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A Tweed Foundation Paper

5th Edition of the Fisheries Management Plan for the Tweed and Eye Fisheries District

The Guiding Principle of this Management Plan is consistent with:

(1) The EIFAC (European Inland Fisheries Advisory Committee) Code of Practice for Recreational Fisheries 2008:-

Article 11.1: *The over-arching goal of recreational fisheries management is to ensure the long-term sustainability of fisheries resources thereby safeguarding the availability of these resources for future generations. Sustainability of fisheries resources includes conserving biodiversity at all levels, including genetic diversity, as well as supporting terrestrial and aquatic ecosystems.*

(2) The Strategic Framework for Scottish Freshwater Fisheries (SFSFF):-

a) *Scotland will have sustainably-managed freshwater fish and fisheries resources that provide significant economic and social benefits for its people*

b) *Management decisions affecting freshwater fisheries and fish species should be underpinned by scientific evidence*

and is based on:

(3) The Resolution adopted by the River Tweed Commission in March 2007 that:-

The Tweed and its tributaries should be wild fish fisheries

and is that:

Fisheries Management within the Tweed and Eye Fisheries District should ensure robust stocks of wild fish that can sustain fishing pressures in the long term, based on a thorough understanding of the natures of these stocks and how they are produced by the local environment so that so that problems can be identified immediately they arise and be dealt with quickly and effectively.

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THE STRUCTURE AND FUNCTION OF THE PLAN

The structure of the Plan arranges and orders the gathering of the information needed to assess and compare the past and present conditions of the different stocks of the exploited fish species of the Tweed. On the basis of these assessments and comparisons, an appropriate Management Level for each stock is recommended to the RTC. The purpose of these Management Levels is either to ensure enough fish of each Salmon, Sea-trout and Brown-trout stock survive all the pressures on them to fully stock their spawning areas for their next generations and to maximise their production (Levels 4 and 5) or to make progress towards such conditions (Levels 1, 2 and 3). Ensuring sufficient spawning escapement is classified as "Output 1" of the fisheries management process and maximisation of juvenile survival as "Output 2".

These two outputs should result in both the preservation of the existing diversity of the Salmon, Sea-trout and Brown-trout stocks and the maximisation of their abundances but the importance of conserving stock diversity in particular is recognised i.e. no management action should assist stronger stocks to overwhelm or displace weaker ones. Stock diversity is the safeguard against a changing environment, the greater the range of stocks, the greater the adaptability of the population to new factors and conditions. The diversity of Salmon stocks is also the basis for the long, ten month, Salmon fishing season of the Tweed.

Defining the sort of management needed for each stock as a particular "Level" also provides a convenient and descriptive system for the members of a large organisation like the RTC to use to discuss fish stocks and their appropriate management.

Each Section of the plan to do with fish is structured around the "Inputs" needed to make the Assessment for each definable stock. These Inputs are information on:

(A) The different stocks of fish and their home areas
(B) The quality and quantity of their nursery habitats (see Note A below)
(C) The extent and state of their juvenile stocks and trends in their abundance
(D) The extent and effect of the fisheries on the adults and their stock structure
(E) The exploitation rate of the fisheries on each stock
and
(F) The counting of adult populations of each stock to show whether enough are escaping to spawn.

-

The function of the plan is to set out the policies to be followed over the next five years to gather the information needed as "Inputs". Not all the policies will be put into operation during this period, some may need particular opportunities to arise before becoming practicable or more funding. Other policies may not run for the whole period of the Plan. Annual combined meetings of the Trustees of the Tweed Foundation and the Committee of the RTC are held each year to see if any further parts of the Plan can be put into execution and, if so, what the priorities should be.

NOTE A: HABITAT WORK BACKGROUND AND STRATEGY:

1 It is now over ten years since the Tweed Foundation began its work on habitat and the context within which such work now takes place has changed greatly. In the early 1990's the whole field was unfamiliar to those working in fisheries in Scotland and a major part of the early work was importing the concepts from Ireland and North America and demonstrating that such ideas worked in this area. The Tweed Foundation then appointed its own Habitat Manager to undertake such work, and raised considerable

sums of money for it.

2 The context is now quite different. Habitat work is now accepted as part of the proper work of fisheries management organisations, and indeed, in other environmental fields as well. Without good habitat, it has been realised, little can be done for the conservation of fish and other wildlife. Agricultural support mechanisms now take this into account, and will undoubtedly do more so in the future.

3 While obstacles to fish movement (Habitat Quantity) will always remain of particular interest to fisheries organisations such as the RTC (who have a statutory remit to improve fish passage), habitat quality in and around rivers is of much wider interest. Fencing of banksides to promote natural revegetation and create buffer zones to run-off is of interest to SEPA (from the pollution / run-off aspect), SNH (wildlife corridors), the Borders Forest Trust (riparian woodlands) and farmers & landowners (Rural Stewardship funding etc.). All these bodies, and others, have or attract funding for such work, which contributes to the Tweed interest, the protection of the existing quality of nursery area habitat.

4 In this changed environment, the Tweed Foundation's approach to general riverside habitat work has also changed and is now largely indirect, encouraging other organisations and advising them on the fisheries aspects of such work. This involves :

a) Supplying other organisations with "added-on" fish reasons for their work. The Salmon is the Icon of the Tweed, as well as being very obviously an economic asset to the area that depends on good environmental quality.

b) Encouraging habitat protection and restoration at the policy and catchment levels, such as extensification of grazing, wetland restoration, native woodland regeneration and reduction in fertilizer run-off.

5 It should be noted that the current climate change predictions for this area are for wetter winters and drier summers, with more extreme storm events. Well-vegetated banks will protect against higher and more frequent spates increasing erosion and damaging habitat, giving some insurance for the fisheries of the catchment against the effects of climate change.

6 The Tweed Foundation's current tactics on habitat protection and restoration are therefore to undertake direct action only in areas of specific fish interests ("Attacking" problems directly affecting fish stocks of importance) and otherwise working indirectly through and with others to upgrade the habitat of the catchment generally ("defending" it against degradation and the impacts of climate change)

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SECTION 1: THE ENVIRONMENT

INPUT 1A: DETERMINING THE RELEVENT PHYSICAL PARAMETERS OF THE WATERS OF THE TWEED AND EYE CATCHMENTS

Rationale: As fish and the insects they feed on are cold-blooded animals, their activity and growth is related to the temperature of the water in which they live. This can therefore have major impacts on their life histories – for example, when the scales of Tweed salmon were first systematically read in 1929-30, it was found that less than 5% had been three year old smolts while when Smolts were netted in the early 1960's, the little surviving data shows that over 50% were three years old. In recent years, Smolt ages have returned to being more like those of 70 years ago. The most likely explanation for this is temperature – the 1940s to 1960s were a period of long, cold, winters when the growing seasons for salmon in the catchment would have been much shorter than at present. The high proportion of three year old Smolts in the 1960s would therefore have been due to the large numbers of juveniles that took three years to reach smolting size. However, very few two year old Parr (which will become three year old smolts) are now found in the catchment, showing that growth is generally faster – the higher number taking only one year to reach smolting size is another consequence of this. As climate change continues, it is likely that three year old smolts will disappear from the population altogether.

The European Freshwater Fish Directive of 2006 defined prime quality Salmon spawning areas as having temperatures during the spawning season of less than 10 C. A pilot project measuring temperatures around the Ettrick and Yarrow in 2005 & 2006 found that the warming effect of St. Mary's Loch could keep the temperature in the Upper Yarrow above this temperature into the spawning season. Should temperatures generally increase, this area could cease to be classifiable as a prime spawning area. Since shading by bankside trees can reduce water temperatures, areas at risk from increased water temperatures need to be identified so that remedial action (tree planting) can be proposed.

Policies for the Fifth Edition of the Management Plan:

Policy 1A.1: Collect historical information on changes and variations in physical parameters

(a) Record anecdotal evidence for floods and droughts affecting spawning streams and tributaries and trends over time.

Policy 1A.2: Record water temperatures within the Tweed catchment

(a) Record the temperature regimes at key points within the Tweed catchment

(i) At fish counters (*the integral temperature monitors on the VAKI counters are not accurate and vary from machine to machine*)

(ii) Where there is wide, open, channel in nursery areas and it is suspected that Summer temperatures may reach the upper limits for Salmonids.

(b) Collect data on the emergence times of salmonid fry to relate to altitude and other factors. This would show how the different temperatures in different parts of the catchment could relate to the formations of distinctive populations. It would also give better guidance on when instream works can take place

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INPUT 1B: DETERMINING THE RELEVENT CHEMICAL PARAMETERS OF THE WATERS OF THE TWEED AND EYE CATCHMENTS

Rationale: The abundances of salmon and fry vary within the catchments of the Tweed and the Eye. One underlying factor in this could be the different chemical richness of the waters and this should be assessed to see if it is significant or not.

Policy 1B.1: Map the chemical richness of the waters of the Tweed and Eye catchments

(a) Take conductivity readings at all electric-fishing sites and relate these to the abundances of trout and salmon fry.

SECTION 2: SALMON

INPUT 2A: DETERMINE AND DEFINING THE STOCKS OF SALMON WITHIN THE TWEED SYSTEM AND THEIR LIFE HISTORIES

Rationale: The most basic information needed on the Salmon of the Tweed is their stock structure : Is there just one interbreeding stock throughout the whole catchment, or are there stocks differentiable by their life-histories and / or genetics - essentially, are there Tweed Salmon or Tweed Salmons ? If the full range of stocks and run-timings is to be maintained in the Tweed, which is what gives the river its 10 month long Salmon fishing season, then it is essential have these stocks defined so it can be assessed how well the spawning requirements of each are being met.

Results from previous editions **:** -

a: *Scale reading showed :*
(i) That early-running Spring Salmon were being caught as far upstream as the Ettrick but only rarely beyond (Appendix 4A.1))

b: *Radio-tracking showed :*
(i) That this pattern could also be found by tracking fish from the time of their entry into the estuary to their final spawning destination : Most early running Salmon of the 1994-96 study went to either the Ettrick or the Whiteadder with only small numbers returning to other home areas. Fish of other run timings had different patterns of home areas (Appendix 4A.1)
(ii) Radio-tracking on the Ettrick in 1998 showed that later running fish spawned in the lower part of the river and earlier fish in the upper parts

c: *Spawning surveys showed :*
(i) That there were still Spring Salmon in the Upper Tweed, despite none being caught for radio-tracking. One area at the very top of the Tweed in which Salmon spawn at the same time as the Ettrick Spring Salmon has been identified so far : The connections between run-timing and spawning timing are given in Webb & MacLay (1996)

d: *Catch Record analysis showed*
(i) That there can be considerable variation between tributaries in the changes in run timing: Spring Salmon appeared in catches downstream of the Ettrick around 1910 but did not do so upstream of that river till around 1930 (see Appendix 4A.1). This is an important finding as it shows that local factors or stocks can affect run-timing, not only large scale marine factors.

e: *A study commissioned from Exeter University and part funded by the Atlantic Salmon Trust showed that the Salmon that have recolonised the Gala Water since the fish pass was installed in 1949 are not (yet) genetically distinctive, and that they came from the neighbouring populations. This study also showed that, with the techniques used, genetic diversity within the salmon of the Tweed was quite low, with regional differences being stronger than more local ones.*

f: *Analysis of the data from the Ettrick fish counter and the annual fry index surveys of the Ettrick and Yarrow is indicating that there is more than one stock in the Ettrick system. The earlier running fish are through the counter by the end of October (in years with normal flow*

patterns) and spawn in the upper and middle Ettrick and Yarrow, while later running fish enter in November and December and spawn in the lower zones. It appears that the numbers of the latter can be restricted by low water temperatures at the fish ladder, resulting in reduced numbers of juvenile salmon in those areas.

These findings clearly show that there are different stocks of Salmon within the Tweed, with different run-timings (see Appendix 4A). The genetics work showed that behavioural differences between populations may be more apparent than genetic and that there will be "blanks" on any genetic map of Tweed salmon due to the extinction and recolonisation of so many tributaries (Leithen, Gala, Leader, Whiteadder, Ale, Jed, Slitrig, possibly Teviot above Denholm and possibly also the Bowmont / Glen [the historical information on the obstacles that could have caused such extinctions on these last two is unclear or contradictory])

Policies for the Fifth Edition of the Management Plan:

Policy 2A.1 – Map the genetically distinctive populations of Salmon within the District and define them by run type.

(a) The Radio-tracking work of 1994-96 on the whole Tweed showed how Salmon of different run timings went to different tributaries and sectors of the main river and the Ettrick tracking work of 1998 showed how earlier and later fish were distributed within a single tributary. Since those days, advances in genetics and the decreasing cost of genetic analysis has changed the technology available to provide this sort of information. With funding from the Scottish Government, through RAFTS, work on the genetic mapping of the Salmon of the Tweed started in 2008 and will continue through the period of this plan. This work requires:-

(i) Taking samples from juveniles throughout the catchment to establish the number and extent of genetically distinctive salmon populations

(ii) Taking samples from a full range of adult Salmon found in the Tweed – Spring, Summer and Autumn fish (including those entering the river during December and January) so that the distinctive populations within the catchment [established by *(i)*] to which they belong can be identified. This in turn identifies the juvenile populations as being the young of Spring, Summer or Autumn fish.

(iii) Given the long-term decline in the size of fish being caught in the Autumn, which dates back to the 1940's [see Appendix **] there is a particular management need to find out if large Autumn fish belong to a particular population or populations or are just the random extremes of all the different populations. If the former, then conservation of such fish could be needed – stocks that fall to low numbers should have their exploitation rate reduced to make sure that angling does not exacerbate their difficulties. The identification of the home areas within the catchment of large Autumn fish is therefore a particular aim of this programme.

(iv) As part of this programme, genetic identification is being provided to the international SALSEA programme, so that Tweed salmon caught at sea can be identified. *This replaces much of the need for the microtagging work listed in previous editions of the plan.*

(b) Produce a map of the geographical distribution of the nursery areas of the different stocks of Tweed Salmon based on **(a)** for use with the Tweed Fisheries GIS. This map will then allow the data from the juvenile surveys undertaken as part of Policy 2C.1 to be recognised as belonging to particular stocks, allowing the strengths of the juvenile stocks of Spring, Summer and Autumn fish to be determined for the first time.

(c) However, preliminary genetics work has shown relatively low levels of differentiation within the salmon of the Tweed and also that newly recolonised areas have not yet developed genetic distinctiveness. The present work uses more genetic markers than the previous, which may make a difference, but it may be necessary to undertake more tracking work in order to relate nursery areas to particular run-timing stocks. If required, this will be formulated for the next edition of this Management Plan.

Policy 2A.2 – Analyse the ages and sizes of the salmon of the Tweed and monitor any changes or trends (see also Policy 2D.2)

(a) Collect and read a representative sample of scales to determine the smolt and adult ages of salmon

(i) Maintain a database of scale readings

(ii) Produce an annual report on findings.

