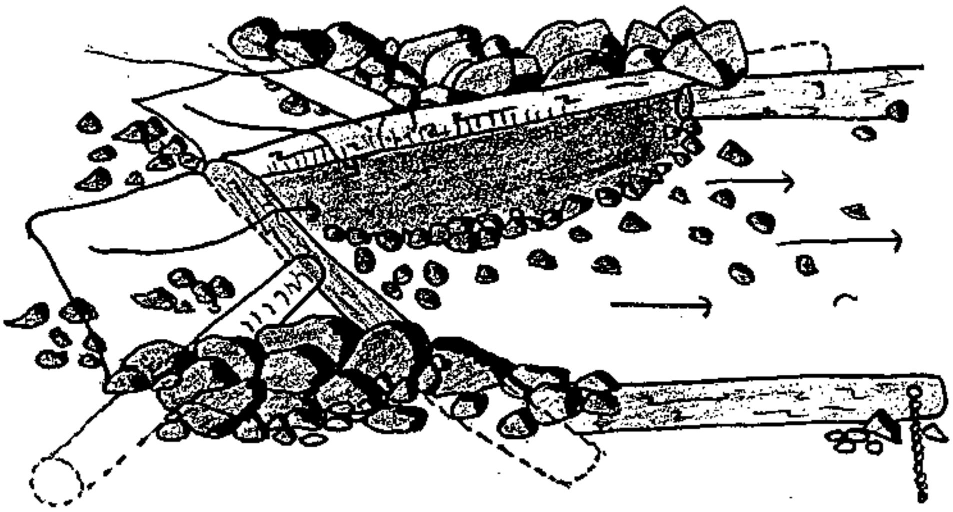
This can be installed in pairs in straight reaches to provide midchannel cover and encourage the development of a plunge pool.

As a single structure, provides cover under the tip and redirects flow towards another structure or an area of naturally good habitat for adult trout.



15. Wedge Dam

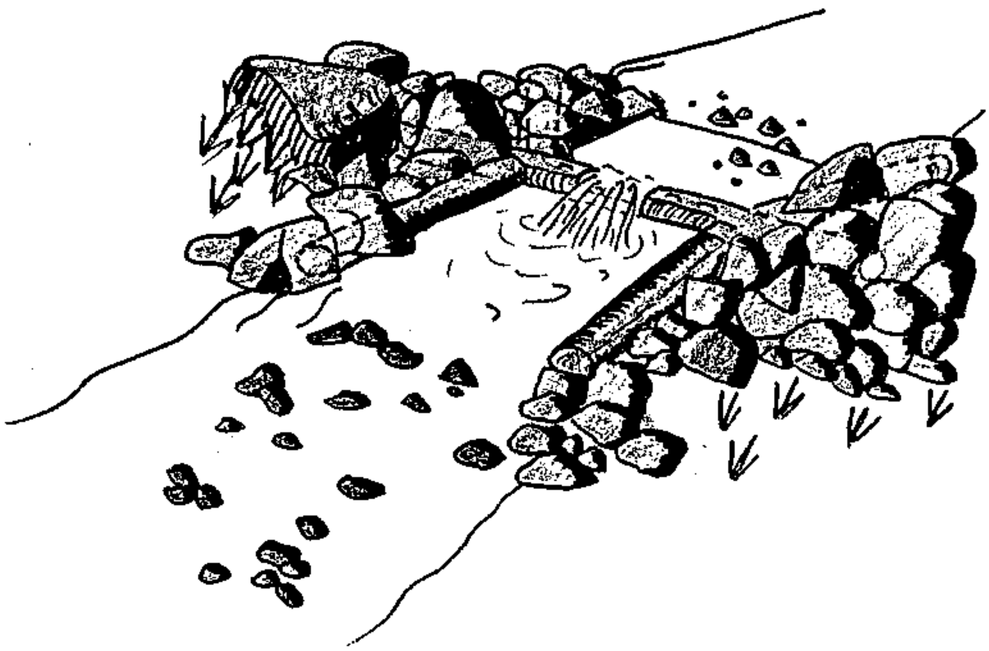
This wedge focuses the stream flow towards the centre and thus scours out a plunge pool below the wedge, and ideally along and under the attached bank cover logs.



