THE RIVER DEE:
STOCK COMPONENT REVIEW 2006.

Summary Report

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October 2006.

A Report for
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FOREWORD

The River Dee Trust is pleased to present its Summary Report on the Stock Component Review of salmon and sea trout stocks in the River Dee. This shorter report details the findings of the main report, copies of which are available from the Trust Office.

While a great deal of worthwhile work has been reported on and is available from previous and continuing studies of particular features of the stock components, this is the first time on the Dee that there has been a comprehensive analysis of the whole current picture. Understandably there turn out to be quite a number of gaps.

I am very grateful to Dr. Helen Bilsby for all her work on this Review. She has drawn together material from a wide variety of sources, analysed it thoroughly and presented the results in a readily digestible form. She has achieved this on time and within budget.

Dr. Bilsby has received assistance from many who have helped in many ways, including making scientific information available, and I should like to thank all of them for what they have contributed. I should mention especially John Pirie and my fellow director Professor Tony Hawkins for their careful and dedicated work on the earlier drafts of the Report.

I should also like to draw attention to the generous assistance given by the proprietors who provided Dr. Bilsby with full access to their fishing records. These records are the only detailed information collected regularly going back before 1945 which give a worthwhile indication of the stock components historically. It proved to be impracticable in the time available to look at more beats' records but what Dr. Bilsby has been able to examine represents a scientifically robust cross-section of active beats in the three sectors of the river.

This Report is a foundation stone on which the Trust can build. It shows us what is currently known about the stock components, what can be deduced and where more, including different, work is needed. These three are interdependent and certainly not mutually exclusive. The process from here on will be one of ongoing, systematic development. We now know reliably from where we can begin.

Randall Nicol
Chairman, River Dee Trust

EXECUTIVE SUMMARY

This review analysed the strengths of the various components that make up the run of Atlantic salmon and sea trout into the River Dee, and how they have changed in recent years. Data was collated from a number of sources: rod returns, net catches, traps and fish counters, and electric fishing surveys. This data was analysed and reviewed and, whilst the review aimed to be comprehensive, gaps in the collective knowledge were highlighted.

GRILSE AND MULTI-SEA-WINTER SALMON

In 2004 catches of spring salmon were at 44% of the long-term average rod catch and catches of multi-sea-winter salmon in the summer months were at 92% of the long-term average.

Across the Dee as a whole the decline in rod catches has extended through all of the spring months and through May and June. In recent years the catches of multi-sea-winter fish have stabilised or slightly improved.

Trap data have indicated that sufficient female salmon to meet spawning targets ascended the Girnock Burn in 2004 and 2005, and the Baddoch Burn in 2004.

Fish counters in the middle reaches of the catchment have not shown any significant increase in the numbers of female salmon over the last five years' operation.

Catches of grilse and of autumn-running multi-sea-winter salmon have shown an increase in their numbers since the mid-1980s.

Data from the Raik net fishery showed that the Dee switches between periods of spring salmon to grilse dominance. The Dee has been in a period of grilse dominance since the early-1960s. The reasons for the switching are not known and the timing of the next switch cannot be predicted, nor can it be known if it will occur at all. During periods of grilse dominance fish tend to be caught later in the season.

SEA TROUT

Rod catches of sea trout appear to vary greatly from year to year and beat to beat. The 2004 catch of sea trout is at 123% of the current long-term average.

Reliable information on sea trout across the catchment was sparser than that for salmon.

CATCH AND RELEASE

It is not possible to quantify the contribution that catch and release has had on the stabilisation and recent improvements in fish catches. Although recent catches of spring-running multi-sea-winter salmon have stabilised it is only since 2004 that spawning targets have been met in the Girnock and Baddoch Burns. Spawning targets for other parts of the catchment are not known. In order to get a full picture, it is going to be necessary to establish the spawning targets for other parts of the catchment and then ensure that they are consistently met for a number of years.

Preliminary estimates suggest that 6% of the 2004 annual rod catch of MSW salmon and grilse was represented by the recapture of previously caught and released fish.

AUTUMN CATCHES

Rod catches of grilse and multi-sea-winter salmon have been increasing late in the season. The increases have been predominantly at the lower river beats.

When considering any change to the fishing season sufficient leeway should be allowed for fish to finish their migration in time for spawning, bearing in mind that flow conditions may not always be ideal.

FUTURE DATA REQUIREMENTS

This study has highlighted gaps in the current understanding of fish populations and their dynamics. A number of suggestions are made to ensure that these gaps can be minimised.

CONTENTS

ACKNOWLEDGEMENTS

The author is extremely grateful to the many individuals who have contributed to this report. These include:

John Koss, Dee Salmon Fishing Improvement Association;
Edward Humphrey, Dee Salmon Fishing Improvement Association;
Lt. Col. R.A. Campbell;
Julian Maclean, FRS Montrose;
Jackie Anderson, FRS Montrose;
Gordon Smith, FRS Montrose;
David Hay, FRS Faskally;
Iain McLaren, FRS Faskally;
Alan Youngson, FRS Faskally;
David Summers, Tay District Salmon Fishery Board;
Ian Jessiman, Aberdeen Harbour Board;
Alistair Thomson, Middle Dee Project;
Derek Fraser, Scottish Environment Protection Agency;
Jason Godfrey, Scottish Fisheries Co-ordination Centre;

and especially the individual estates which allowed use of their game books.

Finally, I would like to thank the staff and directors of the River Dee Trust and Dee District Salmon Fishery Board for their help and support, and Tony Hawkins and John Pirie for their valuable comments on earlier drafts of this report.

LIST OF ABBREVIATIONS

1SW	One-sea-winter salmon or grilse
2SW	Two-sea-winter salmon
DDSFB	Dee District Salmon Fishery Board
DSFIA	Dee Salmon Fishing Improvement Association
FRS	Fisheries Research Services
MDP	Middle Dee Project
MSW	Multi-sea-winter
pers. comm.	Personal communication
S.D.	Standard Deviation

1 TERMS OF REFERENCE

1.1 INTRODUCTION

The Aberdeenshire Dee rises in the Cairngorm Mountains and flows east for over 100 km before entering the North Sea at Aberdeen. Along the way around 20 tributaries of notable size join the main stem, draining a catchment area of 2100 km^2. The catchment is diverse in character, ranging from heather moors and mountains in the west, through forestry and farmland, to the city of Aberdeen in the east. Further details of the geology, hydrology and land use of the catchment can be found in Jenkins (1985).

Iconic of the River Dee are the fish species which inhabit it. Atlantic salmon (*Salmo salar* L.) and their close cousins the sea trout (*Salmo trutta* L.) have inhabited the river since the last ice age. Mankind has always had an impact on these species, whether by exploiting them as a natural resource or changing their habitat through altered land use. The environmental factors affecting these fish have changed and the populations have to continually evolve to come to terms with the modern environment.

Most prized amongst the Dee's fish resource have been the spring-running salmon, attracting anglers to the area from the UK and beyond, seeking fishing at times of the year when the stocks of many other rivers have yet to arrive (Anon., 1994a). In common with other Scottish rivers the rod catch of spring salmon has declined greatly since the 1960s. This decline was more pronounced on the Dee in the late 1980s and early 1990s, arousing great concern and instigating the formation of the Dee Salmon Action Plan and a policy of catch and release (Youngson and Hawkins, 1993; Anon., 1994a; Anon., 1994b). Internationally the Dee has been recognised as an important site for Atlantic salmon through its designation as a Special Area of Conservation under the Habitats Directive.

Over the years the River Dee has been one of the most researched catchments in the United Kingdom. This report highlights the current state of knowledge on how the different populations of fish are faring by drawing together this research and combining it with information on the current and historic catches of fish.

1.2 AIMS

This review aimed to analyse the strengths of the various components that make up the run of Atlantic salmon into the River Dee, and how they have changed in recent years. Data was collated from a number of sources that have been known to collect scientific information on fish stocks within the river, and was then analysed and reviewed.

Whilst the review aimed to be comprehensive it was not expected that the information collated would cover all of the needs of modern fisheries management. The study highlights any gaps in the collective knowledge.

1.3 BIOLOGY OF ATLANTIC SALMON

Atlantic salmon are known to enter the Dee every month of the year. All of these salmon have the common purpose of reaching their spawning grounds and breeding. Within the returning populations of salmon there are two main components: grilse and multi-sea-winter salmon.

Most salmon returning to the Dee are **multi-sea-winter (MSW) salmon**, and of these most have spent two winters since first migrating to sea (2SW salmon). The earliest of these arrive in freshwater in the winter almost a full year before they will spawn and will in fact complete the second of their adult winters in freshwater, before the angling season begins. These are the earliest of the spring-running salmon (reviewed in Youngson, 1995). Most spring salmon, however, enter the river between January and May and have completed their second adult winter before they do so. Examination of the scales of these fish shows that rapid growth has not yet resumed for the current year. The gonads of the fish have not started developing when they return from the sea.

As the year progresses the summer- and then autumn-running MSW salmon arrive. The current year's growth on their scales indicates that they had re-commenced feeding in the sea before they returned.

Grilse are salmon that have spent one winter at sea since they emigrated as juveniles, and have completed approximately one year in the ocean before returning to freshwater. The grilse run in the Dee begins in earnest in June, although smaller numbers may be present as early as April, and continues right up until spawning in the early winter months.

