6. Present status of fish and fisheries

6.1. Species distribution

Unit	Native species	Non-native species
A. Linnhe	Atlantic salmon brown trout Artic char three-spine stickleback European eel Sea, river & brook lampreys	rainbow trout pike perch roach minnow stone loach
B. Lower Lorn	Atlantic salmon brown trout Artic char three-spine stickleback European eel River & brook lampreys	Minnow rainbow trout
C. Kintyre	Atlantic salmon brown trout three-spine stickleback European eel River & brook lampreys	Minnow rainbow trout stone loach
D. Fyne	Atlantic salmon brown trout three-spine stickleback European eel River & brook lampreys	
E. South Argyll	Atlantic salmon brown trout Artic char Powan three-spine stickleback European eel. River & brook lampreys	Minnow rainbow trout
F. Isle of Mull	Atlantic salmon brown trout three-spine stickleback European eel River & brook lampreys	Minnow
G. Islay & Jura	Atlantic salmon brown trout three-spine stickleback European eel. River & brook lampreys	
H. Isle of Arran	Atlantic salmon brown trout three-spine stickleback European eel. River & brook lampreys	
Coll & Tiree	Brown trout three-spine stickleback European eel. River & brook lampreys	

6.2. Biological characteristics

Information on the biological & life history variation of native salmonid species has been collected during sampling programmes;

6.2.1. Atlantic salmon

The biological characteristics of salmon populations suggest some variation in life-strategy;

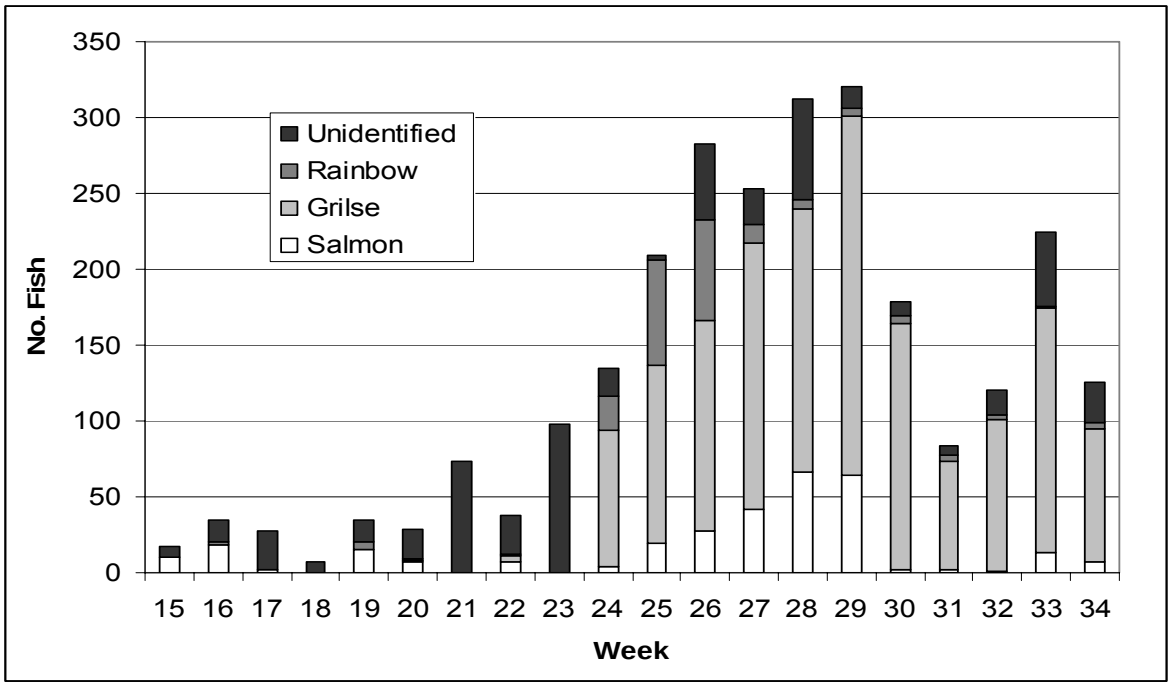
Multi sea-winter salmon

A number of priority catchments in Argyll support multi sea-winter stock components, some of which have historically returned in the early part of the year (February, March & April as 'spring salmon'. This is reflected the February opening dates for the fishing season, such as the River Awe, where until closure in the early 1900s, net fisheries operated in March. The timing of returning salmon appears to have changed over time with most salmon now returning as 'summer salmon' in May and June. Scale data indicates the vast majority of these fish are two sea-winter salmon.