16. K Dam

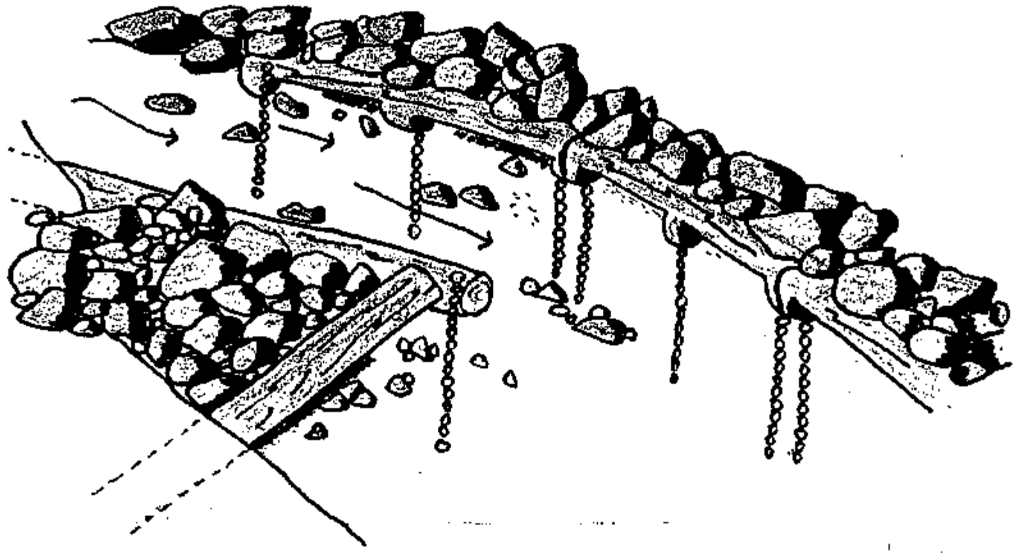
Ideal in straight reaches where obvious breaks in stream gradient occur. A midchannel scour pool is created below the structure and ideally beneath the downstream brace-logs of the K dam too.

If depth is adequate, a half-log or whole log cover can be added in or below the scour pool to provide additional cover for trout.



17. Wing (Current) Deflector & Bank Cover Logs

This combination of structures is ideally used in straight reaches of high-gradient streams or at natural bends.



IMPLEMENTATION STEPS

1. Instream Boulder Placement

- Pattern and location for placement should be finalised before commencement.

- Place boulders beginning at the downstream end and work up the river.

- Ensure boulders are placed on a substrate relatively free of larger rocks and ensure boulders fit snugly to the stream bed.

2. Riffle Building

- Stake out cross-sectional location.

- Place in bank boulders and stabilise around them.

- Place down core boulders across the stream.

- Place down smaller materials in a moderate slope above and below the core boulders. Flattened rock is the most suitable.

- May wish to leave one or two gaps in the riffle to concentrate flow.

- The riffle material should not break the surface at low flows.

- Some boulder material or log covers may be placed below the riffle to increase holding areas.

3. Spawning Gravel Addition

- Determine location of the proposed bed.

- Stockpile necessary gravel nearby.

- Stake out proposed bed. Dimensions of the spawning bed should be approximately 3-4 metres long by approximately 60 - 90 cm wide. The eventual depth of gravel should be 20-30cm.

- Remove the rocks and boulders in the staked area to a depth of 25-35cm.

- Place several large boulders at the downstream base of the bed and extend no more than 5 - 10cm above the level of the natural surrounding stream bed.

- Fill the trough with the gravel. The gravel should be placed up to the level of the natural stream bed. Do not place boulders at the head of the bed as this will promote scour.