In general, as grilse have spent less time feeding at sea than 2SW salmon they are smaller than the 2SW salmon arriving at the same time as them. However, as the season progresses, both freshly-run grilse and MSW salmon have spent increasing amounts of time in the ocean feeding grounds, and become progressively larger as the season proceeds. By the end of the season large, late-running grilse may often be mistaken for MSW salmon, resulting in so called "grilse error" in the reported catches.

The early-running fish of both sea-age groups home to the upper parts of the catchment to spawn, whereas the late-running fish tend to spawn lower down the catchment (Webb, 1994; Hawkins and Smith, 1986; Smith *et al.*, 1998). Spawning takes place over the late autumn and early winter months, beginning in the colder upper reaches of the catchment first (Webb and McLay, 1996). Spawning occurs in the main stem of the Dee and its tributaries wherever areas of suitable clean gravels are accessible. Eggs are covered over with gravel mounds or redds, which protect them over the winter months. After the eggs hatch the following spring the juvenile fish feed on invertebrates and progressively grow, being known as fry in their first year and parr in subsequent years.

Dee salmon spend two or three years in freshwater, growing to a size of around 100 – 130mm (4-5 in) before undergoing a major physiological change in preparation for their emigration to sea as smolts. Most smolts leave the catchment in spring, although a smaller contingent leaves the tributaries in autumn and is first believed to over-winter in the main stem before emigrating in the following spring (Huntingford *et al*., 1992).

Once at sea the changing distributions of salmon are for the large part unknown, although tagged salmon of Scottish origin were caught in the West Greenland (predominantly fish destined to be MSW salmon) and Faroes high seas fisheries when they were in operation (Youngson and Hawkins, 1993; Shearer, 1985). Changes in sea surface temperatures and zooplankton distributions may be affecting their marine survival (Beaugrand and Reid, 2003).

1.4 BIOLOGY OF SEA TROUT

Like Atlantic salmon, sea trout are anadromous fish, spawning and spending the early part of their life cycle in freshwater. However, once trout reach the stage of smolting there are two distinct paths which they can take. Within any population of trout where migratory access to the sea is possible, a portion will undergo the smolting process and migrate downstream to sea. Those that remain in freshwater develop into brown trout. Unlike Atlantic salmon the marine migrations of sea trout are more coastal and they are believed to stay within an average of 30km of the coast.

Sea trout also differ from Atlantic salmon in that they are multiple spawners and will spawn several times over a number of years. Atlantic salmon, on the whole, only tend to spawn once before dying and previous spawners are only occasionally recorded on the Dee.

2 ANALYSIS OF CATCH RETURNS

2.1 INTRODUCTION

The use of catch returns as an indicator of changing trends in fish populations has been widely reported. Long-term netting data sets have been used to examine changes in the relative abundance of multi-sea-winter (MSW) salmon and one-sea-winter salmon or grilse (Summers, 1995) and to look for correlations with the north Atlantic marine temperature (Martin and Mitchell, 1985). As net catches have declined rod catches have increased in significance, both in terms of the proportion of fish caught and in their potential as indicators of stock abundance. Rod catch analysis has been used to examine the return rate and distribution of salmon of different sea ages (Gee and Milner, 1980), and more recently, the trends in abundance of early-running MSW salmon across seven Scottish rivers (Youngson *et al*., 2002).

Whilst it is recognised that catch data provides valuable information on the returning stocks of adult salmon, especially in the absence of other catchment-specific tools such as fish counters, there are limitations to its use (Solomon and Potter, 1992). These limitations include the lack of data recording how the effort, skills and habits of anglers have changed over recent years; the introduction of catch and release; and the number of unreported catches; all of which will affect the accuracy of estimates of abundance.

Three main sources of rod catch information have been considered on different spatial scales from the national to the local. They include:

- Data for the whole Dee catchment submitted as statutory returns by proprietors to the Scottish Executive;
- Data localised to sections of the river as submitted voluntarily by certain proprietors to the Dee Salmon Fishing Improvement Association and
- Data derived directly from the game book records of a number of beats on the river.

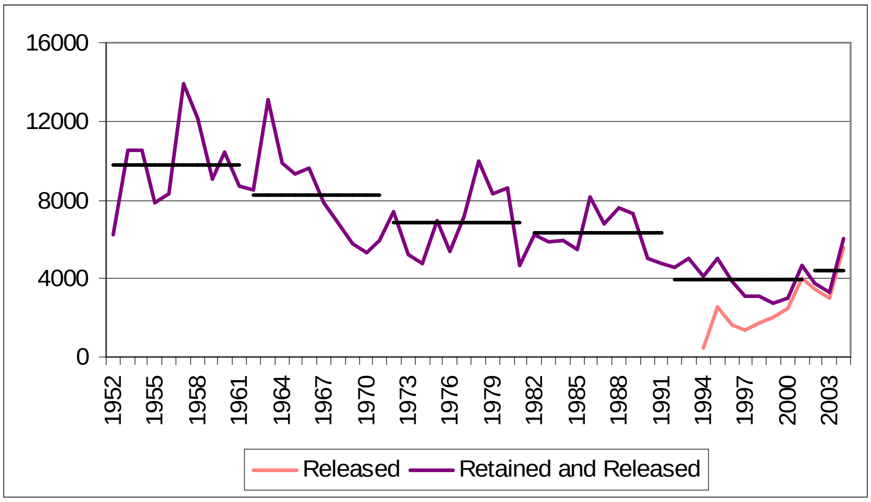
Ultimately all of this information has come from the same source, the angler, but variations in the way the records have subsequently been compiled or amalgamated make them useful for different purposes, depending upon the level of inquiry intended.

The fourth main source of catch data used in this section is from the now defunct Raik and Stell sea fishery, a fixed engine fishery conducted along Aberdeen beach (Section 2.3.2).

2.2 ROD CATCH DATA

The analysis of the rod catch information has illustrated a number of changes in all parts of the fish population available to the rods. Figure 2.1 shows that the total number of salmon and grilse caught by rod and line declared to the Scottish Executive has declined since the 1950s, in contrast to the increase noted in the Scottish rod catch as a whole (Anon, 2005a; data not included).

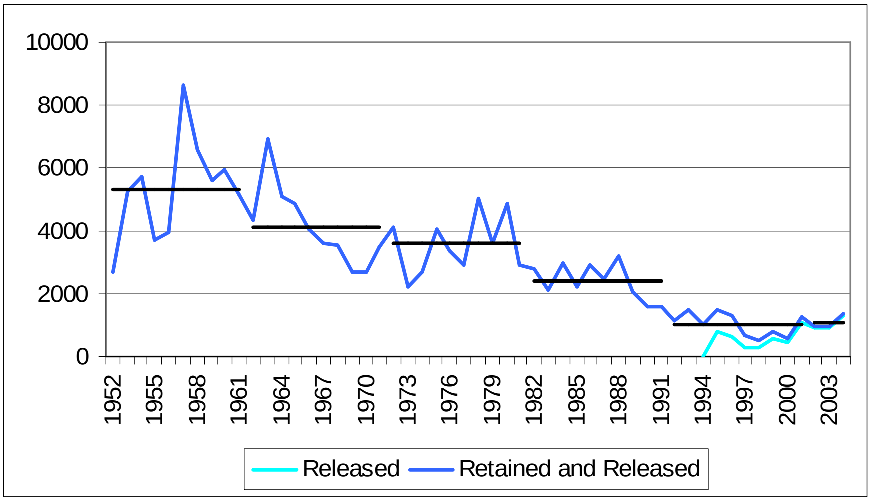
Figure 2.1. Annual declared rod catch for the River Dee: Salmon and Grilse.



Horizontal bars indicate ten-year average catches.

Figure 2.2 reveals how the annual rod catch of MSW salmon declared to the Scottish Executive has decreased in the period since 1952. On a monthly basis these catch submissions confirm that all of the spring months February to April have been affected (data not included). Information from the individual beats examined confirmed that all areas of the catchment have been affected (data not included). The rates of decrease have varied with month and river position, and the decline in the earlier months' catches has continued until more recently in the lower parts of the catchment. Since the mid-1990s spring salmon catches are showing signs of stabilising or a small recovery across the spring months (Figure 2.2). The upper river beats have continued to delay the season's start until the 1st March, and the February catches for the river reflect this. The small increase in catches in recent years has coincided with the widespread introduction of catch and release on the Dee, although it may not be possible to conclusively link the improvement to this policy alone.

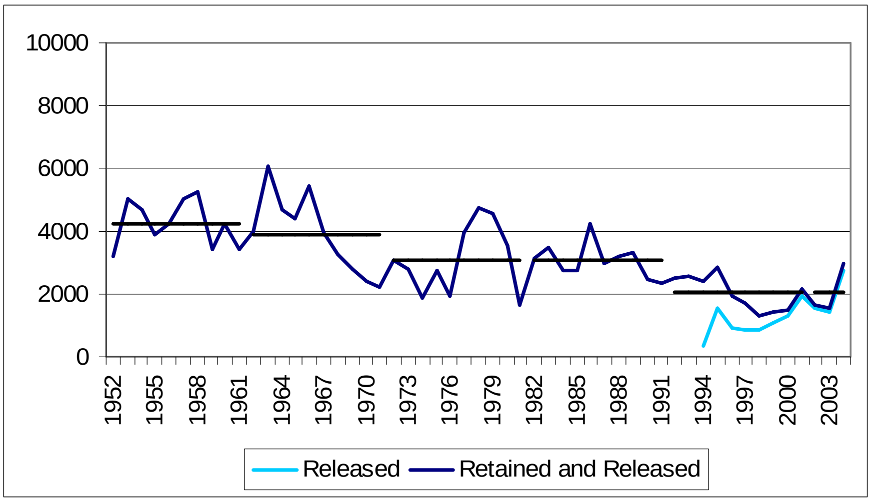
Figure 2.2. Annual declared rod catch for the River Dee: Spring salmon (Feb-Apr inclusive).