(b) Relate present day data on ages and sizes to past records to show up any long-term changes and trends.

INPUT 2B: INVENTORY THE QUANTITY AND QUALITY OF NURSERY AREAS OF EACH STOCK OF SALMON

Rationale: Healthy stocks of Salmon can only come from a healthy aquatic environment, which is much more than simply a good chemical quality of water. The physical forms and shapes of streams and rivers are crucial - larger fish need deeper water but young fry need shallower, gentler, areas so the ratio and mix of stream types, of runs, pools and riffles, is vital if every life-cycle stage is to find enough of the conditions best for it. Overgrazing weakens and destroys the bankside turf that separates soils from floodwaters and so accelerates bank erosion making streams become wider and shallower and less suitable for older fish and for young fish during spates and droughts. Overshading by dense trees kills off bankside vegetation and so has the same effect as overgrazing. Even the best quality of habitat is useless to fish if they cannot reach it to spawn in it, and the industrial history of the Tweed left behind a multitude of barriers to fish migrations. Identification of any areas totally inaccessible to spawning fish or where access over instream structures is restricted to a narrow range of water flows is a management essential. Areas where juvenile abundances are limited by poor physical or chemical conditions also need to be identified, while areas that are in good condition need to be secured as such through protection by fencing.

Once remedial actions are taken, their long-term effects and benefits need to be monitored to assess their effectiveness and value.

The backlog of problems of habitat degradation and blocking of fish migrations in the District is a "by-product" of the farming, forestry, industrial and road-building methods of the past, but with relatively minor changes to traditional practices further problems will not be created and this must be a major aim of fisheries management. The changes in forestry practice brought about through the "Forests and Waters Guidelines" demonstrate what can be achieved in this way.

***Results from previous editions*:**

a: *There have been systematic foot surveys made of all the watercourses between 2 m and 8 m wide (approx.) throughout the catchment. Lists of obstacles to fish migration were produced as a basis for remedial action and areas where banksides were under stress were identified.*

b: *Since 1990 59 obstacles to fish movement have been completely removed and ** eased to make fish passage less difficult.*

c: *Since 1994, 116 kms of bankside have been fenced, to provide protection to the banksides, allowing vegetation to develop and strengthen banks and provide more cover for fish as well as providing buffer zones between the river and other land uses. Much of this work has been "defensive" to protect the existing quality of habitat against deterioration.*

d: *Where bankside erosion has been particularly severe, some 4 kms of instream works have been built to stabilise banks till natural re-vegetation, aided by the planting of native trees, can restore the situation. These fenced and planted riverbanks create corridors of semi-natural vegetation along watercourses that connect up existing woods and wetlands to provide a network for many plants and animals to spread and connect up previously isolated populations.*

e: *Monitoring of sites after habitat restorations has been carried out, but has been reduced by the loss of "controls" – areas without restorations against which those with restorations could be measured. This has been due to the fencing of banksides by local farmers and landowners or the reduction in sheep stocking pressure having similar effects.*

f: *Six pilot projects to monitor the long-term effect of different types habitat improvements were set up during the period of the first management plan and have been monitored since, though some have also been affected by the loss of "controls".*

g: *Leaflets on habitat improvements and on river works have been produced.*

h: *Links with Farmers and Foresters have been established and information on how land uses can impact on waters and fish has now been widely disseminated throughout the District*

i: *All available Rainfall, Temperature and Flow data were collected and computerised for analysis with long term catch data as part of the Catch Records Study 2001-04. Data on marine conditions and climate was also collected.*

j: *Data collected from foot surveys made during the period of the 2nd edition of the Management Plan has been, were practicable, transferred to the GIS system. Some of this data would, however, take an excessive amount of work to transfer and remains on paper. Aerial survey techniques which produce data in digital formats have been developed since this work started and are being brought into use here.*

k: *Most obstacles in Spring and Summer Salmon areas have now been eased : These have been in small and medium sized channels. Habitat restoration in areas of importance for Spring Salmon has been completed where thought useful. Bankside fencing to provide buffer zones to protect watercourses in areas of Spring Salmon production has been largely completed in the Ettrick catchment.*

Policies for the Fifth Edition of the Management Plan:

Policy 2B.1: Collect and Analyse Historical Data on the Environment of the Fisheries District

(a) Continue the collection and map the locations of man-made barriers past and present and quantify the areas of spawning blocked or restricted by them. If possible, maps of the area open to Salmon spawning in 1800, 1850, 1900, 1950 and at present will be produced. *This data could now be of importance in interpreting the results of the genetics work being undertaken under Policy 2A.1*

Policy 2B.2: Survey Salmon Nursery Areas

(a) New technologies of aerial river survey offer a much more objective and usable way to survey and analyse habitat data and the development of these will be monitored and, if the opportunity arises, applied to the catchment.

(b) Existing aerial survey data for the catchment (taken from general rather than from river-specific surveys) will be analysed to show:

(i) Area of wetted habitat in tributaries to show the extent of spawning that needs to be filled by fish

(ii) Connections between instream river habitats and land-use and the wider landscape

Policy 2B.3: Monitor the effects of obstacles on fish passage and undertake appropriate habitat protection and restoration work for each salmon stock.

(a) Monitor the effects of instream structures: Where obstacles to fish migration have been eased with fish passes or breaches rather than removed completely, monitoring is required to check that these continue to work properly – accessibility can change as erosion changes the configuration and depth of the water downstream. *This requirement is covered by the change to Fry Index for juvenile monitoring [Policy 2C.1] which means that a great many sites are now monitored frequently so declines in salmon fry abundance upstream of such eased obstacles are detectable as part of the regular monitoring of juveniles.*

(b) Investigate of areas of weaker juvenile numbers: Where electric-fishing monitoring of salmon juveniles under Policy 2C.1 shows areas of poor juvenile abundances that cannot be explained due to natural causes or to restricted access over some man-made or natural obstacle make further investigations to identify causes and any suitable remedial actions. The protocol for such investigations is given at the end of this chapter.

(c) Defend the existing production capacity of nursery areas: At the present time of historically high Salmon catches, the existing productive capacity of the habitat of the catchment needs to be protected. The main method of this is through bankside fencing to create buffer zones between water channels and potentially damaging activities such as forestry, farming and urban development [see Note A to the Strategy section]. The differing strength [and value] of different stocks of Salmon sets the priorities for such work - Bankside fencing to provide

buffer zones to protect watercourses in areas of Spring Salmon production has been largely completed in the Ettrick catchment: Such areas in other sub-catchments should be similarly protected if these are identified as Spring Salmon areas through Policy 2A.1

Note that Policy 2B.3 fulfils the NASCO guidelines that Salmon management should:-
- protect the current productive capacity of the existing physical habitat of Atlantic salmon
- restore, in designated areas, the productive capacity of Atlantic salmon habitat which has been adversely impacted.

NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat CNL(01)51

Policy 2B.4: Monitor the physical changes and the juvenile salmon populations where habitat protection or restoration has been undertaken

(a) Continue to monitor the long-term changes at the Habitat Pilot Projects set up during the period of the first Management Plan to evaluate the techniques used by amalgamating this with the regular Fry Index surveys of Policy 2C.1. A higher density of these electric-fishing samples below, within and upstream of these sites should provide the required information.

(b) Continue the monitoring programme of sites in areas of habitat rehabilitation by amalgamating it with the regular Fry Index surveys of Policy 2C.1. A higher density of these electric-fishing samples below, within and upstream of these sites should provide the required information.

(c) Maintain a database of protection and restoration sites: To include pre-works photographs and data, rationales, plans, costs and contracts for the restoration work, post-works photographs and continuing monitoring data

Policy 2B.5: Ensure the access and habitat problems of the past do not recur

(a) Collect information from the UK and abroad on best practice in Farming, Forestry and Road-building in relation to waters and fish populations.

(b) Disseminate this information amongst local land-users and provide practical advice on its implementation.

INPUT 2C: MONITOR THE JUVENILE POPULATIONS OF EACH STOCK OF SALMON; THE INFLUENCE OF HABITAT CHARACTERISTICS ON THEM AND THE EFFECTS OF PREDATION

Rationale: Monitoring the abundances of juvenile Salmon in the different parts of the catchment shows how well the spawning areas are being filled with young. If numbers of spawners of a stock were to fall to the extent that it reduced the numbers of juveniles at its monitoring sites, this would become apparent several years before the resulting adults were due to return, and catch regulations to reduce exploitation on them could be prepared in advance. Conversely, knowledge of how well the catchment is stocked with juveniles will also

show if any fall in adult numbers is due to actual lack of juveniles or to some other reason. Once information from Policy 2A.1 is available, it should be possible to categorise at least some of the different areas of the catchment as being the home areas of particular runs of salmon – Spring, Summer and Autumn and so be able to assess the health of the different runs from their juvenile stocks.

Poorer numbers in particular areas also serve to indicate where there are access problems or where habitat restoration may be required. Knowledge of how abundances of juveniles varies from area to area and over time is necessary if those that need restoration are to be distinguished from those that do not or are just naturally poor. The large number of sites covered using the Fry Index technique provides the data for such indications and analyses.

The Tweed Fisheries District is home to significant populations of fish eating birds - Goosander, Grey Heron and to a lesser extent, Cormorant. The first is of much the greatest significance as it feeds purely on fish and is found throughout the system (Herons eat significant amounts of Frogs, ducklings, rodents and insects as well as fish and cannot reach out beyond the banks to where Smolts move and Cormorants are mainly on the lower river, though increasingly are found more inland) The Goosander is also a gregarious rather than a solitary feeder which means that considerable flocks of Goosanders can form where they find fish available. As Smolts are the "end-product" of up to three years of freshwater life, any loss to predation is irrecoverable and must result in fewer adult Salmon returning to the river.

Results from previous editions:

a: In the first edition of the management plan (1990-95), sites in medium-sized channels (dominated by Salmon) that would be electric-fished regularly to monitor the fish densities in them were set up in the Ettrick, Till, Teviot and upper Tweed catchments, and in the second edition (1995-2000) the same was done for the Whiteadder, Leader, Gala and some minor tributaries. The first repetition of the monitoring cycle started in 1999 when the Teviot and Till sites were re-sampled.

b: The information from these samplings (Appendix C) has helped determine the management levels required for Salmon stocks

c: Access problems for spawning Salmon have been shown up by the results from some sites as have areas where habitat restoration work would be beneficial

d: Analysis of the stomachs of Goosanders provided by the TF and RTC to the Institute of Terrestrial Ecology (and now published as part of Marquiss, Carss, Armstrong and Gardiner 1998) has provided estimates of smolt consumption which, when combined with counts of made of these birds during the smolt season, has made possible the estimation of the economic damage to the local economy caused by their predation.

e: The basic method of monitoring was changed from a relatively small number of quantitative sites to a much larger number of semi-quantitative [Fry Index] sites as, on analysis, it was found that a much larger number of samples was needed to show the full picture and patterns of juvenile abundances throughout the catchment. Knowing juvenile densities in detail at a small number of sites simply did not give the management information needed, though some such sites are being continued to keep continuity.

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Policies for the Fifth Edition of the Management Plan:

Policy 2C.1: Monitor the Abundances and Densities of Juvenile Salmon at Sites throughout the Medium-sized Channels of the Catchment

(a) Continue the electric-fishing monitoring of juvenile Salmon abundances throughout the Tweed and Eye catchments on a rolling cycle:-

2010	**2011**	**2012**
Till	Whiteadder	Leader
Teviot	Eye	Gala
Middle Tweed	Leet	U Tweed
	Eden	
	Lower Tweed	

The Ettrick is sampled every year

In setting up this sampling rotation, care had to be taken to avoid following the same generational cycle of Salmon. The Ettrick and Whiteadder are dominated by five year old Multi-Sea-Winter Salmon so if sampling was every five years, it would be same line of Salmon being sampled each time. To avoid this, the sampling periodicity for these sectors has to be any period other than five years. The other sectors are dominated by four year old Grilse and their sampling periodicity therefore has to be three or five years.

(b) Continue to extend the Fry Index sites over the whole catchment – existing coverage is shown in Map *

(i) Continue to develop the database holding the information from these surveys and linking this with physical, chemical and aerial survey data.

(ii) Analyse this electric-fishing data to show areas of good and poor abundances of juveniles and explain such variation. Where areas have no natural explanation for being poor in juveniles, further investigations under Policy 2B.3 are indicated.

(iii) If the information from Policy 2A.1 is sufficient, categorise this electric-fishing data as showing the abundances of Spring, Summer or Autumn salmon & grilse juveniles and analyse the relative strengths of these stocks as juveniles.

(c) Continue a selection of the quantitative electric fishing sites of previous editions to maintain continuity and provide the data required by SEPA and the EA for their water body assessments under the WFD. These sites are shown on Map *

(i) Analyse this electric-fishing data to show any long-term quantitative trends.

(ii) Contribute the data from these sites to the SFCC national database.

(iii) If the information from Policy 2A.1 is sufficient, categorise this quantitative electric-fishing data as showing the densities of Spring, Summer or Autumn salmon & grilse juveniles and analyse the relative strengths of these stocks as juveniles.

Policy 2C.2: Collect Data on the Effects of Predation on Juvenile Salmon, and on Smolts in particular

(a) Continue to count the numbers of Goosanders and Cormorants in January, April, May and September of each year. Counts are organised by the RTC Superintendent and carried out with the RTC bailiffs.

(i) Use the information from these counts and from published analyses of the diet of Goosanders and Cormorants on the Tweed to make annual assessments of the impact that their predation on the smolt run has on the economic value of the Salmon fishery.

(ii) Determine if it is possible to isolate the effects of predation on Spring Salmon and if so, assess these separately from the general damage assessment.

(iii) Analyse the results of the counts to show any geographical pattern to the distribution of Goosanders along the river. If any locations are found where the birds are regularly clustered these could be "choke-points" where smolts are particularly vulnerable and special measures to protect such sites could be taken.

(iv) Find additional methods of counting with which to extend the proportion of the catchment covered and supplement the existing methodology. The Ettrick in particular needs to be included in the regular counts to allow better assessment of the effects of predation on Spring Salmon

(v) Discuss methodologies and analyses with other rivers to standardise these as much as possible

(b) Acoustic tag Salmon smolts in the Yarrow and Gala and track down to the sea:

(i) Determine success rate in reaching the sea, taking account of any handling / tagging mortality

(ii) Determine causes of losses where possible and if there are particular parts of the main river in which losses are greater than in others.

(iii) Relate smolt movements and losses to the pattern of distribution of fish-eating birds on the main river during tracking.

(c) Record damage types and their levels on smolts sampled at smolt traps. At present, the assessment of damage done by predators is based only on the numbers of smolts actually consumed, there being no estimates as yet of the effect of damage by unsuccessful attacks leading to delayed mortality or reduced ability to survive at sea.

(i) Define the types of damage seen, based on the study by Williams (****) and determine if the same types are represented here.

(ii) Determine the levels of each type of damage.