4. **Submerged Log Bank Cover.**

- Determine suitable location based on previous stream assessments. Ideally built on the outside bend of a meander.

- Design and obtain materials.

- Embed vertical support logs into streambed at desired distance from the bank. Stabilise and strengthen by backfilling holes with rock. The verticals should be embedded a minimum of 1.0m into the stream bed.

- Dig trenches into stream bank for horizontal supports.

- Fasten the horizontal supports to the vertical pilings. Ideally the horizontals must remain totally submerged and embedded into the bank a minimum of 1.2m.

- Place large stones at the bottom along the bottom of the original bank to prevent water from eroding under the structure.

- Fix poles perpendicularly to the horizontals to form a platform. The platform should remain completely submerged at low summer flows so that the wood remains soaked. This prevents decay.

- Fix a larger log along the outer edge of the structure. This is to aid in deflecting the water away from the top of the structure. Large rocks can also be placed along the streamside edge of the platform to prevent erosion.

- Check all lumber is firmly in place.

- Place filter fabric over entire platform area of structure.

- Add one layer of rock and gravel over filter fabric

- Cover remainder with soil, then seed as required.

- Stabilise both ends of structure with rock rip-rap.

5. **Removal of Woody Bank Vegetation**

- Mark out area

- Cut from downstream area up

- Cut shrubs to within 10-15cm off the ground.

- Maintenance cuttings will be required every three to four years.

6. Instream Debris Removal

- Select area

- Stream length for debris removal project should not exceed 100m at any one time.

- Begin project at lower most point of project site and work upstream.

- Cut instream root systems of wood, shrubs and remove material from watercourse.

- Remove twigs and loose debris which is wrapped around logs.

- Remove any loose logs which lie near the water's surface.

- Remove any obvious obstructions which may be damming the stream or trapping silt. Any excess woody material near the centre of the channel should be removed first.

- After completing one through pass through your section, stop. Let the stream currents do their job. After two or three days go back and take stock.
  Have new logs appeared?
  Can you see the original stream bottom?
  Is the stream narrowing?

- Repeat this pattern once or twice, or until the original stream bottom begins to reappear.

- Allow one or two years for the stream to vegetate and stabilize before attempting any bank stabilisation

7. Plant Streamside Vegetation.

- Streamside vegetation should consist of a mixture of grasses, shrubs and trees.

8. Tree & Brush Shelters

- Cut whole branches of trees

- Depending upon the specific use anchoring may or may not be necessary.
  For short term duration (Eg. to provide cover for swim up fry), drive branch end into the soft bank soils.
  To use a permanent structure secure branch to a nearby stump or stake.

9. Channel Constrictor

- Use large rough logs for the two main face-logs. These logs may be partially notched out to increase cover for trout.

- Pin the upstream brace-logs at 45^{o} angles to the face-logs, and extend them back 2-3ft into the stream bank trenches.

- Stabilise the ends of the brace-logs with rip-rap.

- Also add rip-rap behind the face-logs.

10. Cross-channel Log/Bank Revetment

- Position the bank revetment log along the outside bend.

- Notch out the revetment log to increase underlog cover for trout.

- Add rip-rap behind the bank revetment log to improve bank stability.

- Install the end of the cross-channel log on the shallow side of the stream several inches higher than the opposite end that joins the bank revetment log.

- Position the cross-channel log at a 30-45^{o} downstream angle and partially bury it.

- This angular deflection of flow, plus the elevated tilt to the cross-channel log, concentrates flow toward the bank revetment regardless of flow stage.

- Reinforce both ends of the cross-channel log with rip-rap.

11. Log Rip-Rap

- Determine location

- Stake the line of the current with temporary wooden stakes to mark the outside edge of the new bank. The line of the current can be determined visually by standing upstream of the planned devices. It is important that this be located with some accuracy as it is essential that the current, if possible, run swiftly along the edge of the outside logs.