Horizontal bars indicate ten-year average catches.

The annual rod catch of summer / autumn MSW salmon declared to the Scottish Executive also illustrates a declining rod catch, albeit one falling at a slower rate (Figure 2.3). The monthly declared catches confirm May's catches, classed by the Executive as a summer month but often regarded as the end of the spring run, as the most affected (data not included). June and July's catches show shallower declines, August has remained fairly stable, and September catches of MSW salmon have risen. The catches from a small number of individual beats show apparent differences in the rates the river sections have been subject to the May declines; upper and middle river beat catches held up for a longer period than the lower beats. Conversely they show the lower beats are responsible for more of the September MSW salmon catch.

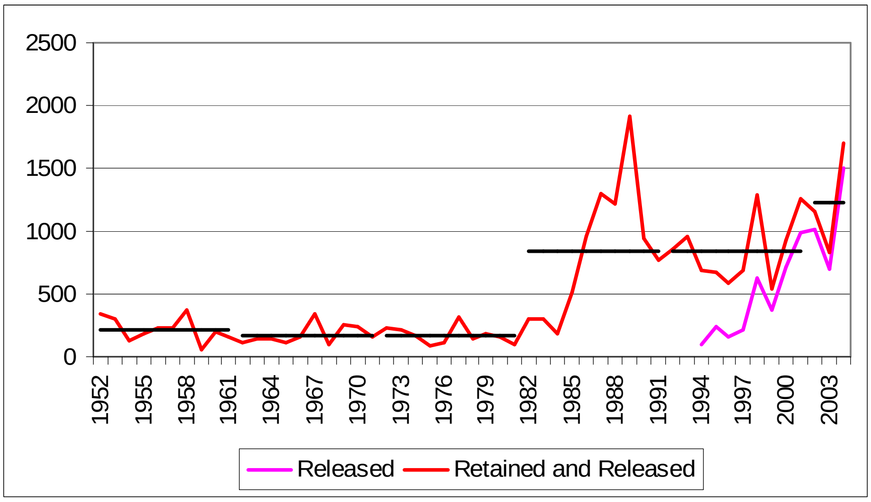
Figure 2.3. Annual declared rod catch for the River Dee: Summer / Autumn salmon.



Horizontal bars indicate ten-year average catches.

The annual declared rod catch confirms an increase in the numbers of grilse caught since the mid-1980s (Figure 2.4). The monthly declared rod catch shows that the grilse catch is increasing for all the months June to September, but as a percentage of the year's grilse catch the proportion caught in September is becoming more important (data not included). Separation of grilse from MSW salmon may not be totally accurate as scale data for the catchment is not exhaustive and there remains the possibility of "grilse error" as mentioned in Section 1.3, but it seems that catches of both grilse and MSW salmon are increasing at the end of the fishing season.

Figure 2.4. Annual declared rod catch for the River Dee: Grilse.

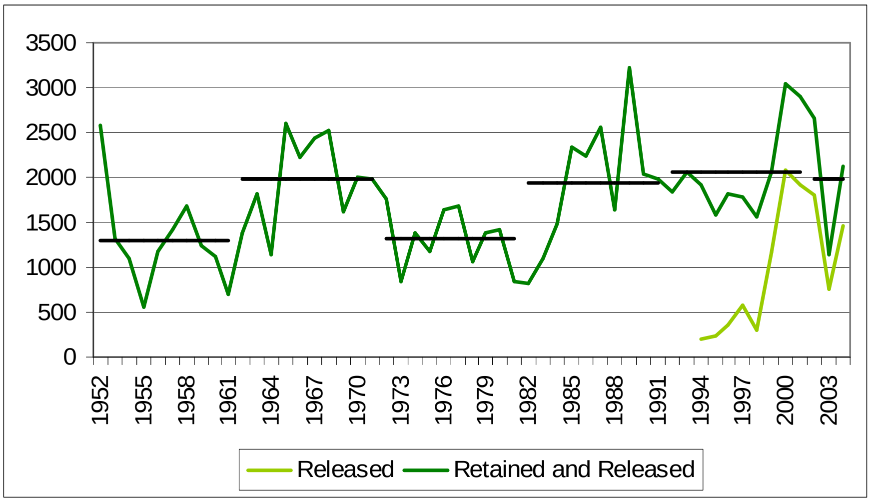


Horizontal bars indicate ten-year average catches.

Catch data from the individual beats examined shows the grilse numbers are increasing from June onwards in the middle beats. For the lower river beats grilse numbers are increasing from July onwards, but especially in September. The DSFIA figures, covering more beats but combined for MSW salmon and grilse, showed that during the 1990s the increases in the grilse and MSW salmon catches in the latter part of the year somewhat stabilised the overall catches of the combined lower river beats against the decline seen earlier in the season (data not included).

The annual declared catches of sea trout for the Dee as a whole have shown a steadily increasing trend since 1952 (Figure 2.5), with this predominantly being due to an increasing June catch (data not included). The detailed rod catches from a small number of individual beats did not highlight any significant trends in their yearly catch totals. There was large variation in the total catches from year to year, but the upwards trend of the June catches was common to all parts of the river (data not included). Comparisons between the Scottish Executive totals and the beats which submitted data to the DSFIA inferred that a large proportion of the sea trout caught in the last fifteen years had been caught in the lower river (data not included).

Figure 2.5. Annual declared rod catch for the River Dee: Sea Trout.



Horizontal bars indicate ten-year average catches.

2.2.1 DISCUSSION

In general, MSW salmon yearly catches on the River Dee are now stable or showing signs of improvement. Numbers reported remain far fewer than in earlier years. Grilse catches are continuing to rise each year and now make a considerable contribution to the year's salmon total. Catches of both MSW salmon and grilse have been increasing in the latter part of the fishing season. Sea trout catches appear to have been highly variable over the periods examined but generally stable.

2.2.2 FISHING EFFORT

From the examination of the game books from individual beats there were indications that fishing effort throughout the year has changed during the period under examination. The reasons for this are complex and will vary from beat to beat but include changes in access to the fishings and changes in angler perception of the state of the fishery. Changes in angling effort can therefore complicate the interpretation of the relationship between the rod catch and the actual abundance of fish present (Shelton, 2002).

Attempts have been made from time to time to record fishing effort on the Dee but without sufficient regularity for them to be analysed here. It would have been possible to extract some information from the game books, but generally just in terms of the number of rods which caught fish on days when catches were recorded. Records of the number of anglers are rarely made on days when nothing is caught, or of the number of unsuccessful rods in a party, or their relative experience. Similarly the length of time actually spent fishing is rarely included.

As a consequence no attempt has been made in this study to take account of changes in angling effort and its relationship with changes in the rod catch.

2.2.3 RELATIONSHIP BETWEEN FLOW AND ROD CATCH

A number of studies have shown that environmental conditions such as flow and temperature affect the rod catch of salmon (Alabaster, 1970; Alabaster, 1990). Considering the effect of flow on the rod catch could provide important information on whether a particularly poor year was a symptom of the conditions encountered during the fishing season.

In all, the relationship between rod catch and river flow is complex. Flow influences the migration of fish into the river and their subsequent distribution through the catchment (Laughton, 1991). It affects their activity and coincidentally their catchability, which varies between salmon which enter at different times of the year and which declines with the increasing time spent in freshwater. Due to this complexity it was deemed outside the scope of this stock component assessment to attempt to relate river flow conditions to the rod catch.

2.3 NET CATCH DATA

The data presented so far has shown there may be changes in the relative abundance of different components of the salmon run available to the rods. Until netting in the area of the Dee catchment stopped towards the end of the 1990s, the catches being taken by the rods represented only a portion of the salmon and sea trout being taken in the vicinity of the Dee.

To illustrate this, between 1952 and 1959 the declared catch from the net and coble and fixed engine fisheries in the Dee district averaged 40,449 salmon and grilse, and 17,381 sea trout per year compared to 9,836 and 1,388 respectively for the retained rod catch (FRS, Statistical Bulletin data, Anon., 2005a).