(d) Establish methods for improving

INPUT 2D: ANALYSE THE CATCH COMPOSITION AND TRENDS OF EACH STOCK OF SALMON

Rationale: Analysis of catches for their composition shows which stocks (and areas of the catchment) are producing the fish that support the fisheries. Knowledge of trends and cycles in catches allows annual figures to be judged in a wider context. The "breadth" of support for catches depends on their composition: Catches that depend on only one age class of fish are more vulnerable to fluctuations due to environmental effects on single spawning or smolting years than those that exploit two or more age groups of fish and this is important information if the significance of fluctuations in catch totals is to be properly assessed. Historic records show how the sizes and run timings of the fish have varied over the years and give the context for assessing the present day situation. Establishing long-term trends will show large-scale changes that cannot be countered,

though could be managed. Variation outside known parameters from the past could be a warning sign of problems

Results from previous editions :

a: Scale reading has shown :
(i) The age structure of the Salmon caught in the rod fisheries. Up to 85% of the Spring Salmon can be the same age (2.2, five years old) though the ages Autumn catches are more diverse
(ii) The relative contributions of the different seasonal types to the catches

b: Analysis of Salmon rod catch records has shown :-
(i) There have been considerable shifts in the timing of the main Salmon rod catches over the last 150 years from Autumn (2nd half of the Season) to Spring (1st half) and back to the Autumn. This shows that before the "decline of the Spring Salmon" there was a very considerable "rise of the Spring Salmon" so the situation is much more complex than generally realised and it is better to think in terms of "change" rather than "decline".
(ii) These changes are reflected in the overall rod catch figures of the last 50 years as shown in the RTC Assessment records in which it can be seen that the most recent change from 50% and more of the catch being taken in the first half of the season to it be taken in the second half of the season was 1968
(iii) The differences between the stocks of the Ettrick and the Upper Tweed found at present can be traced back through the 20th century in the catch records from immediately upstream and downstream of the confluence of the Ettrick with the Tweed.
(iv) There was a five year cycle in the numbers of Spring Salmon caught which appears to have been set off by a catastrophic flood in the Ettrick at the end of October 1977 highlighting the vulnerability of the Ettrick Spring Salmon stock, limited as it is in area of production and age of maturity, to adverse natural factors - and therefore to man-made impacts such as over-fishing as well. This ended in 2002, when Spring catches were equal to those of normal years.
(v) The age classes being exploited by the rod fisheries through the season

c: All known long series of net and rod catch records were collected and computerised during the Catch Records study of 2001-04

d: The lengths and weights of 1507 salmon from 1894 & 95 were computerised from the 13th Annual Report of the Fishery Board for Scotland to give a baseline against which modern data can be tested to show if there have been long term changes in the shape of Tweed salmon.

Policies for the Fifth Edition of the Management Plan:

Policy 2D.1 - Determination of Long-term Changes and Cycles

(a) Continue analyses of catch and environmental data to show any long term trends:
(i) Between catch levels and environmental factors
(ii) In sizes or other features of the salmon of the Tweed.

Policy 2D.2 - Monitor Catch Composition

(a) Continue collection of Salmon scales from the sample fisheries along the course of the main river and from the larger tributaries and develop a database to hold the readings made from scales and allow rapid analyses to be made

(b) Use this database to analyse scale readings to show :-

(i) Geographical pattern and age structures

(ii) Lengths and weights of fish for in relation to area, time of year and age

(iii) The different stocks and age classes of fish being caught. This shows how dependent catches are on particular ages of fish and how success or failure of particular spawning or Smolt years can be reflected in the catches of the resultant adults.

(c) Develop and improve expertise in scale reading through collaboration and co-operation with scale-reading personnel in Trusts and Agencies

(i) Work to ensure consistency of scale reading interpretation throughout the country

(ii) Analyse Tweed scale reading results with those from other rivers to find differences and similarities.

Policy 2D.3: Monitor and Analyse Catch Trends

(a) Publicise the need to maintain the integrity of the rod catch record series now that most fish caught are released

(i) Promote the use of landing nets with integral weighing scales so that the weights of the large numbers of fish caught and released are accurate and thus maintain the integrity of the catch record series which until recently has been based on the weights of fish killed and weighed.

(ii) Undertake checks to compare the sizes of fish recorded as being killed and those being released to find if these are comparable and if particular sizes of fish are being selected for release.

(iii) Encourage research towards finding a tag that is easy for anglers to use and does not require a hole to be made in fish so that the rates of recapture of released fish can be monitored

(b) Continue to analyse the rod and net catch records for trends and changes and improve catch recording detail if possible:

(i) Improve the quality of rod catch records by recording the amount of fishing effort at least a sample of fisheries - the same total of fish caught with a little effort indicates a very different situation than if caught with a lot of effort. This improvement is of particular importance for the monitoring of Autumn Salmon and Grilse as these fish spawn largely in the main channel and at the bottom of the tributaries, they are unlikely to be monitorable by fish counters in the foreseeable future. Rod catch records with effort data therefore offer the only practicable way at present of monitoring this stock.

(ii) In particular, monitor the Spring catches for any signs of more five year cycles of poor catches developing

(c) Continue the accumulation of data for modelling the Salmon stock of the District and the collection of examples from elsewhere.

INPUT 2E: ESTIMATE THE EXPLOITATION RATE OF EACH RUN OF SALMON

Rationale: If spawning targets are to be established, it is necessary to know where the adults of a stock are being killed or are dying and how many are being lost in these ways. If more breeding fish are needed for the spawning areas, then reduction of these losses is the best way to provide them. Early running stocks are generally more heavily exploited than later stocks because they are in a river for more of the fishing season. Later running stocks, may, in fact be only very lightly exploited and if this can be shown, then it can indicate increased scope for fisheries just as high exploitation rates of early running fish can mean that their exploitation should be reduced.

Results from previous editions:

a: Tagging Salmon in the estuary each September to find out how many were later caught by anglers has shown that the exploitation rate by the rod fisheries of these Autumn fish is very low, only 5-10% or so, but shows signs of an upward trend.

Policies for the Fifth Edition of the Management Plan:

Policy 2E.1 : Tag Salmon on the lower river / estuary to find their angling exploitation rates

(a) Continue the assessment of the rod exploitation rate of Autumn salmon through tagging and recapture. This is based on the use of a netting station after the netting season ends.

(b) If possible, extend this to the Spring and Summer stocks as well: This would require the use of a station during the netting season. There are, at present, no estimates for the exploitation rate of Tweed Spring and Summer Salmon stocks but these are very important for the setting of Management Levels. In other rivers, the angling exploitation rates of earlier running stocks are known to be much higher than those of later fish.

Policy 2E.2: Acoustic tag Salmon on the lower river / estuary and track them upstream

(a) Tag net or rod caught fish on the lower river / estuary.

(b) Track the tagged fish upstream to determine non-angler mortality. The ordinary tagging shows the proportion killed by anglers, but cannot show what proportion die in the river due to other causes (predation, poaching, disease etc.). During this tracking, data can also be collected on:-

(i) The speed of movement upstream of Salmon and how this relates to water conditions
(ii) How their movements relate to the pattern of catches as shown on the FishTweed website
(iii) How quickly the fish pass obstacles / find and use fish-ladders.

INPUT 2F: COUNT ADULT SALMON POPULATIONS

Rationale: The most basic need of a stock is that enough fish should escape all the pressures on them to spawn and fully seed their nursery areas for the next generation and this is best known if the fish of each stock can be

counted. This needs fish counters to actually tally the fish - and has to done on a stock-by-stock basis- i.e. each distinct stock needs a counter to record the numbers making it back to their nursery areas so that finally. As well as giving a result for the number of fish passing upstream of it, results from a counter also give checks on a wider range of data : e.g. the totals of a fish counter counting Spring or Summer fish up a tributary should mirror the catches of those fish in the main channel, if these are related to stock size.

Results from previous editions:

a: A fish counter was installed in the fish ladder of the Murray Cauld on the Ettrick, near Selkirk, in 1997 and counts of adult fish going upstream to spawn are now available from 1998 onwards. As this counter measures the length of each fish it counts, samples of fish were trapped in most months of 1998 and their lengths and species identified. This data allowed the counter totals to be split into species - Salmon or Sea-trout - by their length in any month.

b: A first estimate of the spawning escapement needed by Salmon of the Ettrick was made and annual counts have been assessed against this since

c: As a result of this information, a Management Level 3 approach was recommended to the RTC to safeguard the Ettrick Spring Salmon

d: Intensive juvenile surveys of the Fry resulting from each counted run of adults since 1998 have been made on the Ettrick. Data series are too short as yet, but in time this will serve as a check on whether the estimated number of spawning Salmon needed is appropriate

e: The addition of cameras to the Ettrick fish counter allowed much better identification of counted fish as Salmon or Sea-trout. Data from pre-camera years has been re-analysed using the newer information on sizes and species to improve past division into species.

f: A fish counter was installed in the Skinworks Cauld in Galashiels in 2007 to count the fish running up the Gala Water

g: The area of the Gala Water open for spawning was calculated from aerial photographs and an estimate made of the number of Salmon required to fully stock it.

Policies for the Fifth Edition of the Management Plan:

Policy 2F.1: Continue counts at the Ettrick and Gala fish counters and install other counters where possible

(a) Improve and upgrade the existing counters as new technologies or software become available.

(b) Plan for further counters on Tweed tributaries

(i) Gather information on fish counter models, with particular regard to those that could be used on existing caulds and other in-river structures: There are a number of these in the lower reaches of Tweed tributaries that it might be possible to adapt to carry counters.

(ii) Where possible sites match with counter models available, conduct feasibility studies

Policy 2F.2: Improve the spawning targets set for Salmon upstream of the Ettrick and Gala counters and set targets for any new counters established.

(i) Refine the estimates of the number of spawning adults needed, using the estimates of the wetted area of the Ettrick and Gala waters produced under Policy 2B.2

(ii) Under the revised Tweed Spring Salmon Conservation Code (if approved by the RTC), Spring Salmon killed as being unfit for release will be given to the Tweed Foundation for analysis. This will allow an accurate sex-ratio for Spring Salmon to be determined.

(iii) Use the data on size of salmon counted and the number of eggs produced by each size to improve the data on number of eggs being deposited upstream of counters

(iv) Use the data from the electric-fishing surveys of juveniles [Policy 2C.1] to check that juvenile abundances upstream of fish counters are at the highest possible level and are not being restricted by lack of spawning adults.

Policy 2F.3: Monitor the attainment of the spawning escapement targets set for the Ettrick and Gala salmon populations using their counters.

(a) Check the numbers of salmon counted upstream each year against the spawning targets and advise the RTC of any shortfall. If these targets are being met, it is a reasonable assumption that the targets for all the different populations within the catchment are being met, though the more counters spread through the catchment there are, the more secure this assumption is.

Policy 2F.4 : Develop population models for the salmon stocks upstream of counters.

(a) Use the data on spawning escapement (fish counts) and exploitation rates of adults by the fisheries to make models of these populations Knowing where and when mortalities are suffered by different stocks of salmon and the level of these allows full assessment of their health and the degree to which angling exploitation can be supported.

However, better models will require:

(i) Better estimates of the numbers of Ettrick and Gala fish being caught in the fisheries. Some data is available for the Ettrick from the radio-tracking of 1994-96 but this is probably out of date and was based on small samples. Genetic testing of scales from fish killed at fisheries along the river may be able to provide this information and this possibility requires investigation

(ii) To model the complete life-cycle, information is needed on Smolt production from the areas above the fish counters and the mortality experienced by these on their passage downriver to the sea. The second of these points is being investigated by the acoustic tracking of Policy 2C.2

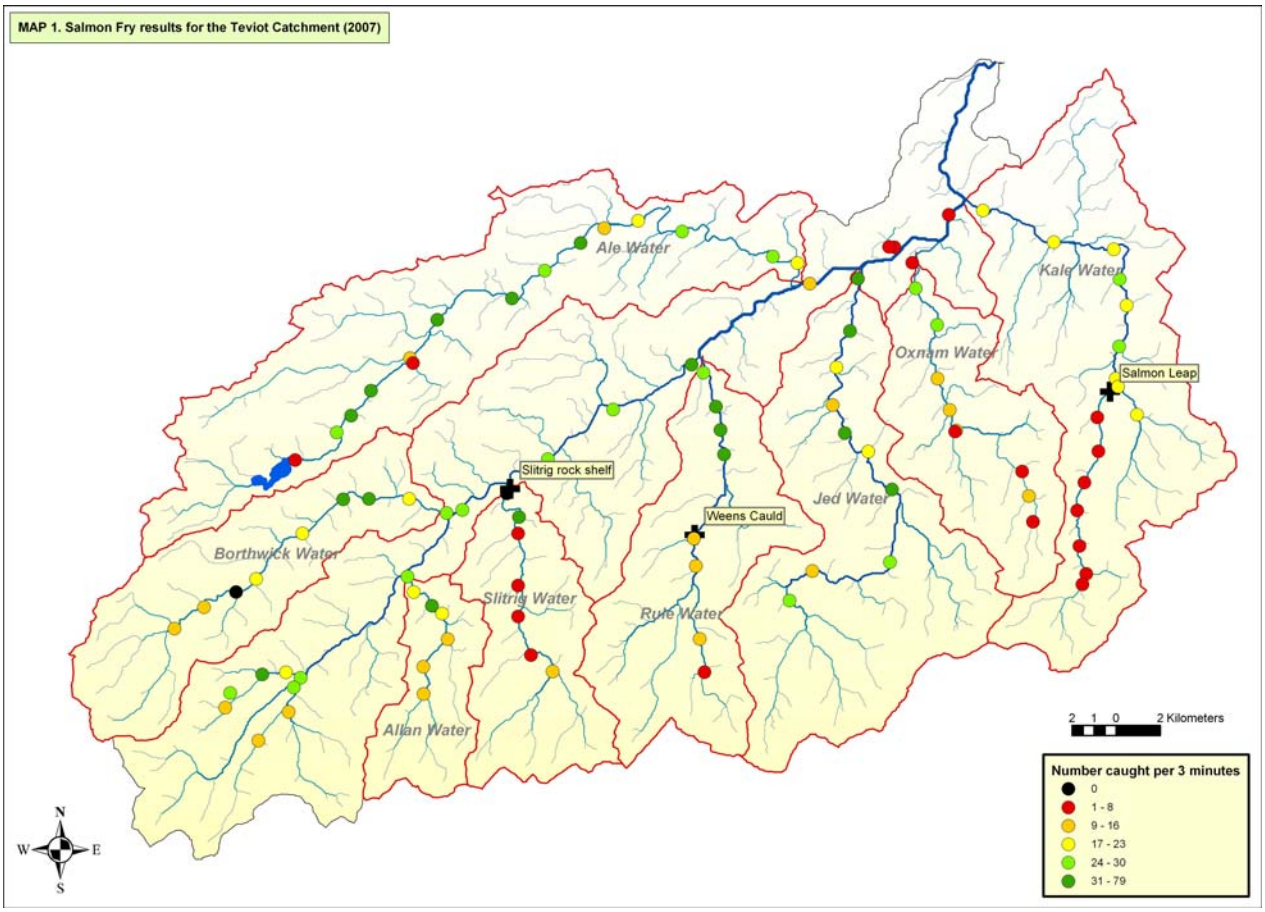
(b) Examine the feasibility of fully modelling the salmon of one of the tributaries with a fish counter – see Appendix 2.2 below for a first outline of how this could be done.