One sea-winter grilse

The vast majority of salmon return to Argyll waters as one sea-winter grilse, appearing in mid-to-late June. Runs of grilse tend to peak in late July on the larger rivers. The majority of smaller rivers are reported to have late-running grilse, which enter rivers from August through October.

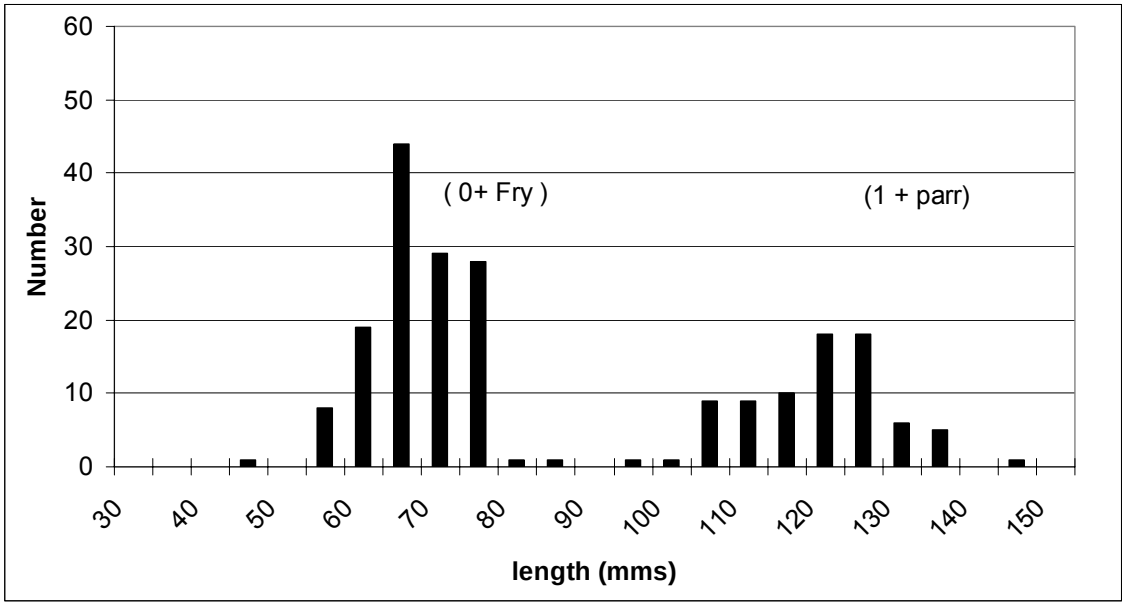
Awe barrage fish counter – stock components
(Numbers of fish identified on video each week)