- Begin work at the upstream portion of the structure.

- Drive a line of metal fence posts into the stream bed at 1.0 - 1.5m intervals so that they lean into the current at about a 10^{o} angle and lean out slightly. This prevents the buoyancy of the logs lifting the stakes out of the water during spring run-off. The metal stakes should be located along the line marked by the temporary stakes which can be removed after all the metal posts are in place.

- Using heavy fence wire, lash a line of logs to the metal posts forming a wall. It is important that these be located right on the stream bed, not on silt or mud which should be removed, exposing the underlying gravel before the logs are moved into place. Wire should be placed around the logs and posts in a figure "8" fashion.

- Repeat the above procedure building up successive rows of logs to within 10cm of the top of metal posts.

- Backfill the space between the log wall and the old bank to within about 15cm of the top of the metal posts.

- Drive a series of stakes (wood or metal) in an offset pattern to the main stakes at a distance of 50-100cm back from the edge of the old bank at an angle back from the stream. Dig a shallow trench to eventually bury the wire. Wire these to the outside line of metal stakes with double strands of heavy fence wire. A cross-over pattern of wire wrapping is suggested. The whole structure can be tightened by inserting a stick between the strands of wire and twisting.

12. Streamside Fencing

13. Whole Log Cover

- Place a large crooked log into a stream approximately parallel to the flow.

- Position the log over stable gravel/cobble substrate where the water is deep enough to cover the entire log most of the time.

- It is recommended placing this structure in or near the tails of pools and in runs of uniformly deep water that lack cover.

14. Tip Deflector (Paired)

- Extend butt ends of deflector logs into stream bank trenches and stabilise with large riprap.

15. Wedge Dam

- This structure consists of two sturdy logs joined mid-stream to form an up-stream pointing wedge, a pair of brace-logs positioned on the upstream side of the wedge, and bank cover logs below the wedge.

- Dig out trenches in the stream bottom so the 2 wedge logs can be partially buried.

- Keep the butt end of each wedge log several inches higher than the apex junction of the 2 wedge logs by tapering the depth of the trenches.

- Dig the trenches deep enough to bury the apex. The wedge logs should join at a 45^{o} angle.

- Attach roadbase fibremat to the wedge logs, extend the fibremat sheet upstream, and cover it with substrate material to prevent undercutting of the wedge.

- Attach the brace logs at 90^{o} angles to the wedge logs well back into the stream banks. Excavate trenches if necessary.

- Use rip-rap at the butt ends to prevent end-cutting by stream flow during floods.

16. K Dam

- This structure consists of a main cross-channel log and downstream extension brace-logs.

- Best placement is in straight reaches where obvious breaks in stream gradient occur.
- If upstream brace-logs are added, extend them well back into each stream bank at a 45^{o} angle from the cross channel log. Armour the ends of all brace-logs and the cross-channel log with rip-rap. Attach and bury filter fabric upstream from the main cross-channel log, and cover it with heterogeneous substrate to restore normal gradient.

17. Wing (Current) Deflector & Bank Cover Logs

- Pin back cover logs in place along the outside bend against one bank in straight reaches.

- Partially notch out bank cover logs to increase underlog cover for trout.

- Add riprap behind the bank cover logs to enhance stream-bank stability and reduce erosion.

- Position the wing deflector on the opposite bank (inside bend) and upstream from the bank cover logs.

- Place the deflector so that redirected flow does not intercept the opposite bank upstream from the bank cover logs.

SECTION 3 WORKED EXAMPLES

A POINT BY POINT EXAMPLE OF HOW THE MANUAL SHOULD BE USED IN ASSESSING, IMPLEMENTING AND MONITORING A SCHEME

1) Pre - Project Assessment
- a) Select stream or site (4.1)
- b) Assess habitat (3.2)
- c) Determine salmonid population estimate (3.3)
- d) Determine biological productivity
- e) Assess other limiting factors (5.2)
- f) Prioritise projects (3.4)
- g) Take photos of chosen site
- h) Undertake cost benefit analysis (see 5f).