Appendix 2.1: The advantages of semi-quantitative Fry Index electric-fishing surveys over quantitative for fisheries management.

The advantage of this method is that it generates very large numbers of sample sites – with three teams of two, 45 sites can be sampled in a day. This gives a picture of the state of juvenile stocks with many more "pixels"

in it, allowing patterns of abundance over the whole catchment to become visible. The limited number of quantitative sites that it is practicable to undertake means that they must be widely dispersed, so it can never be certain if a change in fish density at such a site is the produce of some factor affecting a wider area or is just some factor specific to the site. The large number of sites generated by Fry Index sampling, on the other hand, allows changes in juvenile stocks to become visible because whole groups of sites are affected, not just one as shown in Map 2.3 below, where the abundances of Salmon fry upstream of three different obstacles decrease at all the upstream sites. If there were just one or two quantitative sites upstream of these obstacles, it would not be apparent whether such poor results were the effect of some problem affecting the juvenile stocks of the area or were just the result of some local factor at the sites themselves.

Map 2.3: Fry Index results for Salmon Fry from the Teviot Water



Appendix 2.2: PIT tagging for population modelling of the Gala Water salmon population.

AIM: To establish the parameters for the Gala Water salmon population during this present period of good counts and catches so that the causes of any future downturns can be identified and targeted management action undertaken, if possible. The parameters that would be estimated or measured under this proposal are:

1) The numbers of Smolts leaving the Gala Water each year
2) The survival from Smolt to Grilse or to Salmon returning to the Gala Water each year
3) The relative proportions of Grilse and Salmon in the population each year
4) The relationship between Smolt output and the Fry abundance within the Gala water

Method:

1 All salmon returning to the Gala Water have to pass up the fish ladder there, which has a VAKI counter on it.

2 If a sample of salmon Smolts was PIT tagged, then those returning as adults could be detected in the fish ladder using a system similar to that established by FRS in the fish ladder on the Ken in Galloway. As it is known that around 2000 adult salmon return to the Gala, tagging of around 2500 smolts (assuming a return rate of 8%) should result in around 10% (200) of adults being tagged.

3 The number of adults produced from the known number of Smolts tagged in any year would be found after two seasons – Grilse returns in the first year, Salmon in the second. Adding these two totals would give the total number of returns from the Smolts tagged. Knowing what this return rate was and how it was made up of Grilse and Salmon would provide a monitor of the success of Gala fish in returning to their home river and of how the relative numbers of Grilse and Salmon varied.

If, from Smolt year X when 2,500 Smolts were PIT tagged, 180 returned the next year (Y) as grilse, and 20 the year after (Z) as salmon, then the total return of adults from the number of Smolts tagged in year X would be known - 200 adults from 2500 Smolts.

4 The PIT tagging would show what proportion of the total Gala count was made up of 1SW and MSW each year, which might vary over time. This is not determinable from the length-frequency graphs produced from the counter measurements as these show only a single peak, probably because small early Grilse, large late Grilse, small early Salmon and large late Salmon all go through the counter at much the same time in Autumn regardless of their time of return to the river.

5 If the counter total can be split into 1SW and 2MSW proportions by the PIT tagging, as outlined in (4), then the survival rates derived in (3) can be used to back-estimate the number of smolts that produced the Grilse and Salmon of any one year. Adding these together for the same smolt years will then give an estimate of the total smolt production of the Gala in each smolt year.

6 Repeat spawning rates – fish that returned more than once to spawn would be identifiable by their PIT tags

7 As scales and lengths of a sample of the individual Smolts PIT tagged would be taken, the survival of different sizes and ages of Smolts could be found as well as any relationship between size & age of Smolt and return as a Grilse or Salmon. It might also be possible to see if wet Springs, with good spates to take Smolts down to the sea had better survival rates than drier Springs. As the VAKI counter measures lengths to within 20mm it might even be possible to find general relationships between Smolt size and adult size.

8 The mortality rate from the time of tagging as a Smolt to being counted as a returning adult would become known. This would, however, include three separate components of mortality

1: In-river Smolt mortality, from the Gala Water to the sea
2: Marine mortality from the time of leaving the estuary as a Smolt, to the time of return as an adult
3: In-river mortality as an adult running back upstream to the Gala Water.

Component (1) could be estimated by acoustic tracking Smolts down to the estuary
Component (3) is mostly the angling exploitation mortality which is estimated by tagging fish in the estuary and seeing how many are caught upstream. Acoustic tracking adults back upstream would,

however, give total in-river mortality. Policies 2C.2b and 2E.2 of this present edition will test these two possibilities.

9 If Components (1) & (3) could be estimated independently as suggested above, then if subtracted from the total mortality, it would give the overall marine mortality for this population.

10 Getting estimates of Smolt production in this way should require less manpower than running a Screw trap with the need to do mark & recapture to estimate efficiencies all through the Smolt season.

11 If the PIT tagged Smolts were also adipose clipped:
1) Data on catches by anglers and nets would be available
2) Some estimate of straying by adults would become available i.e. if clipped fish were caught upstream of the Gala or a different part of the catchment altogether (this would mean anglers reporting clipped fish so their PIT tags could be read)

BASIC RESEARCH NEEDS IDENTIFIED FOR SALMON :

For INPUT 2B

(1) Aerial survey of the catchment. This would allow good estimates to be made of the amount of juvenile habitat to be stocked by spawning salmon and therefore better estimates of the number of spawning fish needed. It could also provide the physical data on habitat for analysis with the electric-fishing survey results of Input 2.C, so that salmon fry abundances could be related to catchment features and factors, though techniques may have to develop before this is possible.

For INPUT 2C

(1) Monitoring juveniles of large channels. It should be noted that all the electric-fishing sites monitored as part of this policy are in small to medium sized channels -the furthest downstream monitoring site on the Tweed itself is at Innerleithen, on the Ettrick it is at Lindean and on the Teviot at Kirkbank. The standard techniques for quantitative electric-fishing are basically unsuitable for very wide channels - but such main channels can form 60% to 70% of the total area open to spawning Salmon in a catchment. On the Tweed, Salmon spawn as far downstream as Coldstream (at least) and juveniles can be found throughout the middle and lower river. The lack of coverage of this huge area of main channel is a serious weakness in the monitoring programme, particularly as this is the area of a particular stock, the Autumn Salmon and it has become obvious that some method of sampling has to be devised for this type of channel. The matter has been recently considered by the SFCC but no method suitable for the middle or lower Tweed was produced, so the matter remains open.

(2) Checking the significance of results from both quantitative and Index electric-fishing. This could be carried out upstream of a trap so that the numbers of spawning adults producing the fry and parr sampled would be known. At present, this would only be possible in one of the trout spawning burns with an upstream / downstream trap, but as female trout carry many fewer eggs than Salmon, there is more likely to be significant variation in egg deposition to produce variation in numbers of juveniles sampled.

(3) Comparison of the results of the Tweed with those found elsewhere. At present, the scale on which electric-fishing results are assessment is self-referential based only on Tweed data. While this is very useful for management purposes here, it would also be useful to know how our results compared with elsewhere e.g. whether a site that is rated first class in terms of salmon fry abundance here would be rated as such elsewhere. This would require the electric-fishing data from a range of rivers in Scotland to be analysed to draw up regional and national assessment scales.

For INPUT 2D

(1) With more and more catch-and-release, the consistency of catch records over the years has something of a question over it – how many fish are now caught more than once ? This needs a very easy to use tag that anglers can put on fish they release, that does not require them to put holes in fish. Some sort of "Velcro" band to put round the wrist of the tail would be the simplest thing to do (and tags like these appear to be used for the necks of swans and geese). A six-month life-span (or even less, for the Autumn) would be all that was needed.

For INPUT 2E

(1) An effective way of catching Salmon and Sea-trout in the estuary for tagging.

SECTION 3: SEA-TROUT

INPUT 3A: DETERMINING AND DEFINING THE STOCKS OF SEA-TROUT WITHIN THE TWEED SYSTEM AND THEIR LIFE-HISTORIES

Rationale: The most basic information needed on the Sea-trout of the Tweed is their stock structure: Is there just one interbreeding stock of uniform characteristics throughout the whole catchment, or are there stocks differentiated by location and life-history and, if there are, are such differences genetic? If the full range of stocks and run-timings is to be maintained in the Tweed, then it is essential to know the exploitation rate of each stock and how well their spawning requirements are being met. If there are different, geographically based stocks, then the question of how these are related to the Brown-trout in their home areas arises - are these too different "stocks"?

***Results from previous Plans*:**

a: *Scale reading of Sea-trout killed at the sample rod fisheries and at the estuary has given basic information on life histories and sizes. Till Sea-trout proved to have a different size-range to that Tweed Sea-trout in general (Appendix **)*

b: *A few September Sea-trout were successfully Radio-tagged from 1994-96 which gave their pattern of upstream movement, spawning location and pattern of downstream movement (Appendix **)*

c: *Tagging and recapture of Sea-trout kelts showed that the period spent at sea between return and repeat spawning run can be only 3 to 4 months and that their growth rate at sea could be as much as 15mm per month (Appendix **)*

d: *Collation of all the pre-1990 records of tagged and recaptured Sea-trout has shown that there is a migration route to the south, to East Anglia, the Frisian Islands and the Dutch and Danish coasts. This is a quite different pattern from those of the rivers to the north of the Tweed, whose Sea-trout appear to only come as far south as the Tweed estuary (Appendix **). It appears that there could be two distinct migration routes for Tweed Sea-trout, a shorter, local one and a long distance one to the Waddensee.*

Policies for the next five years:

Policy 3A.1 – Devise a large-scale genetics survey for the trout of the Tweed and Eye catchments to extend the work undertaken under the Living North Sea programme and make a comprehensive trout genetic map. (*Such work could be undertaken as an extension of the genetics work on Salmon presently being undertaken with RAFTS and the FASMOP programme if other Fishery Trusts have similar interests*). This work would show:-

(i) How many different stocks of trout there are and whether Sea- and Brown-trout belong to the same stocks.
(ii) What areas they occupy.
(iii) Whether the number of juvenile sampling sites within each stock's area is adequate to show trends in their numbers.

Policy 3A.2 - Continue to investigate the stock structure and life-histories of the Sea-trout of the District and define any geographical or temporal differences

(i) Geographical / temporal patterns in age structure
(ii) Geographical /temporal patterns in lengths and weights
(iii) Patterns of marine growth
(iv) Characteristics of Spring, Summer and Autumn running fish and whether these could be defined as "runs" produced by particular stocks.

(b) LNS: Determine the marine feeding grounds and migration routes of Tweed Sea-trout

(i) Carlin tag Sea-trout smolts at the smolt traps. Recaptures at sea will show migration routes and marine feeding grounds
(ii) **LNS:** Contribute samples for genetic analysis to the LNS Genetics programme. This will characterise Sea-trout populations from around the North Sea, with the aim of allowing any Sea-trout caught at sea to be identified back to its home population. Tweed Sea-trout caught at sea should be recognisable wherever caught when this programme is completed.

(c) LNS: Continue smolt trapping to determine sizes, ages and timings of Sea-trout smolt runs

(i) Establish sex-ratio of Sea-trout smolts.

(d) LNS: Determine sex-ratio of adult Sea-trout populations:

(i) Trap Sea-trout in the Gala fish ladder to establish the sex ratios of the migratory trout of this tributary. *(As this has the largest, trappable, run of Sea-trout, it is the primary source of such data)*
(ii) Collect data from the other permanent and temporary traps that have Sea-trout spawning runs.

LNS: Policy 3A.3 – Determine the relationships of Tweed Sea-trout to other populations around the North Sea and whether they share historical catch trends

(i) Contribute data on the characteristics (size, age, run timing, sex-ratios etc) of Tweed Sea-trout for analysis with similar data from rivers around the North Sea to identify patterns and differences

(ii) Contribute catch record data of Tweed Sea-trout for analysis with similar data from rivers around the North Sea to allow identification of common trends and the relationship of these to physical phenomena such as sea-temperatures, current patterns etc.

Policy 3A.4 - **Determine the fecundities of Sea-trout** (The fecundity of a fish is the number of eggs that it carries in relation to its size) [*This would require large samples of fish killed near spawning time. At present, these are not available, so fecundities are measured from whatever fish become available*]

(i) Find if Sea-trout that could represent different stocks have different fecundities.

INPUT 3B : INVENTORY THE QUANTITY AND QUALITY OF NURSERY AREAS OF SEA-TROUT

Rationale: *As for Salmon.*

Results from previous editions: *As for Salmon*

Policies for the next five years:

Policy 3B.1: Collect and Analyse Historical Data on the Environment of the Fisheries District

(a) Collect and map the locations of man-made barriers past and present and quantify the areas of spawning blocked or restricted by them. If possible, maps of the area open to Sea-trout spawning in 1800, 1850, 1900, 1950 and at present will be produced.

(b) Continue analysis of long-term catch records and environmental data

Policy 3B.2: Survey of Sea-trout Spawning Areas

(a) New technologies of aerial river survey offer a much more objective and usable way to survey and analyse habitat data and the development of these will be monitored and, if the opportunity arises, applied to the catchment.

(b) Existing aerial survey data for the catchment (taken from general rather than from river-specific surveys) will be analysed to show:

(i) Area of wetted habitat in tributaries to show the extent of spawning that needs to be filled by fish

(c) Where areas of weaker trout juvenile numbers are found during the electric-fishing surveys of Policy 3C.1, these should be investigated according to the Habitat Investigation Protocol (see below) and the reasons for such poorer results identified. If feasible, any problems identified should be removed or mitigated.

LNS: Policy 3B.3 - Monitor the effects of obstacles on fish passage and undertake appropriate habitat protection and restoration work in Sea-trout spawning and nursery areas.

(a) All obstacles in the catchment are now passable by Sea-trout, but possible restriction of access, in particular in dry years, needs to be monitored.

(b) While no specific areas where bankside fencing to provide buffer zones around Sea-trout spawning and nursery areas would be of benefit have been identified, the fencing undertaken for the general protection of watercourses will be of value to Sea-trout.

Policy 3B.4: Monitor the physical changes and the juvenile trout populations where habitat protection or restoration has been undertaken

(a) Continue to monitor the long-term changes at the Habitat Pilot Projects set up during the period of the first Management Plan to evaluate the techniques used.

(b) Continue the monitoring programme of sites in areas of habitat rehabilitation and analyse the results.