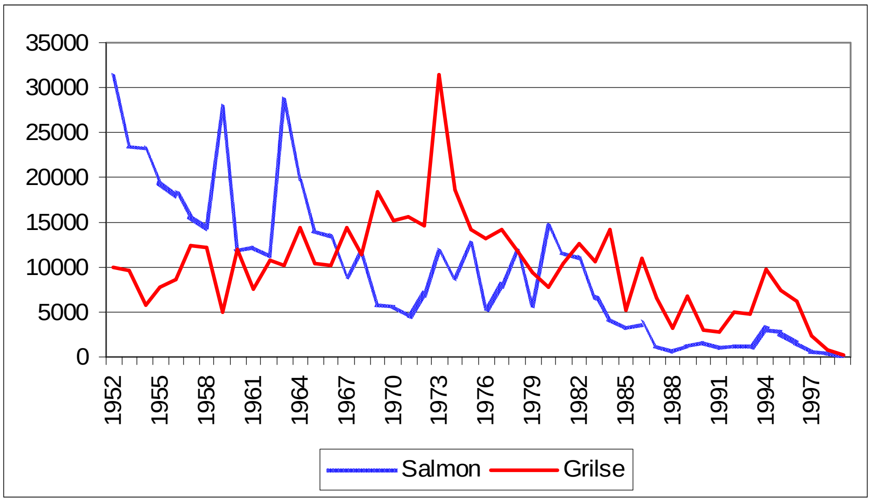
Two main sources exist for the net catch data; the declared returns made to the Scottish Executive from 1952 as presented in the annual Statistical Bulletin and the records of the licence holders for the individual netting stations. The Scottish Executive data represents the total net catches made in the period since 1952, but individual netting stations have been in operation much longer than this. Detailed records of the Raik sea fishery were compiled from the Aberdeen Harbour Board's archives by Dr. David Summers for a different study (Summers, 1995) and have kindly been made available for use here. Monthly figures for all the net fisheries in the Dee district could not be made available through the FRS for reasons of commercial confidentiality.

2.3.1 WHOLE NET FISHERY

The historical data from the Scottish Executive shows the catches of MSW salmon, grilse and sea trout made by the whole of the net fishery in the Dee district. Net and coble operations in the River Dee and its estuary ceased in 1986, whilst the last of the fixed engine fisheries on the Dee district coastline stopped in 1999 (Anon., 2005a).

Figure 2.6 shows the total declared catches of MSW salmon and grilse made by the combined net fisheries from 1952 until netting ceased in 1999. Initially MSW salmon dominated the catch but, except for two years of exceptional catches in 1959 and 1963, decreased steadily throughout the time series. Catches also dipped at the start of the 1970s. In contrast grilse numbers rose during the first twenty years of the recorded catches, peaking at 31,000 fish in 1973 before declining for the rest of the time series. It should be noted that the catches are not a true reflection of netting effort which was gradually curtailed from the 1960s onwards.

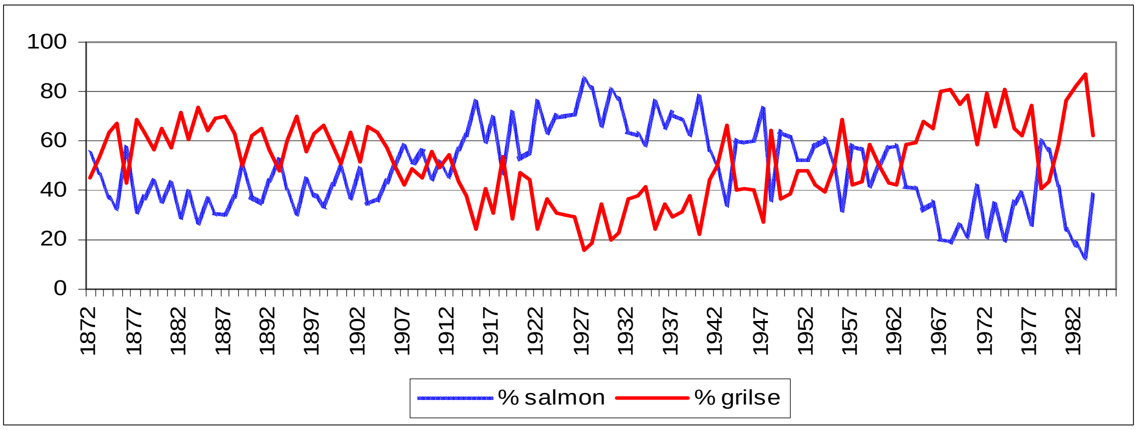
Figure 2.6. Declared net fishery catches of salmon and grilse.



2.3.2 RAIK SEA FISHERY

The Raik and Stell sea fishery was in operation until 1986. It was a fixed engine fishery consisting of bag nets at the mouth of the River Dee and stake nets in Aberdeen Bay extending north to around where the Beach Ballroom currently stands. Until 1910 and again after 1960 grilse dominated the catch; between 1910 and 1960 MSW salmon were dominant. Figure 2.7 illustrates this as the relative proportion of salmon to grilse in the catch. Summers (1995) reported similar, positively correlating, trends in the net catches from the rivers Don, Spey and Tweed. Sea trout catches were relatively stable between 1872 and 1930, after which they steadily rose until the 1980s and the run-up to the closure of the fishery (data not included).

Figure 2.7. Relative abundance of MSW salmon to grilse from the same smolt year in the Raik sea fishery catches.



2.3.3 DISCUSSION

As mentioned above the salmon catch from the nets is not a direct reflection of the effort expended. The catches in recent years were accompanied by large reductions in the netting effort as netting stations became less viable in the face of competition from salmon farming and more netting stations were purchased by angling interests.

It was expected that the removal of the remaining nets from the Dee and most surrounding districts would increase the numbers of fish available to the rod fishery. Net fisheries do still remain on the North and South Esk coasts and further afield. In practice, the expected benefits did not take place. It would seem that reductions in the numbers of returning salmon, perhaps as a result of a decline in marine survival, counteracted any gain.

The catches from the Raik sea fishery reveal different periods of MSW salmon and grilse dominance, as have been reported elsewhere for the Dee and other Scottish rivers (Summers, 1995). Netting by this fishery ceased in 1986 during a period of grilse dominance. The increase in grilse rod catches since the 1980s supports this. During the periods of grilse dominance catches of both grilse and MSW salmon catches in the later months of the year represent a larger proportion of the overall Raik fishery catch. The long-term dataset from the Raik fishery showed that sea trout catches by the nets rose around 1930 and that the runs have apparently become a little earlier.

Conjecture has been made about the influence sea temperature in the North Atlantic has on the sea-age of returning salmon and their time of return with suggestions that lower temperatures in the North Atlantic resulted in more grilse returning, whereas warmer temperatures resulted in increases in the numbers of returning MSW salmon (Martin and Mitchell, 1985). Consistent associations are not apparent throughout all the available time series though (Summers, 1995). Sea temperature effects may occur through affecting the early survival of post-smolts in the North Sea (Freidland *et al*., 2000) and the distribution of food species available to salmon once they reach the North Atlantic (Beaugrand and Reid, 2003).

3 ANALYSIS OF COUNTER DATA

3.1 INTRODUCTION

Automatic fish counters provide an important means of monitoring the total numbers of fish returning to a river rather than just those that are caught. They allow estimates to be made of the numbers of potential spawning fish available each year.

There have been four fish counters in operation on the River Dee. The furthest downstream of these was the Whitley counter at Waterside, approximately 5.4 km from the mouth of the Dee and 0.83 km from the tidal limit (Smith *et al.*, 1997). Two counters are operated by the Middle Dee Project (MDP), one each on the Burn of Canny and the Burn of Cattie, which join the River Dee approximately 2 ¾ and 8 ¾ km upstream of Banchory respectively. The Burn of Canny counter is commonly known as the Beltie counter after the Beltie Burn which forms the headwaters of the Canny. The fourth counter is operated by the DDSFB in the upper part of the catchment. It is on the Feardar Burn which joins the River Dee approximately 3 ½ km upstream of the bridge at Crathie. The Beltie, Cattie and Feardar counters are all Vaki Riverwatcher optical counters using Vaki infra red sensor and detector units.

3.2 WHITLEY COUNTER

The Whitley counter was installed in 1992 at Waterside, near Banchory-Devenick and comprises an automatic resistivity counter mounted on an eight-channel compound Crump weir spanning the river (Smith *et al.,* 1997). The electrode arrays were connected to two four-channel Aquantic "Logie 2100A" fish counters set to record fish above a threshold size of 50cm (Smith, 1994).

Operation of the counter began in August 1992. Technical problems were encountered in 1993 when various electrodes became detached. In 1994, when comparisons were made between the number of ascending fish recorded and the number subsequently entering the Girnock trap, it appeared the counter had considerably underestimated the numbers of fish (Dunkley, 1995). Radio-tagging studies showed the weir itself did not significantly affect fish movement and salmon tended to move when spates allowed following dry spells (Smith, 1994; Smith *et al.*, 1997).

Further investigation by FRS Montrose revealed that fish could pass unrecognised through the low, central counter channels in flows as low as $10m^3s^{-1}$ and past the higher outer channels in flows above $50m^3s^{-1}$ (MacLean and Simpson, 1996). Over the period 1973 – 1983 the daily mean flow was calculated to equal or exceed $10m^3s^{-1}$ 90 % of the time, and to equal or exceed $50m^3s^{-1}$ 20% of the time (Warren, 1985), showing these flow levels are not uncommon.

Consequently, although the counts generated could be viewed as a representation of the absolute minimum number of upstream moving fish, the scope for error is extremely large. Currently the structure of the weir has become so degraded as to be potentially hazardous and the DDSFB is examining options for its removal.

3.3 BELTIE COUNTER

The Beltie's Vaki fish counter is located on the Burn of Canny approximately 450m from the confluence with the Dee. It has been in operation since 1998, but with increased reliability since 2001 (A. Thomson, pers. comm.) and was subjected to video validation of the counts in 2003.

The following are preliminary observations based on the processed upstream data supplied by the Middle Dee Project. Downstream moving fish do not register as reliably as they pass through the counter and so downstream movement data have not been used here. A detailed analysis of the raw counter data is being carried out by Swansea University for the MDP.