2) Pre - Project Planning
- a) Determine target species and age class from stream width and gradient (5.1)
- b) Design a possible scheme (5.1)
- c) Evaluation of wider consequences of work

3) Project Design
- a) Finalise and agree a scheme with all parties (5.1)
- b) Determine a time scale for work (5.3)
- c) Acquire materials and equipment
- d) Set work schedule

4) Implement
- a) Undertake work in/around site.

5) Post Project Appraisal
- a) Take photos of finished work
- b) Assess habitat
- c) Determine salmonid population estimates
- d) Monitor (6.1)
- e) Maintain (6.2)
- f) Undertake a cost benefit analysis (6.3)

Example 1

Site Nos	403.5
Site Name	River Crake us Bouthrey Bridge
HQS	2
TSP	2
BPS	75
PRIORITY	(75/2)/2 = 18.75
GRADIENT	2.0-3.9 M/KM
MEAN WIDTH	12.56M

Suitable age class and species **Salmon Fry**

Choice of schemes

1,2,3,5,6,12,16

Schemes 3,5,6 and 12 are either not a problem or already exist at the site

Scheme 16 is unsuitable at such a large site.

Proposal

Schemes 1 and 2.
Placement of instream boulders to create cover and riffle areas over a 100m section. Riffle area to be increased to 25% with 10% cover. This will increase the HQS to 4 and in theory increase the total salmonid productivity to at least 4.

Consultation

A site visit undertaken with parties from Ecology and Flood defence. All parties agreed there would be no detrimental effects of the proposed scheme and landowner consent was secured. The local angling club have backed the works and will have some holding pools created at the same time.

Timing of works.

The works will be undertaken in May or June of 1995

Monitoring

The site will be surveyed in the July-August window in 1996 for any improvement in salmon fry (0+) densities. This will be repeated in 1997 and 1998. Pre-project data is already available for this site from surveys in 1993 and 1994.

Maintenance Plan

No maintenance is proposed for the first 3 years although an assessment of change will be undertaken each year by scoring the habitat created and monitoring for loss of riffle and cover through siltation or gravelling up.

Cost benefit analysis.

In this case the site will be analysed retrospectively following the 1996 survey work.

Example 2

Site Nos	303
Site Name	River Leven ds Newby Bridge Weir
HQS	4
TSP	2
BPS	75
PRIORITY	(75/4)/2 = 9.4
GRADIENT	2.0-3.9 M/KM
MEAN WIDTH	19.8M

Suitable age class and species Salmon Fry

Choice of schemes

1,3,5,6,12,16

Schemes 2,5,6 and 12 are either not a problem or already exist at the site

Scheme 16 is unsuitable at such a large site.

Proposal

Schemes 1,3
Placement of instream boulders to create cover and riffle areas over a 100m section would assist instream cover for salmon fry. In addition spawning gravels appear to be restricted due to compactation in some areas. This could be broken up with a JCB

Consultation

A site visit undertaken with parties from Ecology and Flood defence. All parties agreed there would be no detrimental effects of the proposed scheme and landowner consent was secured. The local angling club have backed the works.

Timing of works.

The works will be undertaken in May or June of 1995

Works have since been undertaken and the need for instream boulder placement reviewed. Considerable boulder/cobble material was lifted from within the disturbed area of gravel creating considerable cover without the need for additional boulder placement.

Monitoring

The site will be surveyed in the July-August window in 1996 for any improvement in salmon fry (0+) densities. This will be repeated in 1997 and 1998. Pre-project data is already available for this site from surveys in 1993 and 1994.

Maintenance Plan

No maintenance is proposed for the first 3 years although an assessment of change will be undertaken each year by scoring the habitat created and monitoring for loss of riffle and cover through siltation or gravelling up.

Cost benefit analysis.

In this case the site will be analysed retrospectively following the 1996 survey work.