(c) Set up and maintain a database of protection and restoration sites : To include pre-works photographs and data, rationales, plans, costs and contracts for the restoration work, post-works photographs and continuing monitoring data

Policy 3B.5: Ensure the access and habitat problems of the past do not recur

(a) Collect information from the UK and abroad on best practice in Farming, Forestry and Road-building in relation to waters and fish populations.

(b) Disseminate this information amongst local land-users and provide practical advice on its implementation.

INPUT 3C: MONITOR THE JUVENILE POPULATIONS OF EACH STOCK OF SEA-TROUT, THE INFLUENCE OF HABITAT CHARACTERISTICS ON THEM AND THE EFFECTS OF PREDATION

Rationale: *As for Salmon*

Results from previous editions: *As for Salmon, and in addition :-*

a: In the first edition of the management plan (1990-95) timed Electric-fishing surveys were made of the fish populations in the smaller burns (dominated by Trout) of the Ettrick, Eden, Till, Teviot and upper Tweed catchments and in the second edition (1995-2000) the Whiteadder, Leader, Leet, Gala and minor tributaries were surveyed in the same way. The survey of the districts smaller burns has thus been completed. In all 460 locations on 350 streams were visited and trout were shown to be the most widespread fish species in both the Tweed and Eye catchments

b: These smaller burn sites are now being re-sampled as part of the TTGI and differences from the baseline survey analysed. As the timed methodology is now being used for Salmon sites as well, the salmon and the smaller burn trout sampling have been amalgamated.

Policies for the next five years:

LNS: Policy 3C.1 Monitor the densities of juvenile Trout at sites throughout the medium-sized channels of the catchment and survey any smaller burns required.

(a) Continue the electric-fishing monitoring of the sites set up previously - the cycle will be:-

SECTORS OF THE CATCHMENT TO BE SAMPLED IN :				
2010	**2011**	**2012**	**2013**	**2014**

Total number of sites

r sites may be added if found necessary)

(b) **LNS:** Continue to extend the Fry Index sites over the whole catchment – existing coverage is shown in Map 2.1, for Salmon

(i) Continue to develop the database holding the information from these surveys and linking this with physical, chemical and aerial survey data.

(ii) Analyse this electric-fishing data to show areas of good and poor abundances of juveniles and related these to the habitat survey data gathered under Policy 3B.2 . Where areas have no natural explanation for being poor in juveniles, further investigations under Policy 3B.2 using the Habitat Investigation Protocol are indicated.

(iii) Identify where new sites could extend and improve coverage by the monitoring programme.

(c) **LNS:** Continue the smaller burns electric-fishing surveys: These are repeats of the 1990s baseline samples, with appropriate additional sites. Sites selected so far are shown in Map 4.1 in the Brown-trout Section.

(d) Maintain an appropriate selection of quantitative electric-fish sites throughout the catchment to maintain continuity. Liaise with SEPA through the SFCC to establish the role these electric-fishing sites could play in the biological monitoring dimension of the forthcoming Water Framework Directive. The implementation of the Water Framework Directive has been identified as a Key Issue in the "Rivers and Burns" section of the Local Biodiversity Action Plan.

Policy 3C.2: **Collect Data on the Effects of Predation on Juvenile Trout, and on Sea-trout Smolts in particular**

(a) Continue to count the numbers of Goosanders and Cormorants in January, April, May and September of each year (as for Salmon)

(i) Analyse the results of the counts to show any geographical pattern to the distribution of Goosanders along the river. If any locations are found where the birds are regularly clustered these could be "choke-points" where smolts are particularly vulnerable and special measures to protect such sites could be taken (as for Salmon)

(b) **LNS:** Acoustic tag Sea-trout smolts in the Yarrow and Gala and track down to the sea:

(i) Determine success rate in reaching the sea, taking account of any handling / tagging mortality

(ii) Determine causes of losses where possible and if there are particular parts of the main river in which losses are greater than in others.

(*iii*) Relate smolt movements and losses to the pattern of distribution of fish-eating birds on the main river during tracking.

(iv) Record types and levels of predator damage on Sea-trout smolts at traps.

INPUT 3D: ANALYSE THE CATCH COMPOSITION AND TRENDS OF EACH STOCK OF SEA-TROUT

Rationale : Analysis of catches for their composition shows which stocks (and areas of the catchment) are producing the fish that support the fisheries - and also what level of exploitation is being suffered by each stock. Knowledge of trends and cycles allows annual catches to be judged in a wider context.

***Results from previous editions**:*

a: Scale reading has shown the age structure and life-histories of the Sea-trout caught in the rod fisheries. Of fish sampled at the nets, 79% were returning for the first time, 18% for the second and 1.5% for further times (Appendix A2)

b: Analysis of long-term net catches of Sea-trout has shown that the run timing has remained centred in the middle of the year, but with more September fish in the later 19th century and more May and June fish in more recent times (Appendix D)

c: RTC Assessment Records of Sea-trout rod catches have been collated and computerised (Appendix D)

d: All available long series of Sea-trout catch records at individual fisheries were collected and computerised as part of the Catch Records Project 2001-04. These give sizes (weights) of fish and so provide more details than the RTC records.

Policies for the next five years:

Policy 3D.1 - Determination of Long-term trends and changes

(a) Continue analyses of catch and environmental data to show any long term trends or cycles.

Policy 3D.2 - Monitor catches composition

(a) Continue collection of Sea-trout scales from the sample fisheries along the course of the main river and from the larger tributaries:-

(i) Analyse these so show the different stocks and age classes of fish being caught. This shows how dependent catches are on particular ages of fish and how success or failure of particular spawning or smolt years can be reflected in the catches of the resultant adults.

Policy 3D.3 - Monitoring and Analysis of Catch Trends

(a) Continue to analyse the rod and net catch records for trends and changes and improve catch recording detail if possible.

(i) Improve the quality of rod catch records by recording the amount of fishing effort at least a sample of fisheries - the same total of fish caught with a little effort indicates a very different situation than if caught with a lot of effort.

(b) Continue the accumulation of data for modelling the Sea-trout stock(s) of the District and the collection of examples from elsewhere.

INPUT 3E: ESTIMATE THE EXPLOITATION RATE OF EACH STOCK OF SEA-TROUT

Rationale for this work: As for Salmon

Results from previous edition :

*a: Tagging Sea-trout in the estuary each September to find the number later caught by anglers has shown that the exploitation rate by the rod fisheries of these later fish is very low, only 2% or so (Appendix E1), if the recaptures of tagged fish are being fully reported. Of the *** Sea-trout tagged, the * angling recaptures have been distributed between the different sectors of the river as follows:-*

Lower River	*0*
Middle River	*3*
Upper River	*3*
Tributaries	*0 angled, but 2 found dead (one as a kelt the other as an Otter kill)*

This pattern of recaptures seems unrealistic and could indicate that tagged fish on the lower river are not being reported. If this was the case, then it would follow that the Sea-trout catches for the river generally were being under-reported.

Policies for the next five years:

Policy 3E.1: Tag Sea-trout on the lower river / estuary to find their angling exploitation rates

(a) Continue the assessment of the rod exploitation rate of Autumn Sea-trout through tagging and recapture. This is based on the use of a netting station after the netting season ends.

(b) If possible, extend this to the Spring and Summer stocks as well: This would require the use of a station during the netting season. There are, at present, no estimates for the exploitation rate of Tweed Spring and Summer Sea-trout stocks

LNS: Policy 3E.2: Acoustic tag Sea-trout on the lower river / estuary and track them upstream

(a) Tag net or rod caught fish on the lower river / estuary.

(b) Track the tagged fish upstream to determine non-angler mortality. The ordinary tagging shows the proportion killed by anglers, but cannot show what proportion die in the river due to other causes (predation, poaching, disease etc.). During this tracking, data can also be collected on:-

(i) The speed of movement upstream of Sea-trout and how this relates to water conditions
(ii) How their movements relate to the pattern of catches as shown on the FishTweed website
(iii) How quickly the fish pass obstacles / find and use fish-ladders.

LNS: Policy 3E.3: Determine extent and locations of coastal fisheries for Sea-trout around the North Sea

(a) Take samples for genetic analysis from coastal fisheries and from fish merchants (e.g. at Eyemouth) to identify origins of the Sea-trout being caught by fisheries in this area and contribute to the LNS programme to identify the sources of Sea-trout caught at coastal fisheries around the North Sea. This should, in turn, show where Tweed Sea-trout are being caught further from the Tweed.

INPUT 3F: COUNT AND MODEL ADULT SEA-TROUT POPULATIONS

Rationale: As for Salmon

***Results from previous editions*:**

a: Counts of Trout have been made at the Ettrick fish-counter since 1998 and have been re-analysed using the better information on the sizes of salmon and trout available with the video system installed in 2005. This showed that there were more large Sea-trout (over 80cms) and small salmon (under 50cms) than had been previously realised. With the video system however, around 70% of fish going through the Ettrick counter are now directly identifiable as salmon or trout.

b: Counts of trout have also been made since 2007 at the Gala Water fish counter, though the dirtier water conditions there during spates mean that only around 30% of fish can be directly identified as trout or salmon. Identification of the majority has therefore to be by extrapolation from those directly identifiable.

c: Upstream / downstream traps have been set up on two larger burns of the upper Tweed at one of which counts of spawning adult Sea-trout going upstream in the Autumn are made (the other trap has a Brown-trout population)

d: Other, smaller traps have shown that on smaller burns, the great majority of eggs are deposited by female Sea-trout and fertilised largely by male Brown-trout, which shows considerable overlap between the Sea and Brown trout of the system.

e: The distinctiveness of the Till Sea-trout and the local importance of the fisheries based on it gives it particular importance A standard electric-fishing site was therefore set up in 1999 on an upper tributary of the College Burn to monitor the over-summering adults found there (Appendix A2). A second site, further downstream on the main burn has since found to be required as well, as it was found that repeat-spawning fish enter the College later and do not reach the upper site by the time that it is generally sampled.

Policies for the next five years:

Policy 3F.1: Continue the counts of adult trout at the Ettrick and Gala fish counters

(a) Analyse the sizes of the trout counted and compare between the two tributaries to show up any differences.

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Policy 3F.2: Plan for further counters on Tweed tributaries

(a) Gather information on fish counter models, with particular regard to those that could be used on existing caulds and other in-river structures: There are a number of these in the lower reaches of Tweed tributaries that it might be possible to adapt to carry counters.

(b) Where possible sites match with counter models available, conduct feasibility studies

Policy 3F.3: Establish spawning escapement targets for the Sea-trout of the Upper Tweed index tributary.

(a) Model this population by:-

(i) Counting the numbers of Sea-trout (identified through scale reading) running upstream to spawn each year and relating them to environmental conditions (water levels and temperature)

(ii) Counting the numbers of Sea-trout smolts that move downstream each year.

(iii) Survey of the burns upstream of the traps to estimate carrying capacity

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WORK CALENDAR FOR SECTION 3:

		Month											
POLICY	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3A.1	Genetics												
	(a) Scales												
3A.2	collection	A	F	F	F	F	F	F	F	F	F	F	A
	(b) Marine routes			F	F	F	F				F	F	F
	(c) Smolt trapping			F	F	F	F						
	(d) Adult trapping										F	F	
	(e) Till Whitling									F			
	North Sea												
3A.3	relationships	-	-	-	-	-	-	-	-	-	-	-	-
3A.4	Fecundities									F	F	F	F
	Historical habitat												
3B.1	data	-	-	-	-	-	-	-	-	-	-	-	-
	Spawning area												
3B.2	surveys							F	F	F	A	A	A
3B.3	Obstacles & Restor.			O	O	O	F/I	F/I	F/I	F	A	A	AS
	Restoration												
3B.4	monitor.			O	O	F	F	F	F				
3B.5	Best practice	-	-	-	-	-	-	-	-	-	-	-	-
3C.1	Juvenile surveys							O	F	F	A		
3C.2	(a) Bird counts	F			F	F				F	A		
	(b) Smolt tracking		O	F	F	F	F	A	A				
	Historic Angling												
3D.1	recs	-	-	-	-	-	-	-	-	-	-	-	-
3D.2	Catch composition	A	F/A	F/A	F/A	F/A	F/A	F/A	F/A	F/A	F/A	F/A	A
	Catch trends	-	-	-	-	-	-	-	-	-	-	-	-
3E.1	Exploitation rate	A				O	F	F	F	F			A
	Adult tracking	O/A	F	F	F	F	F	F	F	F	F	F	O/A
3E.2	Coastal fisheries	A	A			F	F	F	F	F			
3F.1	Fish counters	F/A	F	F	F	F	F	F	F	F	F	F	F/A
	Upper Tweed Trap	A	A	F	F	F	F				F	F	A

KEY	Not yet undertaken	
	At any time	-
	Organising	O
	Fieldwork	F
	Analysis & reporting	A
	Instream works	I

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BASIC RESEARCH NEEDS IDENTIFIED FOR SEA-TROUT

For Input 3A: A comprehensive genetics survey of the trout of the Tweed**.** To work out how many populations there might be and whether these are distinguished by particular life-histories.

For Input 3C: Monitoring juveniles of large channels. As for Salmon, though large channels are not thought to be as important as trout spawning areas

For Input 3E: A tag that anglers could safely and efficiently put on fish that had been caught and released.

For Input 3F: A comprehensive survey of the fisheries that take Tweed Sea-trout at sea (now part of the Living North Sea programme)

SECTION 4: BROWN TROUT

INPUT 4A.1: DETERMINING AND DEFINING THE STOCKS OF BROWN TROUT WITHIN THE TWEED SYSTEM AND THEIR LIFE-HISTORIES

Rationale: Just as for Salmon and Sea-trout it is necessary to know what the Brown-trout of the Tweed catchment actually are as a base for any sort of management. Are the Brown-trout of the Tweed divided up into genetically distinctive stocks or do they all belong to one, large, interbreeding pool? If they are separated into many stocks, do these have different characteristics (growth patterns, migrations etc.) and what areas of the catchment do they occupy? The key question is how the Brown-trout relate to the Sea-trout of the catchment: the evidence from the traps on spawning burns is that, in most cases, breeding in these small burns is between smaller, male, Brown-trout and larger, female, Sea-trout. This suggests that there may not actually be separate Brown- and Sea-trout populations, simply trout populations. The sex-ratios of Brown-trout and Sea-trout are important information on this point: if these are not balanced within each type, then the "deficit" must be being filled from the other, showing an overlap between the two. Until these questions are answered, it is difficult to determine what management is appropriate for Brown-trout as they are, basically, an unknown quantity.

If there are genetically distinctive stocks of Brown-trout within the catchment, and these are not "self-contained" but are interconnected with their local Sea-trout, then the situation must be that there are distinctive stocks of "trout" within the catchment, each of which has its own resident (Brown-trout) and migratory (Sea-trout) components, with the proportional split between the two forms perhaps varying between these distinctive populations.