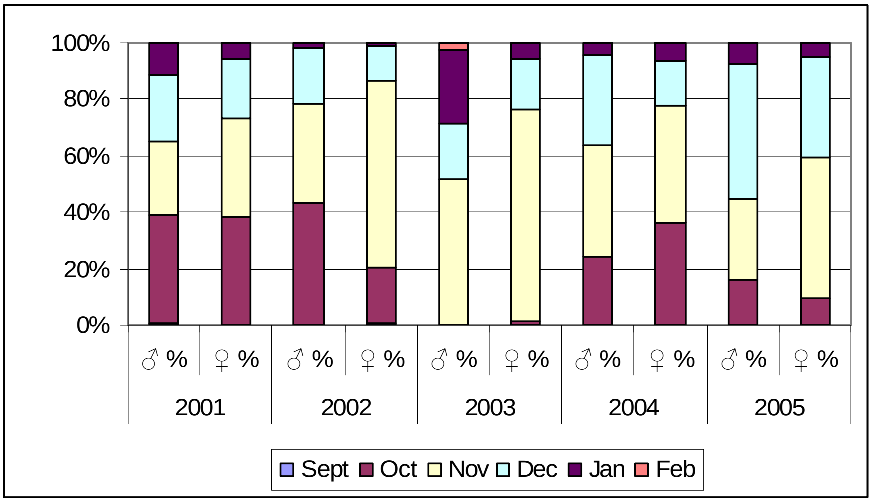
The numbers of fish thought to be salmon moving through the counter encompasses both grilse and MSW salmon. There is currently no reliable way to distinguish between the two. There is an increasing trend to the total numbers of salmon passing upstream over the counter over the seven year period (data not included).

Examining the ratio of male to female salmon over the last five years of counter operation it becomes apparent that there is a large imbalance between the sexes, with male salmon being more numerous (data not included). Some of this bias towards male salmon could be accounted for by the same fish repeatedly swimming upstream and registering in the upstream counts, but bypassing or failing to register in the downstream counts. Male salmon have been observed making such exploratory migrations prior to spawning on the Dee.

Examining only the numbers of females removes any erroneous counts resulting from the males and gives an idea of the available spawning population. The numbers of female salmon over the five years from 2001 does not show a significant trend (data not included).

Figure 3.1 shows the proportion of each year's run of male salmon and of female salmon registered by the counter each month. The proportions moving each month are very variable from year to year, but in each year a slightly larger proportion of the female salmon than of the male salmon have ascended by the end of November. It is possible that some of the later moving males had moved into the Canny once spawning opportunities in the main stem had been exhausted, but there does not appear to be any consistent trends. Movement of salmon over the Beltie counter was seen to be closely associated with changes in the water height, and not necessarily the peak flow levels (data not included).

Figure 3.1. ***Percentage of each sex's salmon run ascending the Beltie counter each month.***



3.4 CATTIE COUNTER

The Cattie's Vaki fish counter is located on the Burn of Cattie approximately 500m from the confluence with the Dee. It has also been in operation since 1998, was repositioned in 1999, with improved accuracy since 2001 over the initial period (A. Thomson, pers. comm.). The counter has not been video validated but has had routine testing of the signal using towed fish. The counts used here have been processed by the MDP and will be scrutinised by Swansea University.

Similarly to the Beltie counter, the total numbers of fish thought to be salmon migrating upstream over the Cattie counter showed a statistically significant increasing trend. Again, when confined to those thought to be females, there was no significant trend to the numbers (data not included).

Figure 3.2. ***Percentage of each sex's salmon run ascending the Cattie counter each month.***

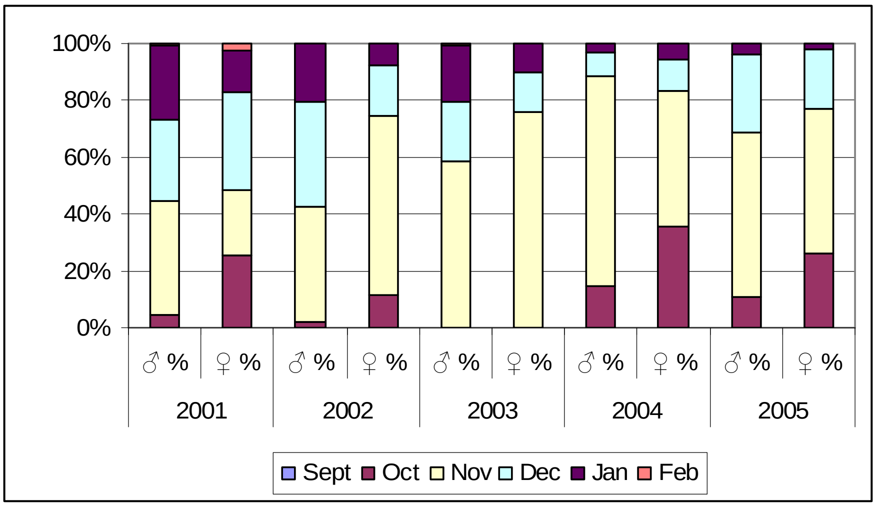


Figure 3.2 shows the percentage of each year's run of male salmon and of female salmon ascending the Cattie counter each month. The proportion of the run ascending during any one month has been variable. In most years it would appear that more of the female salmon tend to ascend the Cattie earlier than the male salmon as the proportion of the female run counted by the end of any one month generally exceeds the proportion of the male run. However it is not known whether there are males making repeat crossings or late entrants coming from the main stem spawning grounds.

3.5 FEARDAR COUNTER

The Feardar fish counter operated by the DDSFB is also a Vaki Riverwatcher optical counter, situated within a fish pass approximately 700m above the confluence with the River Dee. It has been in operation since 2001 without additional validation other than routine towed fish trials. The counter settings have been calibrated against the length and depth of fish captured for broodstock, although it is recognised there may be size overlaps between the different fish species (Hudson, 2002).

From the counter totals there does not appear to be one species of fish which dominates the Feardar Burn as the species most frequently recorded varies from year to year (data not included). There are no determinable trends to the numbers of upstream moving fish of any species if all five years are considered. If the incomplete year's data from 2002 is removed there is a statistically significant decline in the numbers of upstream moving salmon recorded. However, the current level of accuracy of the counter's operation has not been fully assessed. Fish have been observed jumping over the counter under high flow conditions avoiding detection (Hudson, 2002), but further investigations are necessary to determine how frequently this occurs.

3.6 DISCUSSION

Unfortunately the data from the Whitley counter are of little use. Previous analysis has concluded that the potential for error with the counts under even moderate flow conditions is considerable (MacLean and Simpson, 1996). The information which can be drawn from the data is that fish were recorded ascending the river in all months of the year.

For the remaining counters it is worth noting that the Vaki system was developed for use in fish ladders and passes, where water volume could be controlled. There will always be extreme spate conditions in which the volume of water in the burns monitored here exceeds what can successfully pass through the counter void, resulting in some overspill and the potential for fish to bypass the counting mechanism. Better understanding of when these conditions occur will increase the accuracy with which the fish counts and the relationship between the change in flow and fish ascent are interpreted.

Movement of salmon into the spawning tributaries coincides with, but is not necessarily triggered by, changes in the water height. In the autumn fish waiting for the correct flow conditions may be delayed, or even deterred completely, from moving into the tributaries if the increases in flow occur later than anticipated. Under such flow conditions the spawning population and spawning potential in the burn may be reduced. If the fish spawn in the main stem as an alternative their contribution to the total juvenile population will depend upon whether that area is already at its carrying capacity. If the influences on fish movement can be evaluated more accurately it will help to ensure that fish are allowed to complete their negotiation of the main stem ready to be in a position to ascend the tributaries when flows allow. In all three burns it is felt that further information on the sizes of the various fish species and further validation of the counters would increase the value of the data produced.

Preliminary analysis of the total numbers of ascending salmon on the Beltie and Cattie Burns has shown an increasing trend over the period. However, there is no determinable trend in the numbers of female salmon and a large imbalance in the population in favour of adult males. Further field investigations are required to determine if the male dominance found on both of these burns is a real phenomenon or whether the possible explanations of repeated ascents or males roaming from the main stem are correct.

Currently there are concerns as to the accuracy and completeness with which fish numbers are being recorded at the Feardar counter. Field investigations are required to determine whether flow conditions are resulting in a significant underestimation of the fish numbers. Further clarification is also required of the sizes of fish passing through the counter to help with differentiation of the species. The number of redds counted on the Feardar do not appear to have changed significantly (A. Hudson, pers. comm.) but do not by themselves provide an accurate indication of the number of spawning salmon.

The numbers of returning females need to be considered along with the amount and quality of the available habitat for juvenile fish. Existing information on the spawning gravels is not sufficiently detailed to predict if the current numbers of returning females are sufficient to fully utilise the gravels. Further evaluation for these burns is recommended to establish spawning targets.

It should be noted that all of the current facilities for monitoring returning adults are sited in the middle and upper parts of the Dee catchment. Whilst the counters are providing valuable information on the numbers of returning adults, the addition of a similar facility in the lower part of the catchment would expand the information to cover the whole of the River Dee. Consideration should be given to possible locations for such a facility and the logistics of operation.

