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 other 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 numerous, smaller, male, Brown-trout and a few larger, female, Sea-trout. This suggests that in many spawning burns there may not actually be separate Brown- and Sea-trout populations, simply trout populations.

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.

Another question is about the movement of adult Brown-trout within the catchment. Do they stay in much the same area all the time or do they move around and if so, is it for long or for short distances? This is an important consideration for the trout fishery as it needs to be known where the trout that the anglers in any particular part of the catchment actually catch come from – are they local fish or from further away? The fish counters on the Ettrick and Gala show Brown-trout running upstream in spawning time which suggests at least some large scale movement.

The Current Situation: 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 some of the samples. Results from the trapping of spawning burns has shown two quite different forms of trout spawning population. At six of the burns, the great majority of eggs have come from a few, large, female, Sea-trout, fertilised by more numerous but smaller male Brown-trout ("Type II" populations). 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 ("Type I" populations). This suggests that the large Brown-trout that are of particular value to anglers could come from distinctive populations within the catchment and if this was the case then the large trout caught by anglers should also have 50:50 sex ratio. If, on the other hand, trout from the cross-breeding of male Brown-trout and female Sea-trout also grew to large size, the sex ratio of all Brown-trout caught by anglers would show more males (70% of Sea-trout are female creating a gender imbalance in fish available to trout anglers). If the Brown-trout from this cross-breeding did not grow large (as the data from the traps suggests) it would also suggest that the majority of small trout caught by anglers would be male.

If Scenario 3 is correct, the implication is that Brown-trout are longer lived and Sea-trout shorter. As most Tweed Sea-trout spawn only once, but the large Brown-trout of Type I populations spawn several times it could be that resident and migratory life-history strategies can balance-out in terms of number of eggs produced over a life-time: Sea-trout get larger more quickly, but spawn only once, while Type I Brown-trout take longer to get large but spawn more than once.

A long term problem with the management of trout has been the inability to distinguish Brown-trout and Sea-trout before the latter smolt and leave the river. Electric-fishing results for trout fry and parr cannot be identified as being the young of either type, which makes it impossible to determine the sort of management needed if the results are poor – should Brown-trout females be protected or Sea-trout?

New techniques, using Stable Isotopes, can now distinguish between newly hatched fry that come from Sea-trout eggs from those that come from Brown-trout eggs. These are based on the fact that an egg grown in the sea has a different chemical signature from an egg grown in fresh water. Using such techniques it should be possible to map where Brown- and Sea-trout females dominate in the spawning burns of a catchment.

Policies for the next five years

Policy 4A.1 – If the opportunity arises, undertake 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.

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 by all possible methods 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.

Policy 4A.3 – Establish the movement patterns / migrations of Brown-trout within the catchment by tracking individual fish.

(a) Acoustic 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.
(b) Find if the growth patterns seen on the scales of tracked fish can be related 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 were not tracked.
(c) Acoustic tag and 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) Where these fish have come from i.e. where do they go to spawn, so that angling clubs can know the sources of their fish and contribute to the management of those areas.
(iii) Whether they stay in the same area where they were caught or whether they make large scale movements.
(d) Maintain and expand the database of photographs of opercular spot patterns of trout caught by anglers and sampled at traps.
(i) Identify trout that return to traps.
(ii) Plot movement patterns from angling recaptures.
(iii) Gather information on recapture frequency.

Policy 4A.4 – Sample the structure of the trout spawning populations on more spawning burns. **This can be done either by**: -

(a) Setting up a temporary trap for two or three years to show: -

(i) Whether the population using the burn is of the fewer, larger, female Sea-trout & numerous smaller, male, Brown-trout "Type II" or the 50:50 large male and female Brown-trout "Type I" (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 numbers in the spawning population.

(b) Electric-fishing a burn at spawning time to find if there are large (30cms+) Brown-trout present in a 50:50 sex-ratio as this is the characteristic of Type I populations.

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 throughout their life cycle. 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. Trout generally leave their spawning burns after two or three years, dropping down in to larger channels where the water is deeper and they can grow larger. To what extent Brown-trout return to their home burn to spawn or to whether they stray to a significant extent is unknown, though there is some evidence from lochs that the trout of different burns generally return to them to spawn. There is some question over the amount of good, deeper water habitat for adult trout as there are parts of the catchment where gravel accumulation has shallowed the river and this could affect the fishability of areas. 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.

If electric-fishing surveys show trout fry numbers are lower in a burn than they are in the general area, then that is an indicator of a possible access problem for spawning adults and such situations need to be identified and investigated. There may be habitat quality issues as well though these are less easily identifiable.