***Results from previous editions of the Management Plan*:**

a: Genetics research has shown that the trout of the Tweed originate from three different lineages that colonised the catchment after the Ice Age, and that fish from different tributaries can be distinctive. Research has also shown that 20% of the trout examined had an Atlantic Salmon gene in them and that there were high rates of first generation trout-salmon hybrids in the samples.

b: Collection of scales has given basic information on growth patterns and provided a source for more detailed investigations.

c: Results from the trapping of spawning burns has shown two quite different forms of trout spawning population. At four burns, the great majority of eggs have come from a few, larger, female, Sea-trout, fertilised by more numerous but smaller male Brown-trout. At one other burn however, the spawning population has been a 50:50 mix of male and female Brown-trout of between 1 and 6lbs in size.

Policies for the next five years:

Policy 4A.1 – Devise a large-scale genetics survey for the Tweed and Eye catchments to extend the work undertaken under the Living North Sea programme and make a comprehensive trout genetic map. (*Such work could be undertaken as an extension of the genetics work on Salmon presently being undertaken with RAFTS and the FASMOP programme if other Fishery Trusts have similar interests*). This work would show:-

(i) How many different stocks of trout there are and whether Sea- and Brown-trout belong to the same stocks.
(ii) What areas they occupy.
(iii) Whether the number of juvenile sampling sites within each stock's area is adequate to show trends in their numbers.

Policy 4A.2 - Continue to investigate Brown-trout growth patterns and size ranges throughout the catchment

(a) Continue collection of Brown-trout scales and measurements from throughout the Tweed and Eye catchments and analyse these for :-
(i) Geographical pattern and age structure
(ii) Relationships to lengths and weights of the sample fish
(iii) Patterns of growth
(iv) Use the Scales Database to identify areas of the catchment which are poorly represented in the collection so far and ensure that sufficient scales are collected from the trout of any such areas.
(Scale collection is by all available methods: from electric-fishing and netting surveys (4C.1 & 2); Angling Catch logbooks and creel surveys (4D.2a & b) and traps (4F.1)

Policy 4A.3 – Establish the movement patterns / migrations of Brown-trout within the catchment by tracking individual fish (*this will use the acoustic tracking equipment bought for the Living North Sea work on Sea-trout after that is finished*).

(a) Track kelts from spawning burn traps to find where the adults of these particular spawning populations go outside the spawning season. This will show whether Brown-trout from the upper river visit the lower river or the estuary, as is suspected. (*This suspicion comes from the angler catch logbook data, which clearly shows that while many small trout are caught in the middle and upper Tweed and tributaries, fewer are caught in the lower Tweed, which is, however, much better for medium and larger sized trout. The fish counters also show significant numbers of Brown-trout returning to the Ettrick and Gala at spawning time*)

(b) Relate the patterns seen in the scales of tracked fish to the movements shown by the tracking so that the scale patterns produced by different life-histories can be identified e.g. if fish from the upper Tweed visit the lower Tweed / estuary, this should show up as a particular growth pattern on the scales. Defining this pattern would then mean that it could be identified on the scales of fish that had not been tracked.

(c) Track individual trout caught by angling in the main channels during the fishing season to show:
(i) How trout react to "catch and release"
(ii) Habitat use by larger trout in the main channels to allow identification of key habitat types that could be improved or restored.

Policy 4A.4 – Establish the structure of the trout spawning populations on a representative sample of burns.

(a) Set up temporary traps on small burns where suitable sites can be found and volunteers are available**.** Two to three years should be sufficient to show:

(i) Whether the population using the burn is of the fewer, larger, female Sea-trout & numerous smaller, male, Brown-trout type or the 50:50 large male and female Brown-trout type (or of some other form not yet seen).

(ii) The sex-ratio of the spawning fish

(iii) The minimum spawning size of the trout in that area

(iv) The size of the spawning population

INPUT 4B: INVENTORY THE QUANTITY AND QUALITY OF HABITAT FOR BROWN TROUT

Rationale: Whilst this is largely the same as for Salmon and Sea-trout, there is a difference in that adult Brown-trout do not go to sea and so must find suitable habitat within their river systems. It appears that long-range migrations can be made along main channels though little is known about how far trout generally travel from their spawning burns. Deeper water and good cover is a critical need for these larger, mature fish - the broodstock of the populations - and their lack has been identified as the cause of extinctions - The American Fisheries Society has actually identified loss of overhanging banks due to overgrazing as "*one of the principal factors contributing to the decline of native trout in the West*" (American Fisheries Society 1991). Brown-trout are therefore more severely affected by the loss of deeper water and bankside cover through overshading or overgrazing than Salmon or Sea-trout.

Results from previous editions: *As for Salmon and Sea-trout, with the addition of*

a : *Brown-trout use much smaller burns than Salmon or large Sea-trout but the habitat surveys omitted burns under 2m wide to reduce the amount of work to manageable levels. Most small burns go through one or more road culverts which can be obstacles to spawning trout moving upstream. A map study to list all the road and other culverts in the Tweed and Eye catchments started in 2000 and there is now an extensive map / database of these. Many have been visited and assessed, though many still remain to be checked. Habitat quantity, is, as always, a greater priority than habitat quality as even poor habitat can produce some fish, while even the best habitat can produce nothing if the fish cannot get to it to spawn in it.*

b : *As part of the TTGI, baseline photographic surveys have been made of larger channels, where adult trout live, against which future changes can be judged. Historic photographs have also been collected to give older baseline information.*

c: *Existing data on invertebrates from SEPA and other sources has been collated as a baseline for trout food sampling programmes. A programme of sampling has been set up as part of the TTGI.*

Policies for the next five years :

Policy 4B.1: Survey and map Brown-trout spawning and juvenile habitat (*TTGI Spawning Burn Surveys*)

(a) Continue surveys of the smaller spawning burns that have not yet been visited. Any obstacles found will be added to the Obstacles Database and appropriate measures to ensure fish passage devised, if the blockage is significant.

(*i*) Organise Angling Clubs to survey habitat and obstacles in small burns not previously covered.

(*ii*) Set up habitat survey training days for Club members with the Wild Trout Trust.

(*iii*) **LNS:** Analyse survey results with Clubs and the Wild Trout Trust and formulate restoration plans for damaged areas

(b) During the trapping of spawning burns, large, sometimes very large numbers of immature trout have been found heading upstream along with the spawners. Why this migration should occur is not known. It may be that smaller burns are important winter habitat for trout parr that otherwise live in the larger channels. The first point to establish about this movement is the length of time that these small fish spend up the burns and this could be found by acoustic tagging a sample. It could be that the abundances of parr found in smaller burns during summer electric-fishings tell only part of the story of how these areas are utilised by trout. Such tagging should be possible after the Living North Sea tagging work is completed.

Policy 4B.2: Survey, Assess and Monitor adult Brown-trout habitat (*TTGI Baseline Photographic Surveys*)

(a) Continue to collect and collate historical evidence for changes in the amount of deeper water in the larger channels and establish the present day, baseline, state.

(*i*) Continue to collect historic photographs & anecdotes on gravel movement and loss of deeper waters.

(ii) Continue photographic and video surveys of each Club's area of water to show present day distribution of gravel and pools and establish baseline points for monitoring gravel movements.

Policy 4B.3 - Inspect the culverts and road crossings for which investigation is thought necessary, as listed under Policy 4B.1 and prepare plans for easing, if appropriate

(a) Ease obstacles to Brown-trout spawning migration:

(i) Have all culverts and road-crossings listed as a result of previous work inspected according to a standard protocol. *Inspections will be made by the RTC Bailiffs.*

(ii) Maintain a list of those that appear to require a more detailed investigation or electric-fishing surveys to show whether they are problems or not. These surveys consist of six three-minute samples upstream and downstream of a possible barrier, any differences showing up the effect of the obstacle *(The protocol for obstacle assessment is given in ******)*

(iii) Evaluate those culverts and road crossings shown to be obstacles in terms of the value of the spawning that would be opened up if they were eased and whether easing would result in the spread of introduced species into an area that they had been barred from. *Where remedial works are undertaken, the aim should be to allow access to fish that can jump, such as Trout and Salmon, or can otherwise get over, such as Eels and lamprey but not allow access to introduced species and so allow them to spread to hitherto inaccessible areas. Even quite small barriers can prevent the upstream movement of Signal Crayfish or Bullheads.*

(iv) Prepare work plans to ease those culverts identified as blocking access to valuable spawning areas and set up a programme to undertake these.

(v) Before easing any culverts, undertake "before" electric-fishing so changes upstream after the work can be assessed and monitored.

(vi) Take any opportunities that arise through the River Works Group or through Wind Farm or other developments to improve native fish access.

(b) Ensure the access problems of the past for Brown-trout do not recur:

(i) Collect information from the UK and abroad on best practice Road-building in relation to waters and fish populations.

(ii) Disseminate this information amongst local land-users and provide practical advice on its implementation.

Policy 4B.4 - Restore areas of damaged spawning and nursery habitat identified through Input 4B.1

(a) Organise training of Club members in restoration techniques with the Wild Trout Trust

(b) Organise restoration of damaged habitat with Club members on the basis of the surveys and restoration plans made under Policy 4B.1

(c) Ensure habitat problems for juvenile Brown-trout do not recur:

(i) Collect information from the UK and abroad on best practice Forestry and Farming in relation to waters and fish populations.

(ii) Disseminate this information amongst local land-users and provide practical advice on its implementation.

Policy 4B.5 : Survey and Assess invertebrate food supplies for Trout (*TTGI Fly-life Surveys*)

(a) Continue the monitoring of each Club's area of water to show present day levels of invertebrates and species distribution and record places and dates of hatches of particular species :

(*i*) Collect historic evidences of insect hatches and timings as a baseline against which to judge the present day situation.

(*ii*) From time to time, set up training days in invertebrate identification and sampling techniques for Club members

(b) Where opportunities arise, record the contents of trout stomachs.

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INPUT 4C: MONITOR THE BROWN-TROUT POPULATIONS THROUGHOUT THE TWEED AND EYE CATCHMENTS, ANALYSE THE INFLUENCE OF HABITAT CHARACTERISTICS ON THEM AND ASSESS THE EFFECTS OF PREDATION

Rationale : *As for Salmon*

Results from previous editions *: As for Sea-trout*

a : It has been found possible to electric-fish long sections (500m) of medium-sized (3 to 8m wide) channels for two-year and older trout, where there are no large areas of inaccessible deep water as a way of looking at their populations and collecting scales for information on growth.

b: It has also been found possible, under low flow conditions, to net sections of the main channels and sample adult Brown-trout. This sampling is, however, limited to areas with smooth channel bottoms and so cannot cover the best areas for trout, where there is cover from boulders, wood debris etc.

Policies for the next five years:

Policy 4C.1 Monitor juvenile Trout throughout the Tweed and Eye catchments (*TTGI Electric-fishing surveys*)

(a) LNS: Continue the timed electric-fishing of juveniles in burns for comparison against the baseline surveys made in the 1990's, covering the same zones of the catchment as the salmon juvenile electric-fishing surveys of the year.

(b) Analyse results against the 1990's baseline to show trends and changes.

(*i*) Relate results to the habitat characteristics of sample sites to give information on the habitat preferences of juvenile trout

(c) LNS: Continue to identify and survey electric-fishing sections in "medium-sized" channels

(*i*) Relate results to the habitat characteristics of sample sites to give information on the habitat preferences of older trout.

Policy 4C.2 Monitor adult Trout throughout the Tweed and Eye catchments

(a) Continue the netting of main channels to give:

(i) Minimum densities of adult Brown-trout in angling areas.

(ii) Scales for information on growth patterns and ages.
(If a method for the non-lethal determination of sex can be found, then fish caught in this way will also provide data for Policy 4A.1(d))

INPUT 4D : COLLECT DATA ON, AND ANALYSE TRENDS IN THE ROD CATCHES OF BROWN TROUT

Rationale: Monitoring the catches and fishing efforts of a sample of anglers is the only way in which a reasonable indication of the state of the trout fishing can be produced . The recording of the amount of effort and the methods that produced catches also means that they can be compared over the years. The sizes and ages of the trout being caught are also indicators of the state of stocks. Without a sound and reliable knowledge of the past nature and state of the Brown Trout stocks of the Tweed it is impossible to properly evaluate their present state.

In recent years there has been a perceived decline in the trout fishing, though the lack of systematically kept records means that this has been based on opinion and memory rather than on statistics. Understanding whether or not this perceived decline is due to an actual reduction in the abundance of Brown Trout within the catchment; changes in catch regulations and angling culture or simply a form of nostalgia is of crucial importance - if it is the first of these, then action is required, if the others, it is better catch recording and

reporting methods that are needed so anglers can have a better understanding both of the present and the past. As trout catches have not been of commercial importance, records such as those available for Salmon do not exist, so historical trends and changes have to be reconstructed from club competition records; angling diaries and published accounts. The present pressures on the stock also need to be known so that clubs can be advised on appropriate catch regulations.

The most basic need of a stock is that enough fish should escape all the pressures on them to spawn and fully seed their nursery areas for the next generation. Pressure on a fish population can be shown by changes in sizes and in age of maturity as well as by numbers, and if good baselines of the sizes and ages of each stock of Brown-trout being caught by anglers can be established, changes in these over the years can be monitored as indicators of pressure on the stocks.

Results from previous editions :

*a: A history of the Brown Trout stocks and fishing has been compiled from published sources (Chapter ** Brown-trout Fisheries)*

*b: Competition catch records of the Ellem, Kelso, Selkirk, Greenlaw, Hownam & Border have been computerised and analysed (Chapter ** Brown-trout Fisheries)*

*c: Three angling diaries, covering 1900-1928; 1951-1991 and 1967-1990 have been computerised and analysed (Chapter ** Brown-trout Fisheries)*

*d : A Trout catch diary recording scheme was started in 1991 in which a sample of anglers record their catches (Appendix **). This was suspended in 2000 to make way for a national catch recording scheme organised by the SFCC . A local version of this was produced in 2006 and is being used to record catches each season.*

*e: A questionnaire for anglers was distributed in 2007 & 2008 from which information on what anglers want from their fishing was gathered. The results of this are given in Chapter ** Brown-trout Fisheries)*

Policies for the next five years:

Policy 4D.1 - Analyse the history of Brown-trout catches of the different sectors of the Tweed and of the Eye for as far back as possible

(a) Continue the collection of Tweed Brown Trout records and references in published sources.

(b) Continue the collection and computerisation of angling club competition records.

(c) Continue the collection and computerisation of angling diaries.

(d) Establish any historic trends apparent in these sources.

Policy 4D.2 - Monitor present day Brown-trout catches and their composition (*TTGI Trout Catch Monitoring programme*)

(a) Continue the trout catch logbook system and analyse the data to show:-

(i) Geographical patterns in catch rates and size of trout caught

(ii) Relationships between fishing methods and conditions and catch rates of different sizes of trout

(*iii*) Trends in catch rates and sizes
(*iv*) Patterns in the use of the catchment by anglers, in particular identification of heavily fished areas.