4 ANALYSIS OF TRAP DATA

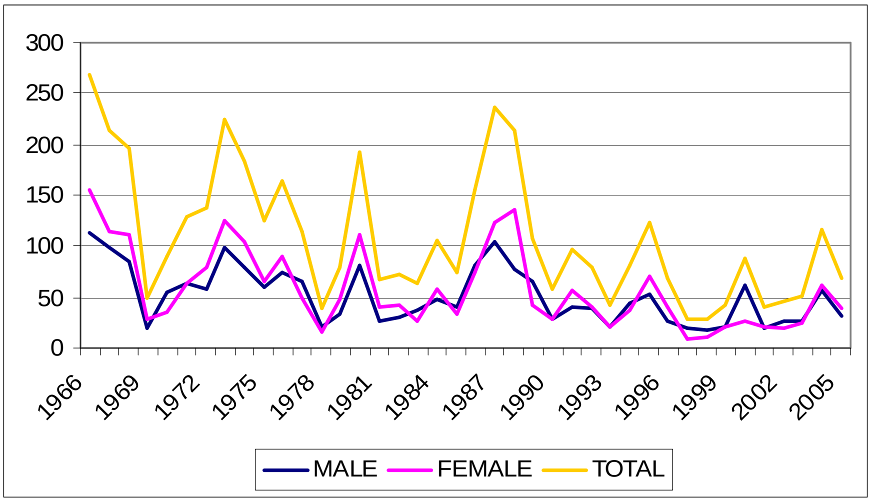
4.1 INTRODUCTION

There are two fish traps located on the River Dee, both on tributaries within the western part of the catchment. They are both operated by Fisheries Research Services who kindly provided the data used in the full Stock Component Review. The first is situated on the Girnock burn approximately 700m upstream of the confluence with the Dee (Buck and Hay, 1984), and has been operational since 1966. The second is located on the Baddoch burn, approximately 150m upstream of its confluence with the Clunie Water, and was installed in 1988. The operation of the Girnock trap is described in Buck and Hay (1984).

4.2 GIRNOCK TRAP

Figure 4.1 shows that the numbers of salmon ascending the Girnock Burn varies from year to year and that over the period of trap operation the trend has been downwards. The lowest numbers of returning adults were trapped in 1997 and 1998, a total of 29 salmon in each. Since this low point the average number of ascending salmon has risen to 65, ranging from 41 to 117.

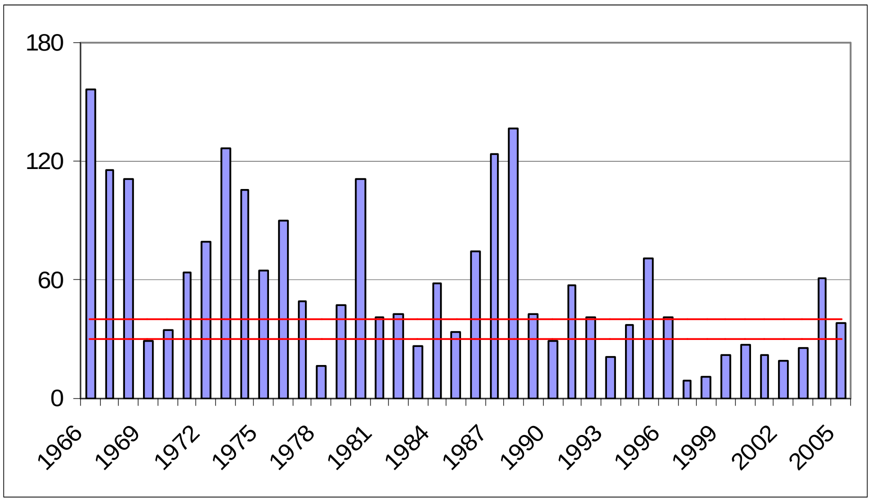
Figure 4.1. Numbers of adult salmon trapped ascending the Girnock Burn.



The ratio of male salmon to females ascending the Girnock Burn has ranged from 1:1 in 1971 and 1993, to a maximum of 2.3 males per female in 2000 and a maximum of 1.74 females per male in 1988. The female salmon are predominantly MSW salmon; the male salmon include a rising number of grilse (data not included).

Stock recruitment curves produced from the trap data on the Girnock Burn indicate that in the region of 30 – 40 spawning female salmon are required to fully stock the burn with juvenile fish (Buck and Hay, 1984; Hay, 1994). Figure 4.2 shows the number of female salmon counted ascending the Girnock Burn and the target number of spawning females. It can be seen that the number of females moving upstream through the trap fell below the target number in only 5 years prior to 1990, compared to 11 years from 1990 onwards. The run of 38 female fish in 2005 represents the second best run of female salmon since 1996.

Figure 4.2. Numbers of female adult salmon trapped ascending the Girnock Burn.



Red lines indicate the target numbers of 30-40 spawning females required to repopulate the burn.

The numbers of descending juvenile salmon has shown much greater consistency than might be expected from the declining numbers of adults. This has been in part due to accelerated growth of the progeny of eggs deposited in the year following a poor spawning year. The reduced competition for resources allowed the parr to grow more quickly, resulting in larger numbers of two-year-old emigrants. Following years when egg deposition was greater the offspring grew more slowly and more emigrated as three-year olds (data not shown).

4.3 BADDOCH TRAP

The numbers of adult salmon returning to the Baddoch burn have also shown a decline over the period of trap operation (Fig. 4.3). The lowest number of returning adults was forty recorded in 2002. The number of male salmon migrating upstream through the trap has always exceeded the number of adult females, ranging from a minimum of 1.33 males to every female in 1993, to 7 males per female in 1997. 1997, 2000 and 2002 recorded the lowest number of female salmon; nine in each year.

Figure 4.3. Numbers of adult salmon trapped ascending the Baddoch Burn.

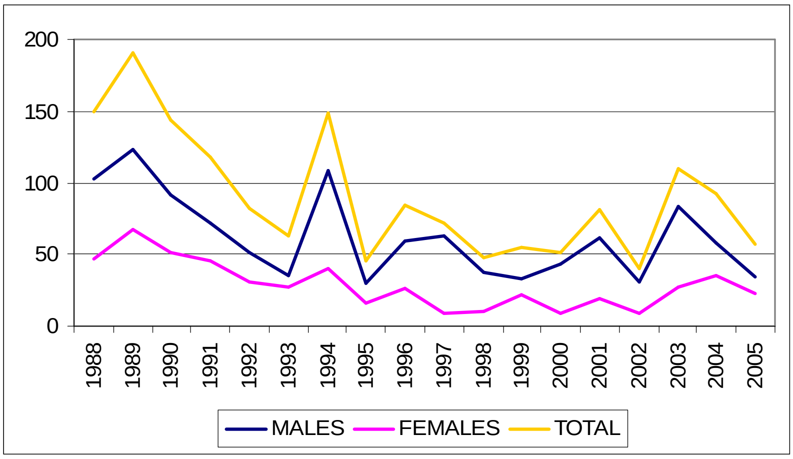
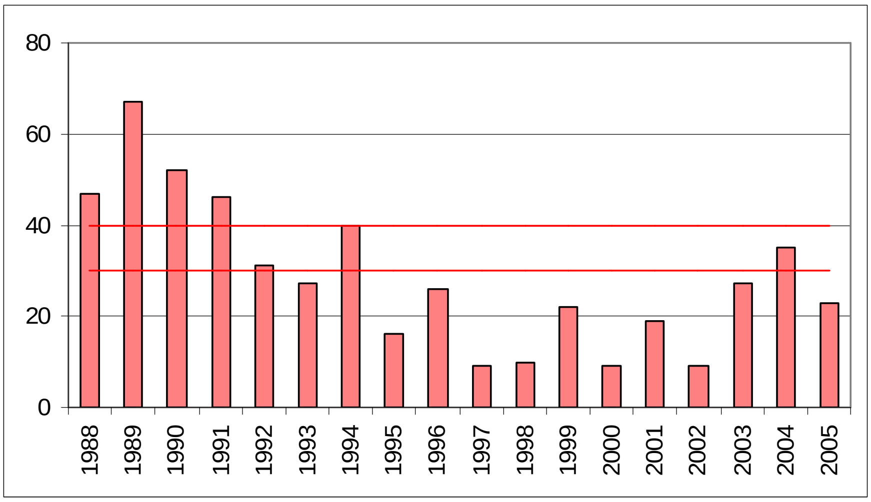


Figure 4.4. Numbers of female adult salmon trapped ascending the Baddoch Burn.



Red lines indicate the target numbers of 30-40 spawning hens required to repopulate the burn.

The target number of spawning females required to repopulate the Baddoch burn is similar to that for the Girnock, circa 30-40 females (Hay, 1994). Figure 4.4, above, illustrates that in 13 of the

18 years of operation the number of returning females has fallen below this level and has only once exceeded thirty females since 1995.

On the Baddoch burn juvenile salmon continue to emigrate mainly at three years of age and a decrease in smolt age has not been as consistently recorded as at the Girnock burn following a poor spawning year (data not included).

4.4 DISCUSSION

The numbers of adult salmon returning to the Girnock Burn have declined over the period of trap operation. In recent years they have shown a small improvement, with the numbers of females exceeding the minimum spawning target in both 2004 and 2005. Prior to this the target number had not been reached since 1996. Two-sea-winter salmon continue to form the bulk of the returning population, but the numbers of male grilse are increasing. The numbers of emigrating juveniles have remained steady, although accelerated growth rates have resulted some years in more smolting after two growing seasons in freshwater rather than three.