Brown-trout, unlike Sea-trout and Salmon, must grow just on the food provided within the river and some check needs to be kept on this, particularly as a warming climate could change the insect species that live in the river or their distribution within the river. Warmer waters could also change the growth pattern of trout, starting their growth earlier in the year but reducing it later on as trout put on less growth in warm water.

The Current Situation: Habitat and map surveys of the smaller burns used by Brown-trout have found many obstacles, mainly culverts, to their migration and an extensive database has been produced and is being maintained. Electric-fishing surveys are used to show which instream structures are actually problems – i.e. whether the fish numbers upstream are reduced compared to those below and there is a rolling programme of checking on burns in this way. The practical issue however is that the areas of spawning obstructed are not individually large, though collectively significant. This makes it difficult to justify the use of any great amount of resource for the opening up of any particular stream. The development of simple and inexpensive methods working with local angling clubs is gradually dealing with these obstacles. Contributing data on obstacles to forestry management plans is another way of having smaller streams opened up. 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. Existing data on invertebrates from SEPA and other sources has been collated as a baseline for trout food sampling programmes.

Policies for the next five years

Policy 4B.1 - Survey and map Brown-trout spawning and juvenile habitat

(a) Continue surveys of smaller spawning burns that have not yet been visited using the AST Small Burns Survey protocol for survey work and train personnel in its use. (http://www.atlanticsalmontrust.org/small-streams-course/)

(*i*) Take immediate action to restore fish access if significant and obvious barriers are found.

(*ii*) Add any other instream structures to the Obstacles Database for further investigation.

(b) Record areas of poor quality habitat.

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) Update the TTGI baseline survey as and when appropriate.

Policy 4B.3: Inspect the instream structures for which further 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) Check the possible impact of instream structures by electric-fishing. These surveys consist of six three-minute samples upstream and downstream of a possible barrier. If the structure is not having an effect, fry and parr numbers upstream should be no different from those downstream.

(ii) 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.*

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

(iv) Before easing any culverts, undertake a "before" electric-fishing survey of the whole burn so that changes upstream after the work can be assessed and monitored.

(v) 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 restoration of damaged habitat with local angling club members.

(b) 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) Build on past work to check on 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 JUVENILE AND ADULT BROWN-TROUT POPULATIONS THROUGHOUT THE TWEED AND EYE CATCHMENTS AND ASSESS THE EFFECTS OF PREDATION

Rationale: For juveniles, this is the same as for Sea-trout. For adult Brown-trout it is useful to know the sort of abundance of takeable trout that could be expected to be found in the size of channels that are fished by anglers.

The Current Situation: Trout fry and parr have been surveyed throughout the catchment since 1992 and many sample sites now have series of results spanning more than 20 years so that changes and trends could be identified. However, little has changed in these years, with trout fry continuing to be widespread and abundant. Juvenile trout are surveyed both as part of the salmon juvenile electric-fishing programme and as additional surveys of burns too small for salmon. For adult trout, 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. 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. This sort of survey work gives information on the sort of trout fished for by anglers, though is only possible in low flow Summers.

Policies for the next five years

Policy 4C.1: Monitor juvenile trout throughout the Tweed and Eye catchments *(Salmon juvenile survey programme [Input 2C] and TTGI Electric-fishing surveys*)

(a) Continue the timed electric-fishing of juveniles in burns for comparison against the baseline surveys made in the 1990s, covering the same zones of the catchment as the salmon juvenile electric-fishing surveys of the year. While many burns are sampled as part of the Salmon programme, smaller burns that are likely to hold only trout juveniles are not part of that programme, so such burns need to be surveyed as part of a distinct programme.

(b) Analyse results against the 1990s' 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.
(*Predation on juvenile trout is covered by Policy 3C.2 in the Sea-trout section*)

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

(a) Continue the netting in main channels as and when possible to give:

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

(ii) Scales for information on growth patterns, sex and ages.

(b) Continue to identify and survey electric-fishing sections in "medium-sized" channels to look at larger sizes of trout.

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

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 at present. 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.

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 the state of the stocks.

The Current Situation: A history of the Brown Trout stocks and fishing has been compiled from published sources (Chapter 4.2 Brown-trout Fisheries) and angling club competition catch records have been computerised and analysed (Chapter 4.2 Brown-trout Fisheries). Three angling diaries, covering 1900-1928;1951-1991 and 1967-1990 have also been computerised and analysed (Chapter 4.2 Brown-trout Fisheries). A Trout catch diary recording scheme was started in 1991 in which a sample of anglers record their catches. 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. 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 4.2 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 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 and check to find if these could be linked to environmental or social trends.

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) Promote the use of the SFCC online angling catch logbook to Tweed anglers.
(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*).
(d) If possible, make bankside surveys to gather data from anglers: this covers visiting anglers who are more difficult to include in logbook surveys.