(b) Continue bankside creel surveys to gather data from anglers: this covers visiting anglers who are more difficult to include in logbook surveys :-

(c) Continue to organise Fishing Days in areas of the catchment where other sources of catch data are insufficient (*Anglers get free fishing for a day in return for providing information on their catches*)

INPUT 4E: ESTIMATE THE EXPLOITATION RATE OF BROWN-TROUT

Rationale for this work: As for Salmon and Sea-trout

Results from previous editions:

None - this has not been possible due to lack of a good method for tagging adult Brown-trout that live in rivers. Further attempts will be made to find suitable methods.

INPUT 4F: MONITOR ADULT BROWN TROUT POPULATIONS AND ESTABLISH TRENDS IN NUMBERS AND POPULATION CHARACTERISTICS.

Rationale: The most basic need of a stock is that enough fish should escape all the pressures on them to spawn and fully seed their nursery areas for the next generation. Pressure on a fish population can be shown by changes in sizes and in age of maturity as well as by numbers, giving various methods by which the health trout stocks can be assessed.

Results from previous editions:

a : A trout trap was set up on a small Middle Tweed burn 1998 and has been operated by the St. Boswells Angling Association since then, producing annual counts of spawning runs (Appendix F). A similar trap on a small tributary of the Jed Water has been working effectively since 2002 (with the Jedforest Angling Association)

b : Two traps on larger burns of the upper Tweed came in to operation in 2001 and have produced annual counts for their Brown-trout spawning runs since then (Appendix F). As these trap both adults migrating upstream and juveniles migrating downstream, their populations can be modelled. These monitored populations are taken as 'index" populations for the catchment as a whole.

c: One of these traps has shown that very large numbers of one and two year old parr can migrate out in Spring, well before the usual start of electric-fishing in July. It follows from this that summer electric-fishing may well not reflect the numbers of trout parr actually produced in burns, especially where these leave after only one winter at a size of only 90mm or so.

Policies for the next five years:

Policy 4F.1: Establish spawning escapement targets for the Brown-trout of the Upper Tweed index tributary and monitor the numbers of spawners and their age composition.

(a) Monitor the adult numbers from year to year and find:-

(i) The effect of environmental conditions (water levels and temperatures) on the size of spawning runs

(ii) The pattern of ages and sizes within the spawners to see if these change over the years *(i.e. the more older fish there are, the better survival from year to year must be. If older fish were to start to disappear from these populations so that the spawners became increasingly younger and smaller, it would show that they were under stress)*

(iii) The year-on-year mortality rates of the fish *(i.e. the numbers surviving from being two years old, to three years old, three to four, four to five and so on. The rate of survival from one age to the next shows when fish are dying and if these rates can be established, increases in death rates in the future will show if pressure on the population is increasing and at what size / age)*

(b) Model the populations to relate adult numbers to the number of juveniles migrating out of these burns

(i) Count the numbers of trout (identified as Brown or Sea through scale reading) running upstream to spawn each year
(ii) Count the numbers of juveniles (smolts and others) that move downstream each year and determine the proportions of different ages.
(iii) Survey the burns upstream of the traps to estimate carrying capacity
(iv) Use this information to help interpretation of electric-fishing results from the catchment generally.

Policy 4F.2: Construct a Life-table or tables for Tweed Brown-trout (Life-tables show how many fish survive from one age to another e.g. how many 2 year olds survive to become 3 year olds; how many 3 year olds to 4 and so on. They thus show how large the losses are in a population and when they occur. This can change over time as fish find it easier or more difficult to survive and show where management help would be useful.)

(a) The difficult in constructing life-tables is that they need either representative samples in which all sizes / ages are fairly represented or complete measurements of all the fish in a population unit. At present, only the data from Upper Tweed Brown-trout trap is available for this: netting and angling samples are both unlikely to give representative samples of all ages and sizes.

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WORK CALENDAR FOR SECTION 4:

		Month											
POLICY	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4A.1	Stock structure (a) Scales collection	A			F	F	F	F	F	F	F	F	A
	Tracking												
	Genetics												
	Spawning B												
4B.1	surveys	F/A	F/A	F/A	F/A								
4B.2	Adult Habitat	-	-	-	-	-	-	-	-	-	-	-	-
4B.3	Obstacles	F	F	F			I	I	I		F	F	F
4B.4	Habitat Restoration				O/F	O/F	O/F	O/F	O/F				
4B.5	Fly Life				F	A					F	A	
4C.1	Juvenile surveys						O	F	F	F	A		
4C.2	Adult surveys				O	F	F	F	F	A			
	Historic Angling												
4D.1	recs	-	-	-	-	-	-	-	-	-	-	-	-
4D.2	Angling monitoring												
	(a) logbooks	A	O	O							A	A	A
	(b) creel surveys				F	F	F	F	F	F	A	A	
	Spawning burn												
4F	traps	A	A			I	I	I			F	F	F

KEY	Not yet undertaken	
	At any time	-
	Organising	O
	Fieldwork	F
	Analysis & reporting	A
	Instream works	I

BASIC RESEARCH NEEDS IDENTIFIED FOR BROWN-TROUT

For Input 4A: A comprehensive genetics survey of the trout of the Tweed. To work out how many populations there might be and whether these are distinguished by particular life-histories.

For Input 4E: A tag for Brown-trout that is safe and efficient for fish that live in rivers. Ideally, the tag would be of a type that anglers could use themselves to tag fish that they had caught and released.

For Input 4F: Life-tables for Brown-trout in a range of Scottish rivers. Life-tables show how many fish survive from one age to another e.g. how many 2 year olds survive to become 3 year olds; how many 3 year olds to 4 and so on. These tables thus show how large the losses are in a population and when they occur. This can change over time as fish find it easier or more difficult to survive and show where management help would be useful. While the construction of a Life-table for Tweed Brown-trout is part of the work of this management plan, it would be useful to have similar tables for other rivers for comparison.

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SECTIONS 5 to 9: OTHER FISH SPECIES

The species lists for the Tweed and the Eye are given in Chapter 3, where it is also pointed out that the introductions, deliberate or accidental, of alien species has meant that the original, native species community of the Tweed has been well diluted. However, all of these species have not spread to all of the catchment : Grayling, for instance, are kept out of the Gala altogether by a cauld and out of some sections of other tributaries by caulds and waterfalls and other alien species have been limited in smaller channels by culverts and other obstacles. As mentioned elsewhere, when obstacles to Salmon and Trout are eased, attention is given as to whether this might allow alien species to spread further and fish passes and other alterations can be designed to allow native species (Trout, Salmon, Eel and Lamprey) to pass but prevent other species from doing so - this is possible as none of the alien species in the Tweed catchment at present are either good jumpers or crawlers.

The species complex of the Eye Water is closer to the original, only Baggies (Minnows) and Beardies (Stone Loach) having arrived there. Although no historical records of Salmon being present in the Eye have yet been found, there is a significant population at present, as shown by electric-fishing of juveniles. The ammocoete larvae of Lampreys are widespread in the Eye, but it is not known what species these represent, most likely the Brook and River Lampreys – there are no known records of adult Sea Lampreys.

Apart from Salmon and Trout, the only other exploited fish species within the Fisheries District are the Grayling and the Eel of the Tweed. The former was deliberately introduced to the Tweed in the 1850's to provide Winter fishing for anglers as Grayling are in prime condition at that season as they approach their spawning time in Spring (trout, in Winter, are, by contrast in poor condition as they recover from their Autumn spawning). Eels are native to the Tweed and the Eye and have occasionally been the target of small commercial net fisheries. As a species however, they have undergone a steep decline in Europe generally and advice now is that their exploitation should be reduced. As there is no commercial exploitation at present, the logic of the situation would be not to allow any new fishery to start here.

Much of the Tweed is a European Special Area of Conservation (SAC) for all three species of Lamprey as well as for Salmon.

The management issues for this group of species are therefore to:-

(1) Establish a Management Level for Grayling, as these are exploited as a Winter fishery.

(2) Protect the native fish species

(3) Map the present distribution of alien fish species and prevent their further spread

(4) Prevent the arrival of any more alien aquatic species - see Section 6, Biosecurity

SECTION 5 : GRAYLING

The plan for Grayling generally follows the same form as for Salmon and Trout, but varies where differences in life-history make this necessary

INPUT 5A: DEFINE THE POPULATIONS OF TWEED GRAYLING

Rationale : Little is known of how much the Grayling of the Tweed move around or whether there are migrations to particular spawning areas and this needs to be determined if the effect of angling pressure is to be assessed. If there is much movement of fish, then pressure will be on the population as a whole, if there is little movement, then pressure will be on local stocks. After 150 years since introduction (c. 75 breeding generations) it is possible that some genetic differentiation may have taken place but this is unlikely to be of significance yet.

***Results from previous plans*:**

a: *Recaptures of tagged Grayling have shown that they generally move around very little, most recaptures being very close to the original tagging sites. Two recaptures did, however, show that longer distances can be travelled and that such movements could be spawning migrations, taking fish from the main channel into tributaries.*

b: *Genetic analysis of Grayling from the Tweed carried out by the Grayling Research Trust confirmed that the R. Derwent in Derbyshire was the source of the fish brought to the Tweed in 1855. Preliminary analysis showed that genetic variation within populations was low*

Policies for the next five years:

Policy 5A.1: Tag juvenile and adult Grayling to show patterns and extent of movements

(a) Tag adult Grayling caught and released at the Earlston Grayling competition each year and monitor recaptures at this competition and elsewhere

(b) When the equipment becomes available after the end of the Living North Seas tracking work on Sea-trout and Salmon, acoustic tracking of Grayling will be possible. Two approaches would be possible

(i) Tagging of Grayling in tributaries at spawning time to find if they are local or have migrated up from the main river.

(ii) Tracking of fish in the main river to check that movements are as restricted as the external tagging suggests.

Policy 5A.2: Investigate the genetic diversity of Grayling in the Tweed (if resources and opportunities become available)

Policy 5A.3: Find suitable methods to age larger Grayling. As Grayling get larger, their scales thicken and become unreadable, so other body parts in which growth patterns are laid down have to

used, such as the otoliths (ear-bones) or operculi (gill-covers). To use these requires the fish to be killed but it may be possible to use fin-rays, which can be cut off without killing. However, otoliths or operculi would be needed to validate the use of fin-rays.

INPUT 5B: INVENTORY THE QUANTITY AND QUALITY OF HABITAT FOR GRAYLING

Rationale: Little is known of the habitat used by juvenile or adult Grayling or what and where their spawning areas are. If nursery areas with good numbers of juvenile Grayling could be identified where electric-fishing was practicable, they could be assessed and monitored in the same way as Salmon and Trout juveniles.

***Results from previous editions*:**

a: Juvenile Grayling have been regularly found in electric-fishing surveys of the lower Leader, Eden and Ale, but in very small numbers. It may be that most of their spawning takes place in the larger channels.

b: Main channel netting, although aimed at catching adult trout and Grayling, has also caught Grayling fry, sometimes in large numbers, from which the habitat types utilised by this life cycle stage have become apparent.

Policies for the next five years

Policy 5B.1: Maintain a map of the areas used for spawning by Grayling

(a) Grayling are very obvious at their spawning areas and it should be possible to observe and map these, especially in tributaries. This could give information on

(i) Stock strength – large numbers of spawning areas should indicated large stocks

(ii) Stock distribution – some parts of the catchment may have higher densities of spawning areas than others.

(b) Add the sites where Grayling fry are electric-fished during the fry surveys and found during main channel netting.

INPUT 5C: COLLECT INFORMATION ON GRAYLING FRY AND PARR

(a) Count and measure the Grayling fry and parr taken during large channel netting

Large numbers can be taken in this way, from which it is apparent that the main production areas for Grayling are in the large channels. There is therefore little or nothing that can be done to improve the habitat for these life cycle stages, other than the maintenance of good water quality and flows.

INPUT 5D: MONITOR AND ANALYSE ANGLING CATCHES OF GRAYLING

Rationale: Grayling being inhabitants of deeper water and not running in to small trappable burns at spawning time, like trout, it is not possible to examine their stocks in the same way. Catches at fishing competitions are therefore the only source of information on the adults of this species.

***Results from previous editions*:**

*a: Monitoring of the catches made at the Earlston Angling Club's annual Grayling competition have shown that catches - and probably stocks - have fluctuated greatly over the past eight years (Appendix **)*

b: Grayling angling catch logbooks have been devised for use by anglers during the Winter grayling season.

Policies for the next five years:

Policy 5D.1: Monitor the angling catches of Grayling as an index of stock abundance

(a) Continue the Grayling Angling catch logbooks and increase the numbers of anglers keeping records

(b) Monitor the catches at the Earlston Grayling competition each year

(c) Assist / organise other Grayling competitions in other areas

(d) Analyse Grayling catch records to show trends and changes over the years.

(i) In particular, monitor the numbers of one year old fish caught during competitions as an index of year class strength. Scales from larger Grayling are difficult to read due to very slow growth as they age, but one year olds are obvious from both size and scale readings. There is some evidence that occasional year classes can be weak, possibly due to unsuitable temperatures during the Spring spawning season and these should be monitored for as explanations for poorer catches in some years.

Policy 5D.2: Check catch regulations against catch data, to be able to give advice on appropriateness.

INPUT 5E: ASSESS THE EXPLOITATION RATE OF GRAYLING

Rationale: Unless the degree of pressure being put on stocks by angling is known, it is not possible to assess what management, if any, is appropriate

Results from previous editions:

a : After an appropriate tagging method was found in 2004 recaptures of Grayling showed them to be very sedentary, most remaining in the same areas and being fished over repeatedly, giving very high recapture rates of up to 100%. It is clear therefore that there is considerable

"recycling" of Grayling in popular fishing areas with anglers' catches including many fish that have been caught before.

Policy 5E.1: Tag Grayling to find recapture rate (few Grayling are killed, so recapture rate very different from the exploitation rate for this species)

(a) Continue the tagging of adult Grayling where and when possible to monitor recapture rates.

SECTION 6 : EEL

Due to concerns over the widespread decline of this species, the UK is now covered by regional Eel Management Plans, the local one being the SolwayTweed Eel Management plan (ST EMP). This section therefore includes relevant items from this plan.

All work in this section is subject to the availability of resources and opportunities

The European Eel population of the Tweed differs in one very basic respect from all the other fish species found in the Tweed - it breeds outside the Fisheries District and arrives here by migration from its marine spawning areas to live until it is mature enough to leave and spawn. Setting a Management Level for the stock found in the Tweed alone would not therefore serve any purpose, but if it was determined that the species was in decline throughout its range and there was international action to reduce exploitation levels, then conservation measures could be introduced here.