On the Baddoch Burn male salmon continue to outnumber females and, in all years since 1995, female numbers have fallen below the minimum spawning target. The exception was in 2004 when thirty five female salmon ascended the burn. Juvenile emigration has also remained quite steady in the Baddoch Burn, although compensation for poor spawning years through accelerated juvenile growth is less apparent.

Both facilities provide trend data for fish returning to and emigrating from tributaries in the upper part of the Dee catchment. The upper catchment is associated with spring salmon production in the Dee, as in other rivers (Hawkins and Smith, 1986; Laughton, 1989). The Dee traps intercept all salmon that attempt to ascend past them but there is the potential that the traps themselves may act as a deterrent and cause some fish to turn back, rather than ascending. Trials of a “weir-less” fish counter electrode array taking place in the burn below the Girnock trap in 1993 detected repeated ascent and descent of fish across the counter. Although this behaviour has been reported previously in Atlantic salmon (Laughton, 1991) and especially during the approach to spawning (Webb and Hawkins, 1989), the authors suggested that the presence of the Girnock trap may have hindered upstream migration under the lower than seasonal norm flow conditions encountered (Smith *et al.*, 1994). Any potential impact the traps may have upon runs into the Girnock and Baddoch Burns under such low flow conditions are unavoidable if data is to be collected.

Microtagging studies have shown that, of the adults returning to the Girnock trap between 1988 and 1990, 45% of them had previously been tagged and fin-clipped as juveniles descending through the Girnock trap (Youngson *et al.*, 1994). Youngson *et al* (1994) suggested that the remaining 55% were derived from spawnings in the Girnock Burn below the trap, or that the homing unit to which Girnock fish are returning takes in additional habitat outwith the Girnock Burn. It is not known how many tagged fish which originated above the Girnock trap return to the upper Dee without again passing through the trap, but it is reasonable to expect that some might. Peak movements through the Girnock trap are associated with the build up to, or the decrease following, peaks in river discharge (Webb and Hawkins, 1989). Flows at the time fish are waiting to enter the burns could influence whether the ascent is successful or whether salmon resort to spawning elsewhere, or not at all. It has been occasionally observed that dry autumns have impeded access to the Girnock Burn and the fish have instead been “lost” to the main river (A. Youngson, pers. comm.). FRS are currently modelling the relationship between flow and spawner entry into the burn.

Once adults have entered the spawning tributaries their subsequent distribution is also dependent on adequate flow conditions and is a key factor in determining spawning success and a good distribution of eggs throughout the length of suitable spawning habitats.

As mentioned regarding the location of counters on the Dee, information is not being gathered on stocks returning to the lower parts of the river which may be performing differently to the upper and middle river.

5 ANALYSIS OF ELECTROFISHING DATA

5.1 ELECTRIC FISHING DATA

The quantitative electric fishing of juvenile salmonids in streams less than 10m wide can provide an estimate of the population of fish occupying a given area. Comparison of the same sites over time, in terms of numbers and species composition, can also provide information on the well-being of that population.

Data has been collected on the Dee by various groups, primarily FRS and Dee DSFB, but unfortunately it has not been across the whole catchment for a statistically sufficient number of sites, or with sufficient regular visits to them all, to gain a useful insight into the health of stocks in different tributaries. Many of the DDSFB's survey sites have been chosen in order to monitor the success of specific enhancement work, for example through monitoring the introduction of hatchery-origin fry, or tracking changes in juvenile occupancy following instream habitat improvements. As such, these sites do not provide an unbiased indication of stock health.

This does not detract from the high quality of the data that has been collected, nor does it imply that the data collected so far does not answer the specific questions which the individual surveys set out to investigate. It was noted however, that the electric fishing has tended to favour high quality instream habitat which will probably be amongst the last areas to exhibit sub-optimal residence by juveniles.

Electric fishing surveys carried out previously by FRS provided important information on the distribution of juvenile salmon (throughout the Dee catchment) and juvenile trout (primarily in the lower and middle reaches), and also on growth rates in different parts of the catchment (Shackley and Donaghy, 1992). The presentation of the data as total biomasses in the report rather than fish densities made it difficult to compare the data with subsequent fishings carried out in 1994 (McLaren and Hay, 1994), in 1996 (McLaren *et al.*, 1996) and in 2005 (I.S. McLaren, pers. comm., unpublished data). Some variation in the number of sites and position of sites selected precluded further statistical analysis of these data.

It is suggested that a statistically appropriate number of sites from a wide variety of habitats are monitored on a regular basis. Over time this will give a better picture of how the various tributaries of the catchment are performing. By selecting a variety of habitat types the less favourable ones, which will be the first to go unused should there be a fall in juvenile occupancy, will be early indicators if juvenile fish numbers should decline. Conversely increased usage of poor sites could be indicative of increasing juvenile populations. Further advice is available from the Scottish Fisheries Co-ordination Centre on the number of sampling sites required for the statistical power to detect changes in the juvenile population.

6 CONCLUSIONS

6.1 SALMON

Rod catches of multi-sea-winter salmon on the River Dee have declined significantly over the last fifty or more years, as demonstrated by the Scottish Executive's Statistical Bulletin (Anon., 2005a). This has been especially true of the spring catch and has been of great importance to the fishery. The early running component of the Dee stock has meant the fishery has attracted anglers early in the season, when salmon are not available on other rivers, and has given the Dee a high profile as a leading spring fishery. Consequently reductions in the spring run have affected the fishery's reputation (Anon., 1994a). Measures to counteract the decline included the development of the Dee Salmon Action Plan and the introduction of a catch and release policy in 1995 (Anon., 1994b).

The reasons for the decline are manifold and not fully understood, but reduced survival in the marine environment through changes in the sea surface temperature (Friedland *et al*., 2000) and copepod production (Beaugrand and Reid, 2003) have recently been suggested as contributing factors, whereas netting in the West Greenland and North Faroese fisheries between the 1960s and early-1990s reduced the numbers returning to home waters (Mills, 1989). Exploitation by the local net fisheries until they ceased and by the rod fishery until the introduction of catch and release further impacted the numbers available to spawn. Localised factors such as run-off from forestry and agriculture have affected the success of spawning and juvenile survival.

Since the late-1990s small recoveries have been detected in the rod catches of both the spring and later-running MSW salmon. Catches in 2004 for the Dee district were 44% of the current long-term average spring catch and 92% of the current long-term average summer catch. At their lowest points in 1998 the spring catch was 17% of the current long-term average and the summer catch 41% of the current long-term average. Salmon returns on other rivers where catch and release is less prominent appear to be increasing, but at a lesser rate than on the Dee. From this it appears that general marine survival is improving but that the measures being taken specific to the Dee are having an additional affect. It is not possible to fully quantify the effect of the catch and release policy, but the combination of improved marine survival, enhanced freshwater survival to reach spawning, and habitat improvements on the catchment aimed at juvenile survival are all likely to be contributing to the recent increases.

Examining the MSW salmon catches more closely has shown that there are localised changes occurring in different parts of the river. The main trends that this has highlighted are:

- Across the Dee district as a whole declining rod catches have extended through all of the spring months and through May and June.
- At a level localised to different sections of the river the declines have occurred at differing rates, with recent declines being in the February and March catches in the lower parts of the river, but between April and May in the upper river beats.
- Although at levels much lower than previously, MSW salmon catches across all parts of the catchment do appear to have stabilised or improved slightly in the last five years.
- Numbers of late-running MSW salmon are increasing such that the number caught in September now accounts for approximately 20% of the year's reported MSW catch. These are predominantly caught on the lower river, as would be expected with fish coming in late in the season.
- Catches from the Raik sea fishery, which closed in 1986, indicated that the numbers of MSW being caught later in the season (June to August) were rising. This supports the rise being seen in the late season rod catch.

Catches of one-sea-winter salmon or grilse have shown a very different picture from the MSW salmon. Since the mid-1980s the numbers of grilse being caught by the rod and line fishery have increased significantly. This coincides with the removal of the last of the net and coble stations in the river estuary in 1986 which were intercepting large numbers of fish, but it also coincides with a period when the numbers of grilse being caught by the nets was surpassing the number of MSW salmon they were catching. The long-term data from the Aberdeen Harbour Board indicates an earlier period of grilse dominance in the net catches pre-1910. During these periods of grilse dominance there appears to be a tendency for more of the autumn runs of grilse and MSW salmon to be running later. Increases in the rod catches in September on the lower river seem to support this.

Efforts have been made here to separate the MSW and grilse elements of the rod catch by looking at the weight-frequency distribution of the catch, and this has shown that the September catches of both are increasing. This will not remove all instances of misclassification of large grilse as MSW salmon, but the increasing size of grilse later in the season was taken into account as the separation of the year classes was carried out. Unless much more detailed scale analysis of the catch is carried out it is unlikely that this identification can be improved upon. Consideration would have to be given to the risks of increased handling of fish as they become closer to spawning as well as the man-power required for the scale reading analysis. In addition it becomes more difficult to remove scales from male salmon as the season progresses.

Further caution should be applied to the interpretation of the increasing numbers of MSW salmon and grilse being caught at the end of the season. No systematic records are made of the angling effort being expended and so increases could be accounted for by either increased angling effort or an increase in fish abundance at the end of the season. The observations from the net fisheries' catches that autumn runs were later during times of grilse dominance would support the latter suggestion. However, anecdotal accounts from one of the lower river beats examined told that angling efforts in the second half of the fishing season had indeed increased since the mid-1970s. Increases in the end of season catch could therefore be due to a combination of both angling effort and fish abundance.