INPUT 4E: ESTIMATE THE SURVIVAL, EXPLOITATION AND RECAPTURE RATES OF BROWN-TROUT

Rationale: If the catch rate of Brown-trout could be found, it would allow estimates to be made of total trout stocks, but the lack of a suitable tag for river trout prevents this being done. Now that Catch and Release for Brown-trout is prevalent, it would be useful to know what the "recycling" rate of trout was, so that the contribution of released fish to catches could be estimated, which has a bearing on assessing the health of trout stocks from angling catches. If the recycling rate is high, high catches will not necessarily mean high stocks, though the fact that older and larger trout are being caught suggests that stocks are building up.

The Present Situation: It is apparent from the trout catch logbooks that the killing of trout by anglers has greatly reduced and may, indeed, no longer be of management significance. It is now possible to use photographs of the opercular spot patterns of trout caught by anglers to uniquely identify individual fish, which replaces the need to externally tag them for identification to find out recapture rates. This spot pattern recognition has shown a surprisingly high rate of recapture by anglers and it appears that large trout, far from being the shy and hard to catch type that they were assumed to be, are actually an aggressive type that can be caught multiple times. Such behaviour would, however, have been almost instantly fatal before catch and release became common and raises interesting questions on how angling practice can affect trout population characteristics. The recapture

rate may be partly due to the fish having quite strong "site fidelity" which keeps them in the area in which they were first caught, increasing the likelihood of them being caught a second time. It also seems possible that some fish at least will return to the same area of the main river after leaving to spawn in the Autumn.

Policy 4E.1: Maintain and expand the database of photographs of opercular spot patterns of trout caught by anglers.

(i) Maintain a library of pictures on the website with notes on recaptures.

Policy 4E.2: PIT tag Brown-trout on the Gala Water to find survival rates

(a) PIT tag emigrating juvenile Brown-trout caught at the smolt trap in Spring to see how many make it back to the Gala Water in later years.

(b) PIT tag adult Brown-trout caught in the Gala fish ladder trap to see how many return in subsequent years.

Both these actions should allow an estimate of year-to-year survival for Brown-trout and possibly allow a "Life-table" to be constructed for Tweed Brown-trout.

INPUT 4F: MONITOR ADULT BROWN TROUT POPULATIONS AND DETERMINE THEIR SOURCES AND ORIGINS.

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. However, a particular problem with adult Brown-trout is their origin – to what extent are the fish caught by trout anglers coming from the eggs of Sea-trout or from those of Brown-trout females? If most are coming from Sea-trout, then little effect can be expected from management of Brown-trout (size, bag limits etc) but if Brown-trout eggs are a significant source, then such management is of importance.

The Current Situation: At present, the only monitoring of Brown-trout possible is through their angling catches and the catch recording scheme is now in its 11th year and providing solid data that is building up over the years – recent data has, for example, shown increasing numbers of large trout being caught in the Upper Tweed. If more was known about the movements of adult Brown-trout, counts from the fish counters could also be used to monitor Brown-trout. A genetic test is now available by which the sex of salmonids can be determined from tissue (scale) samples or even just from fish glaur (slime). This means that trout caught during the angling season before they start to develop their external gender characteristics can now be identified. As outlined in Input 4A, trapping of spawning burns has shown two distinctly different types of trout spawning populations: -

Type I: Large Brown-trout, 50:50 male and female, living up to 10 years old, and spawning several times
Type II: Many small, mainly male Brown-trout and a few large, mainly female, Sea-trout, the latter mostly spawning just once.

From these, three scenarios for the sources of the Brown-trout caught by anglers can be constructed, and testable hypothesis for each made:

Scenario	Testable hypothesis
(1) The large Brown-trout (30cms+) caught by anglers come only from Type I spawning populations	The large Brown-trout caught by anglers will be 50:50 Male & Female (If males are shorter lived, could be xs females – males start spawning earlier)
(2) The mainly male Brown-trout from Type II populations grow on to become large	All sizes of Brown-trout caught by anglers will be mainly male (as the balancing females from Type II spawning populations will be Sea-trout)
(3) The mainly male Brown-trout from Type II spawning populations do not grow on to become large, but are short-lived and die while still small	Most small Brown-trout caught by anglers will be male, but the large Brown-trout will be 50:50 Male & Female. (If males are shorter lived, could be xs females – males start spawning earlier)

Scales have, and are, being collected by anglers to test this hypothesis and so far some support for Scenario 3 has been found (Appendix 4F).

Policies for the next five years

Policy 4F.1: Collect samples from trout of all sizes to determine the sex ratios of the trout caught by anglers.

(a) Collect sufficient from different zones of the catchment to be able to make comparisons between these.

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 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.