***Results from Previous Plans*:**

a: Data on the Eel population of the Tweed and Eye was supplied to a study being undertaken at Westminster University on the stock levels of the species

*b. Electric-fishing data showed large declines in the numbers of Eel found at monitoring sites (see Diagram **)*

INPUT 6A: Stock structure of Eels. *As Eels return randomly to rivers from their marine spawning grounds, there is no opportunity for the development of locally adapted stocks.*

INPUT 6B: Ensure access to all parts of the Tweed and Eye catchments by Eels [STEMP Table 5.2 Passage]

Policy 6B.1 Collect information on the ability of Eels to pass barriers and on the design of suitable fish passes

Policy 6B.2 When fish passes are being redesigned or rebuild, ensure that they will allow Eels to pass (but not allow non-native species to do so). *As Eels are predators of Crayfish, it is an advantage to have them well spread through the catchment as a way of controlling crayfish spread and numbers.*

INPUT 6C: Survey and monitor the Eel populations of the Tweed and the Eye [STEMP Table 5.2 Monitoring]

Policy 6C.1 Maintain the database of Eel distribution

(a) add historic records when these are found

(b) add records from electric-fishing and other surveys as these are made. Presence / absence of Eel should be recorded at all electric-fishing sites (on the SFCC scale where appropriate methods are being used)

(c) Eels over 500mm are females and of particular importance and their distribution within the catchment needs to be recorded.

Policy 6C.2 **Where quantitative electric-fishing takes place, continue to count and measure the Eels captured**.

(a) Retrieve past data and consolidate into the Eel distribution database

(b) Establish 10 electric-fishing sites at which to monitor Eels every two years, re-using sites from which data is available from the 1970's in Hussein (1983)

(c) Examine all Eel caught in electric-fishing or other surveys for signs of "Cauliflower Disease" and database any resulting records

(i) Photograph any infected Eels and add to database.

(d) Assist in the proposed monitoring of Glass Eels in the estuary

INPUT 6D: Eel Catches – ***there are no Eel fisheries now on the Tweed and advice is that that such fisheries would be inappropriate in the present situation.***

INPUT 6E: Record predation and exploitation of juvenile and adult Eel

(a) Record examples of predation on Eels

(i) Record details of the manner of predation.

(b) Record examples of bye-catch of Eels by anglers.

SECTION 7: LAMPREYS

Much of the Tweed catchment is a European Special Area of Conservation for the three British species of Lamprey: Sea Lamprey, River Lamprey and Brook Lamprey

All work in this section is subject to the availability of resources and opportunities

***Results from previous editions*:**

a: *A survey of the River Till for lamprey larvae was undertaken in 2002, financed by English Nature.*

b: *A survey of the Scottish Tweed catchment for lamprey larvae was undertaken in 2004, financed by SNH*

INPUT 7A.1: Investigate the genetic stock structures of the lamprey species

(a) It is not thought that Sea or River Lamprey show any great genetic diversity within river catchments, but more research on this is needed.

(b) Brook Lamprey, not being migratory, may therefore be more likely to develop locally distinctive populations but this also needs more research. Any investigations on the Tweed should specifically include the Brook Lamprey populations:

(i) upstream of Stichill Linn on the Eden Water. These may have been isolated for a very long period.

(ii) above the Skinworks Cauld on the Gala Water as these have probably been isolated since 1821

(iii) in the Meggat Water and Little Yarrow as these have probably been isolated above St. Mary's Loch for a very long time.

INPUT 7B.1: Define the habitat requirements and distribution of the larvae of the three species.

(a) Collect and analyse data on the types and characteristics of habitat used by lamprey larvae from surveys to try and make a simple protocol that can be used to predict the value of any particular area for larvae.

INPUT 7C.1: Survey the distribution of lamprey larvae

(a) Maintain the database of lamprey larvae distribution

(i) add historic records when these are found

(ii) add records from electric-fishing and other surveys as these are made.

(b) Determine the extent of Sea Lamprey spawning within the Tweed catchment. Their larvae have been found as far upstream as Kelso, but spawning behaviour has been reported further upstream at Mertoun. Adult Sea Lamprey have also been captured much further upstream, at Elibank and from the Jed Water, a secondary tributary.

INPUT 7D.1: Survey the distribution of adult lampreys

(a) Maintain the database of adult lamprey distribution
(i) add historic records when these are found
(ii) add records from electric-fishing, other surveys and general observations as these are made.

(b) Determine the extent of River Lamprey penetration within the system by trapping during their spawning season in April (*While the spawning penetration of Sea Lamprey can be worked out from the distribution of their larvae, which are distinctive, the larvae of River Lamprey cannot be distinguished in the field from those of Brook Lamprey*)

INPUT 7E.1: Record predation and exploitation of juvenile and adult Lampreys.

(a) Add records of predated lamprey to the juvenile & adult distribution databases
(i) Record details of the manner of predation.
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8: OTHER NATIVE FISH SPECIES
(Flounder and Three-spined Stickleback)

INPUT 8.1: COLLECT AND COLLATE HISTORICAL AND PRESENT DAY RECORDS OF THESE SPECIES

Rationale: Knowing what fish species are present and where throughout the District is a basic background requirement for fisheries management. Such information is often of interest to other organisations concerned with conservation and maintenance of this information in a compatible, database, format allows requests for this type of information to be answered quickly and easily.

***Results from previous editions*:**

a: Distribution data derived from both Tweed Foundation and earlier surveys have been combined into a database from which fish species distribution maps have been made. This data has been contributed to the local Biological Records Centre and to the Institute of Terrestrial Ecology's Atlas of British Fishes.

Policy 8.1.1 : Survey the distribution of Flounder and Stickleback.

(a) Add records of these species to the distribution database
(i) add historic records when these are found
(ii) add records from electric-fishing and other surveys as these are made.

(b) Ensure database formats are compatible with those used generally

(c) Provide updates of species distribution data to the local Biological Records Centre and to SNH if and when requested

9: NON-NATIVE FISH SPECIES
(Perch, Pike, Roach, Dace, Gudgeon, Rainbow Trout, Bullhead, Carp spp)

INPUT 9.1 : COLLECT AND COLLATE HISTORICAL AND PRESENT DAY RECORDS OF THESE SPECIES

Rationale: Knowing what fish species are present and where throughout the District is a basic background requirement for fisheries management. Such information is often of interest to other organisations concerned with conservation and maintenance of this information in a compatible, database, format allows requests for this type of information to be answered quickly and easily.

***Results from previous editions*:**

a: Distribution data derived from both Tweed Foundation and earlier surveys have been combined into a database from which fish species distribution maps have been made. This data has been contributed to the local Biological Records Centre and to the Institute of Terrestrial Ecology's Atlas of British Fishes.

b: The distribution data collected has formed the basis of the RTC's stocking policy, showing which parts of the catchment already have populations of non-native fish species and which do not.

Policy 9.1.1 : Survey and monitor the distribution of non-native fish species.

(a) Add records of these species to the distribution database
(i) add historic records when these are found
(ii) add records from electric-fishing and other surveys as these are made.

(b) Ensure database formats are compatible with those used generally

(c) Provide updates of species distribution data to the local Biological Records Centre and to SNH if and when requested

INPUT 9.2 : MONITOR THE EFFECT OF NEWLY ARRIVED PREDATORY SPECIES ON SALMON AND TROUT POPULATIONS

Rationale: Where a species that is a known predator of some stage of the life-cycle of salmon and trout is found in a new area, there is the opportunity to monitor its effects – if it cannot be removed. This will show what its impacts are and if they are significant and if the latter, will demonstrate the need for action if any other sites are colonised. If such a predator can be show to have a serious impact, then the case for spending the resources to remove it from any new areas can be made.

Policy 9.2.1: Set up monitoring sites to examine the effect of Bullhead (*Cottus gobio*) on salmon and trout juveniles. (*This species has two confirmed locations in the Tweed catchment: on the Langton Burn near Ashkirk in the Ale system and on The Stank, a tributary of the Bowmont. Information on its effects on salmon and trout in the scientific literature are conflicting but include a report from Sweden of the density of juvenile salmon in areas with Bullhead being only one tenth of the level in areas without and of considerable predation on eggs*)

(a) Set up a monitoring site on the Langton Burn, where there is previous electric-fishing information and record Bullhead, Salmon fry and trout fry numbers.

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(b) Ensure database formats are compatible with those used generally

(c) Provide updates of species distribution data to the local Biological Records Centre and to SNH if and when requested

SECTION 10: BIOSECURITY

(*This section is an interim one as Biosecurity planning is the topic of a RAFTS programme funded through the Scottish Government which is running from 2008 to 2010. A full section that will include the results of this programme will replace this interim section in 2011*)

Rationale: The plants and animals that have evolved together in and along the waters of the Tweed catchment and of the Eye since the Ice Age, give a particular local character and interest to our area. Every time a non-native species establishes itself this local character is weakened and our rivers become more anonymous and generalised. If the process is unchecked both here and nationally, then the rivers of the British Isles will no longer be characteristic of their local areas but will simply be channels of water inhabited by a random collection of plant and animal species from around the planet. The aim of this section is therefore to "keep Tweed, Tweed"

One of the most distinctive characteristics of our rivers and of the rivers of Scotland the North of England generally, is the lack of native fish species. Since there was no freshwater link between the northern parts of Britain and the continent, no purely freshwater species such as Pike, Perch or Carp species such as Roach, Rudd, Dace, Tench, Barbel etc. could colonise this area after the Ice Age. The only native species are therefore those that could cross salt water (Salmonids, Eel, Stickleback and Lampreys). This lack of native species is sometimes thought of as a deficiency to be remedied by introduction but it is actually one of the things that makes our rivers different from elsewhere and therefore of particular interest.

As well as the fundamental damage done to our local identity and ecology by the presence of non-native species, there is also the particular damage that can be done by individual non-native species. Signal Crayfish, for instance, exclude juvenile salmon from hiding places, making them more vulnerable to other predators and reduce the numbers of large invertebrates on which fish feed. Giant Hogweed and Japanese Knotweed can completely dominate banksides, excluding light and destroying all native vegetation underneath. While these particular situations are more dramatic and obvious and grab the headlines, the dilution of local ecological identity by the infiltration of non-native species that do not cause any particular damage is actually just as significant. What has to be remembered is that animal *communities* can become extinct, not only individual species and the presence of even one alien species means that a community has become extinct, even if all the original, native, species are still present.

A PREVENTION

Rationale: As it is difficult to eradicate a non-native* species once it is established, the best course is to prevent the arrival of new species altogether. This not only means alerting and informing the public in general and bodies such as garden centres and aquarists shops in particular of the dangers of non-native species but also working with national agencies to support national policies aimed at exclusion or restriction of non-native species beyond the boundaries of the Fisheries District.

1 Keep national plans and strategies under review and introduce locally any relevant polices or programmes to prevent the arrival of non-native species

a) Co-ordinate work with national agencies such as SNH, Natural England, SEPA and the EA.

b) Give scientific support to the RTC's policy on the prevention *Gyrodactylus salaris*

2 Increase public awareness of the issue through local publicity and the provision of materials to local clubs and schools

a) Highlight species that are nearing the boundaries of the catchment e.g. the Chinese Mitten Crab is now established in the Northumberland Tyne.

3 Check the local efficiency of national codes

a) On the sale of plants and animals in garden centres and aquarists shops.

i) Obtain copies of national codes and of identification guides to banned plants and animals
ii) Draw up a list of all local garden centres and aquarists shops
Write to the managers of all of these to ask if they are following their national codes of practice
iii) Set up a programme to monitor local garden centres and aquarists shops to check on plants and animals on sale

b) On the discharge of ballast water from ships in Berwick harbour (Eyemouth) (ballast water from ships is known to be a serious biosecurity risk and has been responsible for the transfer of many marine species of plants and animals around the world)

i) Contact the Berwick Harbour Commissioners to ask what policy they have on ballast discharge and check that this meets national / international standards

4 Provide scientific support to the RTC's Code on the stocking and movement of fish species into and around the District.

a) Maintain a list of local still-water fisheries

b) Liaise with the SBC's Biodiversity officer on the creation of new ponds within the District and ensure appropriate restrictions on the stocking of these with plants and animals are imposed.

B RESPONSE

1 Newly arrived species

a) Ensure that the appropriate channels for reporting the presence of new non-native species to national bodies are known.

i) If any such species are found, report immediately
ii) Alert local agencies and join any group set up to deal with the new arrivals (this is an interim measure – a national system for rapid response is being developed. However, this may only be triggered if species of national significance are involved, it may not cover local situations)

2 Establishing species (Signal Crayfish and Bullheads)

a) Determine extent of colonisation

b) Work to contain the spread of these as a first response

c) Establish if eradication is feasible. Particular attempts should be made if there is only one population within a sub-catchment that would otherwise be free of that particular alien species. Two such situations are known at present – there are single ponds with Signal Crayfish in the Middle Tweed and Whiteadder catchments. Eradication of these would make these areas free of Signal Crayfish, reducing the risk of further spread. The Whiteadder catchment is unlikely to be further colonised by Signal Crayfish without human assistance as its river mouth is in salt water so eradication of the single pond within this catchment would have the effect of creating a Signal Crayfish-free zone within the Tweed catchment.

i) Carry out a feasibility study in to the possibility of eradicating Signal Crayfish from the Whiteadder catchment.

d) If eradication with present techniques is not feasible, see if it is possible to define areas within the catchment that these species could not reach without further human assistance and work to ensure that these, at least, remain free of these species.

i) Identify such refugia
ii) Advise farmers, landowners, etc. within these areas of the issue and ask that they ensure that no stocking or transfer of these species is made on their land.

C ERADICATION

1 Support eradication initiatives being undertaken by local bodies (e.g. The Tweed Forum's Invasive Plants work)

a) Maintain awareness of techniques in use

b) Develop links with bodies using such techniques

c) Obtain any appropriate training.

2 Where and when practicable, undertake eradication of non-native aquatic species if no other body prepared to do so.

a) Identify extent of problem
i) Obtain necessary consents for use of biocides (poisons) or other techniques.
ii) Obtain training in use of eradication techniques or commission outside experts
iii) Undertake eradication
iv) Check for success

3 Where no practicable eradication techniques are available support research to find these

D MITIGATION & INVESTIGATION

1 If there is no possible method of eradication, establish any possible mitigation measures, such as identification of areas within the catchment that an alien species cannot get into (without human assistance) and alert farmers, landowners etc. within such areas to the situation. The aim of this would be to ensure that the alien species was not accidentally introduced into the parts of the catchment they could not invade by themselves. (as for RESPONSE 2d)

2 Better information is needed on the impacts of alien species both to assess likely impacts and to provide information to support any case for eradication.

a) Set up monitoring sections where Bullhead have established to find their impacts on juvenile Salmon and Trout (there is no consistent view on this – in some cases Bullhead are known to have replaced trout entirely in small burns but in other places they do not cause any apparent problem)
b) Investigate the possibility of monitoring Signal Crayfish and juvenile trout in the Flodden Burn, a small stream where the former are very numerous. However, a monitoring programme would require the return of any crayfish sampled back to the water, which would be illegal.