In line with the decline of spring salmon in the rod catch the numbers of early-running MSW ascending the spawning burns in the west of the catchment later in the year have declined steeply. The FRS-monitored traps on the Girnock and Baddoch Burns have recorded significant drops in the numbers of male and female 2SW salmon since they started operating in 1966 and 1988 respectively. However, slight increases in the numbers of both sexes have been observed in recent years. The numbers of females available has met the spawning target levels in the Girnock in 2004 and 2005 and in the Baddoch in 2004. Although this is a positive sign, a number of years will have to pass by before it can be seen if it is a true trend in the salmon numbers.

Fish counters further downstream in the middle section of the river have not shown any significant increase in the numbers of ascending female salmon. The Cattie and Beltie counters' data are due to be re-scrutinised but currently indicate that male salmon far outnumber female salmon in the spawning populations of these burns. Migratory behaviour of the males at spawning time requires further investigation to determine if there are many roaming, opportunistic males adding to the population using the burns. Data from the Feardar fish counter in the upper part of the catchment shows a possible decline in salmon numbers, but requires validation of the counting procedure and currently the data should be treated with caution. Target numbers of spawning females have not been established for the counter burns.

6.2 SEA TROUT

Rod catches of sea trout on the River Dee appear to more variable from year to year. The Scottish Executive recorded sea trout rod catches for the Dee district as a whole have shown a significant increase over the last fifty-two years, but over the period since the early-1980s they have stabilised and show no significant trends. The DSFIA sectional river data indicates a decrease in the middle river catches and implies, as the submissions are incomplete, that catches in the lower river have increased. Data from the individual beats selected did not show any significant trends in the catches, suggesting that there must be large variation in the sea trout catches between beats within the same river sections in order to generate the DSFIA record trends.

Some low periods in the sea trout rod catch for the whole of the Dee have coincided with increases in the numbers being intercepted by the local net fisheries, for instance in the late-1950s and early-1960s when the nets were catching 25,000 or more sea trout. Later declines in the rod catch in the 1970s were also common to the net catches, implying there was a reduction in the overall abundance of sea trout at this time. The final removal of the net and coble fishery in 1986 and of the fixed engines in 1999 have been accompanied by short term increases in the rod catches in the years immediately following. Currently sea trout rod catches are 123% of the fifty-two year long term average and 69% are now being returned to the water.

Separation of sea trout from brown trout and salmon in the data derived from the Vaki fish counters is not likely to be completely accurate due to the overlapping sizes of fish of different species (data not included). Using the current length breakpoints there are no statistically significant changes being detected in the total numbers of ascending sea trout since 2001. Two of the counters are on tributaries to the middle part of the river. Although the DSFIA collated catches showed sea trout numbers caught in the middle river have declined over the last twenty years, catches since the late-1990s have shown an improvement. Therefore, monitoring should be continued in order to determine if the spawning population does increase, or to detect the earliest signs if any problems do arise. Research and information on the sea trout populations of the Dee is sparser than that for salmon.

6.3 CATCH AND RELEASE

As mentioned above, it is not possible to evaluate fully the contribution that catch and release is having to the Dee fish populations as a whole. Too little is known about the total numbers of fish coming into the catchment and also about the exploitation rates on the different components of the Dee stocks. FRS has made some calculations for the spring-running stocks of the Girnock Burn where it is known how many adults are ascending. Based on an exploitation rate of 30%, i.e. assuming anglers catch 30% of all spring-running salmon, and knowing the percentage which Dee anglers subsequently release, FRS have estimated that in 2004 catch and release resulted in approximately 20 extra female 2SW salmon returning to spawn above the 40 that would have been the total returning in the absence of catch and release (Anon., 2005b). Comparisons have also suggested that catch and release is contributing to the Dee’s improved catches above the rate of recovery seen on other East Coast rivers through general increases in marine survival (Bradford, 2005).

Although recent catches of spring-running MSW salmon have stabilised, the data from the Girnock and Baddoch traps show the numbers of returning females have only begun to exceed the spawning targets since 2004. It would therefore not be prudent to consider relaxing the catch and release policy until the spawning targets have been consistently met for a number of years to provide a safety margin. Spawning targets for other parts of the catchment also need to be established and, for areas in which both grilse and MSW spawn, consideration should be given to the total number of eggs being deposited from both age groups as the dynamics between the two components are not understood.

6.4 GRILSE AND MSW SALMON NUMBERS

The data from the Aberdeen Harbour Board nets indicated that net catches of salmon since 1960 have been dominated by grilse, in common with other east coast rivers (Summers, 1995). The surge in the grilse rod catch since the 1970s, and the increases in grilse and MSW salmon catches late in the fishing season support this. The similarity between the different rivers would indicate that factors in the marine phase common to the emigrants from these rivers, rather than freshwater influences, are likely to be causal. The net data have also shown that the period between 1910 and 1960 was dominated by MSW salmon. However the conditions responsible for the switch between grilse dominance and MSW salmon dominance are not known. Correlations between sea surface temperatures and salmon sea-age or the timing of grilse return have only illustrated that causal relationships can not be deduced and that the effects of the marine environment are likely to be complex (Summers, 1995). Heddell-Cowie (2003) also found for the Tweed's net catches that there were only weak relationships between the marine thermal habitat, as represented by the sea surface temperature and the sea ice coverage of the North Western Atlantic Ocean, and the catches of grilse and MSW salmon. Their influences on salmon survival and subsequent capture are therefore likely to be general in effect. Possible means of effect are through initial post-smolt growth (Friedland *et al*., 2000) or through temperature affecting the abundance and distribution of food species (Beaugrand and Reid, 2003). Without understanding the conditions affecting the shift from grilse to MSW salmon dominance, there is no way to predict when or if such a change could occur again in the future.

6.5 AUTUMN CATCHES

Rod catches of grilse and MSW salmon have been increasing late in the fishing season, primarily in September on the lower river beats. Consideration has been given in the past to reducing fishing pressure on the spring run of fish by delaying the season start, such as was introduced between 1995 and 2000, and instead making a compensatory extension at the end of the season. Prior to 1949 the fishing season on the Dee extended into October.

Investigations in 1996 and 2004 carried out experimental fishing in the first two weeks of October on four lower river beats (Smith *et al*., 1998; Hudson, 2004). Freshly run grilse and MSW made up 28% and 32% of the rod catches made during these two periods respectively. Radio tracking of 21 of the salmon caught in October 1996 (19 grilse and 2 MSW) showed that 12 of them (57%) remained in the lower 35km of the river during the spawning period; the furthest upstream that spawning was thought to occur was 70km from the sea. The general trend was for fish from the further upstream tagging sites to penetrate higher up into the catchment.

If the end of the fishing season is to be reviewed in light of the current increase in September catches there are a number of considerations to be taken into account. Redd counts have shown that lower river spawning begins early in November and carries on into early January (Webb and McLay, 1996). In October fish are becoming increasingly ready to spawn and care should be taken when handling them. Radio tracking showed that some of the late-running salmon do still travel quite a distance up into the catchment, or may also have to negotiate the tributaries (Smith *et al*., 1998). Any change in the close date should be made allowing leeway for fish to finish their migration ready for spawning, bearing in mind that flow conditions may not be immediately ideal.

Monitoring of the lower river populations, possibly through a tributary counter or trap facility for returning adults, and through a thorough programme of juvenile surveys, will be necessary to establish the current situation regarding spawning targets and juvenile occupancy and to track any changes. If numbers were thought to be declining any alteration to the season close date could be reconsidered or reversed. The policies of the Dee Conservation Code should remain in operation to the end of the season. As mentioned above the factors affecting the current grilse dominance in the salmon population are not known. Pre-fishery abundance trends for Scotland as a whole indicate a decreasing availability of salmon in September and October, although the performance of different rivers may vary (Anon., 2003).

6.6 FUTURE DATA REQUIREMENTS

The current study has established that it is valuable to examine rod catch data on a closer scale than that published in the Scottish Executive's yearly Statistical Bulletin. Efforts should be made to request the monthly figures from FRS Montrose each year after the Bulletin has been produced. It would be useful if the regular submissions of catch data to the DDSFB and the yearly submissions to the DSFIA could be co-ordinated to avoid proprietors having to duplicate efforts, as these will allow catch analysis of the different river sections.

Spawning targets have been established for the Girnock and Baddoch Burns allowing FRS to relate the number of females ascending the burns to the number required to repopulate the available habitat. The amount and quality of spawning and juvenile habitat available on the Beltie, Cattie and Feardar Burns where fish counters are sited should also be assessed and used to calculate spawning targets for these parts of the catchment. Consideration should be given to locating a similar facility for monitoring adults returning to a lower river tributary.

An electric fishing programme should be established with the aim of being able to detect changes in the juvenile population with statistical confidence and should encompass a range of habitat types. Advice on the sample number and frequency can be sought from the Scottish Fisheries Co-ordination Centre. Scale sampling of the juvenile population can be incorporated into this to provide data on growth rates and freshwater age classes. A comprehensive scale survey of adult fish would require wider co-operation with anglers to ensure samples were distributed across the catchment, but would need balancing against the increased man-power commitment to analyse the samples and the increased handling of the fish which it would involve.

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