Example 3

Site Nos 721

Site Name Castlehowe Beck (River Duddon)

HQS 4

TSP 4

BPS 25

PRIORITY (25/4)/4 = 1.5

GRADIENT >39.9 M/KM

MEAN WIDTH 1.93M

Suitable age class and species Trout Fry/Trout Parr

It is apparent from the low priority score and the low BPS that this site is probably being limited partly through lack of food availability for fish. Although habitat improvement work could be undertaken, the benefits may only be small without significant measures to increase invertebrate productivity.

Choice of schemes

Schemes 3,4,7,8,9,10,11,12,13,14,15,16 and 17 are proposed.

Schemes 3 and 7 are either not a problem or already exist at the site.

Proposal

Schemes 8 combined with 12 and in the future any of 11-17 could be undertaken.

STAGE A
Scheme 8 to increase bankside tree and bush cover would be required first to increase productivity. This would probably require some fencing to protect the saplings planted.

STAGE B
Schemes 11-17 are relatively expensive to undertake but would increase cover for trout parr, which are currently

Monitoring of juvenile salmonids would be undertaken yearly as would an assessment of the cover and riffle area available for juvenile fish.

Maintenance Plan

Maintenance will be required although it is hoped no heavy maintance will be needed in the first five years post scheme implimentation.

Cost benefit analysis.

This will be undertaken once a final scheme design has been approved by all parties, and prior to work commencing.

Example 4

Site Nos	**760.5**
Site Name	**River Lickle ds Tennants Meadow**
HQS	1
TSP	8
BPS	100
PRIORITY	**(100/1)/8 = 12.5**
GRADIENT	>4.5 M/KM
MEAN WIDTH	6.4M

Suitable age class and species **Salmon Fry/Salmon Parr**

Choice of schemes

Schemes 1,2,3,5,6,9,10,12,13,14 and 16 would be possible at this site.

Schemes 3,5,6 and 12 are already present or are not deemed to be a problem at this site.

Proposal

The proposal is to use a mixture of schemes 1,2,9,10,13 14 and 16 to increase cover to 15% and shallow riffle area to at least 40%. This will increase the HQS to 5 and a predicted total productivity score of a minimum of 6.

Consultation

A site visit will need to be undertaken with parties from Ecology and Flood defence. All parties need to agree there would be no detrimental effects of the proposed scheme. In particular the landowner and tenant farmers consent needs to be secured as considerable machine access will be required to the site.

Timing of works.

All works would be undertaken in the months May to end of July.

Monitoring

absent from the site in question. These could be used if stage A is successful.

Consultation

A site visit will need to be undertaken with parties from Ecology and Flood defence. All parties need to agree there would be no detrimental effects of the proposed scheme. In particular the landowner and tenant farmers consent needs to be secured.

Timing of works.

Schemes 8 and 12 could be undertaken at most times of the year whilst schemes 11-17 would be undertaken in the period May or June.

Monitoring

The site will be planned for repeated surveys following the introduction of schemes 8 and 12, prior to stage B

Maintenance Plan

No maintenance is proposed initially other than monitoring fencing.

Cost benefit analysis.

This cannot be undertaken at this stage.

Appendix 3b

BIOLOGICAL ASSESSMENT - HABITAT IMPROVEMENT SCHEMES

ONE MINUTE KICK SAMPLE

SAMPLE DATE	7.6.95
SITE	R. CRAKE u/s BOUTHREY BRG
SITE NOS	403.5
SAMPLER	DM

NOS OF INDIVIUALS

	0	1-10	10-50	50-100	100+
* STONEFLIES			✓		
* MAYFLIES			✓		
BAETIS				✓	
* CADDIS			✓		
GAMMARUS		✓			
ASELLUS	✓				
OTHER					