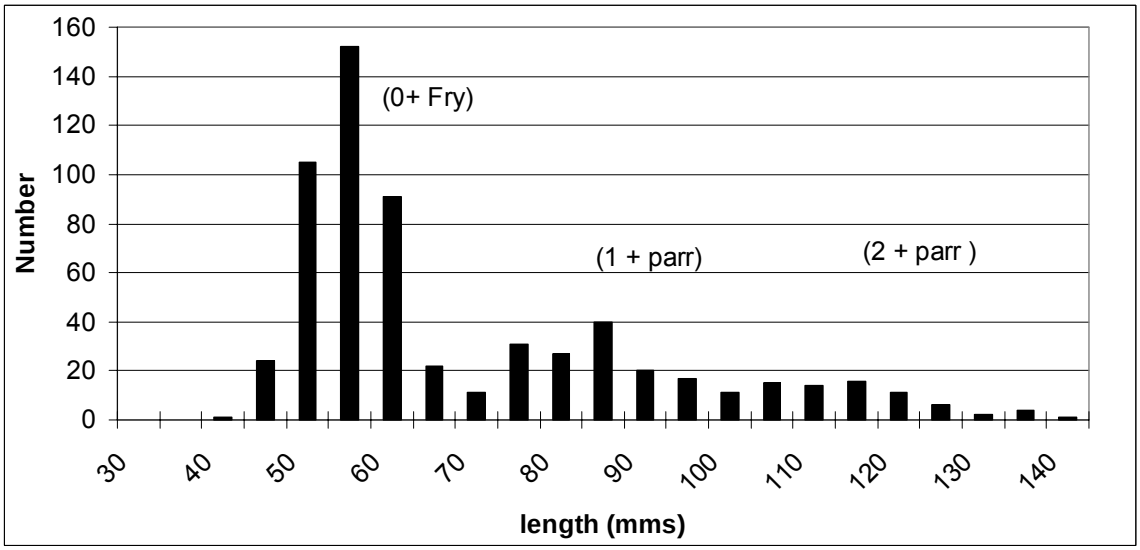
Juvenile growth

In the majority of Argyll's salmon populations consist of 0+ fry components and a smaller component of 1+ parr. There is also a small component of 2++ parr, particularly in the higher altitude sites of larger catchments. This is demonstrated by comparing length-frquency distributions of juvenile salmon sampled in the River Awe and the River Orchy;

Length-age frequency of juvenile salmon populations in the River Awe



Length-age frequency of juvenile salmon populations in the River Awe



Two age classes of salmon in the River Awe suggest that the majority of fish smolt in their second spring, while Orchy salmon have a large component of salmon that smolt in their third spring. Differences in body-shape of salmon parr have also been noted and recorded between the River Awe and River Orchy stock components.

6.2.2. Brown trout

There is a large degree of life-history variation in brown trout populations in Argyll including both resident and migratory forms;

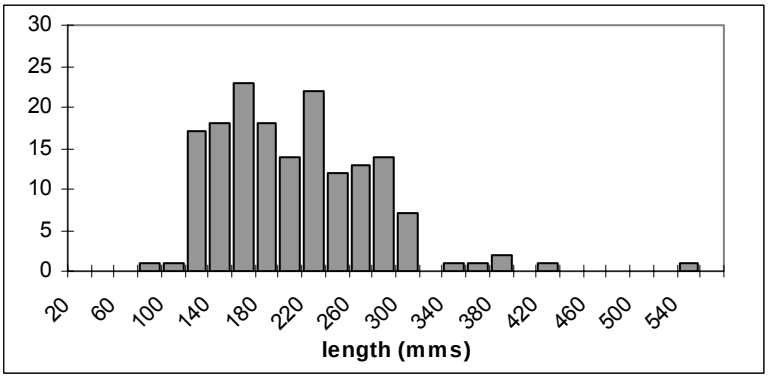
Resident brown trout

Isolated components of brown trout populations, upstream of impassable waterfalls and the upper reaches of rivers and hill lochs, are widespread. These populations are largely dominated by older parr and adults, with fewer 0+ fry. Large lochs, such as Loch Awe, brown trout have a more diverse range in life-history variation, including both 'ferox' and more typical and numerous loch trout.

Loch trout

Typically, the majority of Loch Awe brown trout migrate from nursery streams into the loch by the end of their first summer as competition for diminishing resources increases. In-loch populations mostly consist of two and three year old fish, with fewer 'ferox' trout that are longer-lived and reach much larger size. Length-frequency distribution of brown trout sampled in Loch Awe as part of a fish community study in 1997, provide an insight into the population structure;

Length-frequency distribution of brown trout in Loch Awe 1997



The largest single catch of brown trout was made at the Braevallich site in April (60 fish). Unlike perch, brown trout featured in the February samples and numbers peaked in the spring. Brown trout were infrequently encountered in the littoral zone during summer. This result illustrates the seasonal migration pattern in this species with a movement offshore in late spring into deeper water. The mean size of brown trout was found to be 195mm length (+ 5.16mm SE, range 79-522mm) and 121g weight (+ 11.8g, range 6.5-1159.8g). Large numbers of fish in the 2-4+year class were encountered (120-320mm classes) with small numbers of 1+ year old fish present in samples collected in June and August. Only 6 fish (3.5%) of the total catch of brown trout was composed of older, larger fish (>300mm).