ASSESSMENT

SCORE	
0	
25	
50	
75	
100	✓

COMMENTS

VARIOUS OTHERS

* CLOSE TO 50-100

NOT A TRUE RIFFLE SAMPLE

Appendix 3b

BIOLOGICAL ASSESSMENT - HABITAT IMPROVEMENT SCHEMES

ONE MINUTE KICK SAMPLE

SAMPLE DATE	7/6/95
SITE	R. LEVEN D.S NEWBY BRIDGE
SITE NOS	303.
SAMPLER	Don

NOS OF INDIVIUALS

	0	1-10	10-50	50-100	100+
STONEFLIES					
MAYFLIES			✓		
BAETIS				✓	
CADDIS			✓		
GAMMARUS			✓		
ASELLUS		✓			
OTHER					

ASSESSMENT

SCORE	
0	
25	
50	
75	✓
100	

COMMENTS

Very high zooplankton drift.

Appendix 3b

BIOLOGICAL ASSESSMENT - HABITAT IMPROVEMENT SCHEMES

ONE MINUTE KICK SAMPLE

SAMPLE DATE	3/1/96
SITE	R. LICKLE DS TENANTS MEADOW
SITE NOS	DS 1
SAMPLER	Don.

NOS OF INDIVIUALS

	0	1-10	10-50	50-100	100+
STONEFLIES					
MAYFLIES				✓	
BAETIS			✓		
CADDIS			✓		
GAMMARUS				✓	
ASELLUS		✓			
OTHER		✓			

ASSESSMENT

SCORE	
0	
25	
50	
75	
100	✓

COMMENTS

Abundant food in riffle area.

Appendix 3b

BIOLOGICAL ASSESSMENT - HABITAT IMPROVEMENT SCHEMES

ONE MINUTE KICK SAMPLE

SAMPLE DATE	3/1/96.
SITE	CASTLEHOW BECK
SITE NOS	721.
SAMPLER	DM

NOS OF INDIVIUALS

	0	1-10	10-50	50-100	100+
STONEFLIES			✓		
MAYFLIES					
BAETIS					
CADDIS					
GAMMARUS					
ASELLUS					
OTHER					

ASSESSMENT

SCORE	
0	
25	✓
50	
75	
100	

COMMENTS

No other invertebrates seen. Beck partly frozen over.

HABITAT IMPROVEMENT FIELD SHEET

SITE NO. 403.5	CATCHMENT Crake	U/S NGR SD292 889
DATE 31/3/95	RIVER Crake	D/S NGR

LENGTH OF RIVER FOR PROPOSED HABITAT IMPROVEMENT - 50

RIVER WIDTH (10 measurements equally spaced along length)

1) ______ 2) ______ 3) ______ 4) ______ 5) ______ Mean = 12.56

6) ______ 7) ______ 8) ______ 9) ______ 10) ______ Gradient = ______

1) SUBSTRATE

Bedrock 0	Cobbles 3	Fine Sand/Silt 6
Gravel 90	Boulders & Rocks 1	

2) COVER

Total cover 2%

Express each type of cover as a percentage of the total area

Boulders 0	Undercut Banks 0	Branches & Logs 2
Tree Roots 0	Overhanging Vegetation 0	Other Eg. Walls Please Specify 0

3) FLOW

Pools 5	Shallow Riffle 0	Shallow Glides (<30cm) 30
Deep Riffle 20	Deep Glides (>30cm) 45	

4) What Percentage of the River is Shaded? 20%.

5) Is the River Fenced? (Please Tick)

No	One Bank ✓	Both Banks

6) Is the river prone to drying up? No

Office Use :

HQS = 2.

APPENDIX 1a HABITAT IMPROVEMENT FIELD SHEET

SITE NO. 303	CATCHMENT LEVEN	U/S NGR SD 368 864
DATE 7/06/95	RIVER LEVEN	D/S NGR SD 366-863

LENGTH OF RIVER FOR PROPOSED HABITAT IMPROVEMENT - 100m

RIVER WIDTH (10 measurements equally spaced along length)

1) 22.7 2) 24.0 3) 23.6 4) 20.4 5) 19.2 Mean = 21.98

6) ____ 7) ____ 8) ____ 9) ____ 10) ____ Gradient = 2.5mKm⁻¹

1) SUBSTRATE

Bedrock	Cobbles 3	Fine Sand/Silt 2
Gravel 90	Boulders & Rocks 1	

2) COVER

Total cover 4

Express each type of cover as a percentage of the total area

Boulders 1	Undercut Banks	Branches & Logs 1
Tree Roots 1	Overhanging Vegetation 1	Other Eg. Walls Please Specify ____

3) FLOW

Pools	Shallow Riffle 40	Shallow Glides (<30cm) 30
Deep Riffle 30	Deep Glides (>30cm)	

4) What Percentage of the River is Shaded? 4

5) Is the River Fenced? (Please Tick)

No ✓	One Bank	Both Banks

6) Is the river prone to drying up?

No.

Office Use :

HQS = 4

HABITAT IMPROVEMENT FIELD SHEET

SITE NO. 721	CATCHMENT Duddon	U/S NGR NY 238-002
DATE 29/3/95	RIVER Castlehowe Beck	D/S NGR NY 239-002

LENGTH OF RIVER FOR PROPOSED HABITAT IMPROVEMENT - 50

RIVER WIDTH (10 measurements equally spaced along length)

1) ______ 2) ______ 3) ______ 4) ______ 5) ______ Mean = 1·93m

6) ______ 7) ______ 8) ______ 9) ______ 10) ______ Gradient = 100.0 mkm⁻¹

1) SUBSTRATE

Bedrock 0	Cobbles 50	Fine Sand/Silt 1
Gravel 46	Boulders & Rocks 3	

2) COVER

Total cover 1

Express each type of cover as a percentage of the total area

Boulders 1	Undercut Banks 0	Branches & Logs 0
Tree Roots 0	Overhanging Vegetation 0	Other Eg. Walls Please Specify 0

3) FLOW

Pools 3	Shallow Riffle 60	Shallow Glides (<30cm) 37
Deep Riffle 0	Deep Glides (>30cm) 0	

4) What Percentage of the River is Shaded? 0

5) Is the River Fenced? (Please Tick)

No ✓	One Bank	Both Banks

6) Is the river prone to drying up? No

Office Use :

HQS = 4

APPENDIX 1a HABITAT IMPROVEMENT FIELD SHEET

SITE NO. 760	CATCHMENT LICKLE	U/S NGR
DATE 3/1/96	RIVER LICKLE	D/S NGR

LENGTH OF RIVER FOR PROPOSED HABITAT IMPROVEMENT - 300m+

RIVER WIDTH (10 measurements equally spaced along length)

1) ______ 2) ______ 3) ______ 4) ______ 5) ______ Mean = 6.40.

6) ______ 7) ______ 8) ______ 9) ______ 10) ______ Gradient = 4.5 mkm⁻¹

1) SUBSTRATE

Bedrock	Cobbles 5	Fine Sand/Silt 10
Gravel 84	Boulders & Rocks 1	

2) COVER

Total cover 2

Express each type of cover as a percentage of the total area

Boulders 1	Undercut Banks 1	Branches & Logs
Tree Roots	Overhanging Vegetation	Other Eg. Walls Please Specify ______

3) FLOW

Pools 50	Shallow Riffle 25	Shallow Glides (<30cm) 5
Deep Riffle	Deep Glides (>30cm) 20	

4) What Percentage of the River is Shaded? 0

5) Is the River Fenced? (Please Tick)

No	One Bank	Both Banks ✓

6) Is the river prone to drying up? No

Office Use :

HQS = 1

4.0 Salmonid Densities (nos 100m2)

Site	Salmon		Trout	
	0+	>0+	0+	>0+
403.5	4.45	0.00	0.00	0.20
303	0.43	1.11	0.00	0.11
721	0.00	0.00	21.1	0.00
760	5.0	3.5	3.1	1.38