6.2.3. Arctic charr

Of the five known Arctic char populations in Argyll, AFT has sampled four; Loch Awe, Loch Seil, Loch a' Phearsainn and Loch a' Mhinn. Variation in length-at-age is less well understood in char as no otolith analysis has been undertaken.

Loch Awe charr

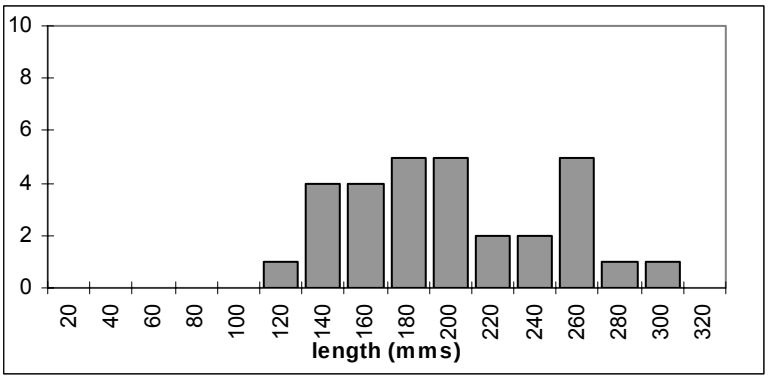
AFT has sampled charr in Loch Awe as part of a loch community study in 1997;

Loch community sampled in gill-net survey of Loch Awe 1997

Species	Total no. sampled	February (48 hrs)	April (72hrs)	June (72 hrs)	August (72 hrs)
Brown trout	170 (34%)	30	85	38	17
Rainbow trout	28 (6%)	13	11	0	4
Arctic char	33 (7%)	21	6	4	2
Atlantic salmon	8 (2%)	0	3	4	1
Perch	227 (45%)	1	25	100	101
Pike	6 (1%)	0	5	0	1
Roach	31 (6%)	16	3	0	12
TOTAL	**503 (100%)**	**81**	**138**	**146**	**138**

Charr were represented in 7% of all samples of fish collected, which is likely to be an underestimate of the actual abundance as few survey nets were deployed in deep or open-water habitats, which are preferred by charr.

Length frequency of Loch Awe charr sampled in 1997



Char were encountered at every site with the exception of Braevallich. The highest catch of char was made at the entrance to Ford Bay in February (19 fish). Examination of this sample revealed that the majority of these fish were mature and had recently spawned. The mean size of char was found to be similar to brown trout in length, at 191mm (± 8.9g SE, range 114-300mm) but lighter at 90.6g weight (± 12.0g, range14.6-243g). Fish were found to range from 2+ years old to 4+ years old. No attempt was made to distinguish between the types of char proposed to be present in Loch Awe (benthic and pelagic morphs).

On-going studies of char in Loch Awe by Glasgow University indicate that there are both spring and autumn-spawning components present. There are also both benthic and pelagic morphs. Current studies aim to investigate genetic, morphometric and life-history variation.

6.3. Stock Structuring

6.3.1. Loch Feochan - New insights for salmon management from the analysis of DNA

Species	Studies	Summary Findings
Atlantic salmon	River Nell genetic structuring (juveniles) River Euchar genetic structuring (juveniles) Loch Feochan net catches (adults)	Structured populations within and between catchments. Net catch derived from all components (FRS, 2006).

Caroline Thompson, Eric Verspoor, Fisheries Research Services, Freshwater Laboratory.
Alan Kettle-White, Argyll Fisheries Trust

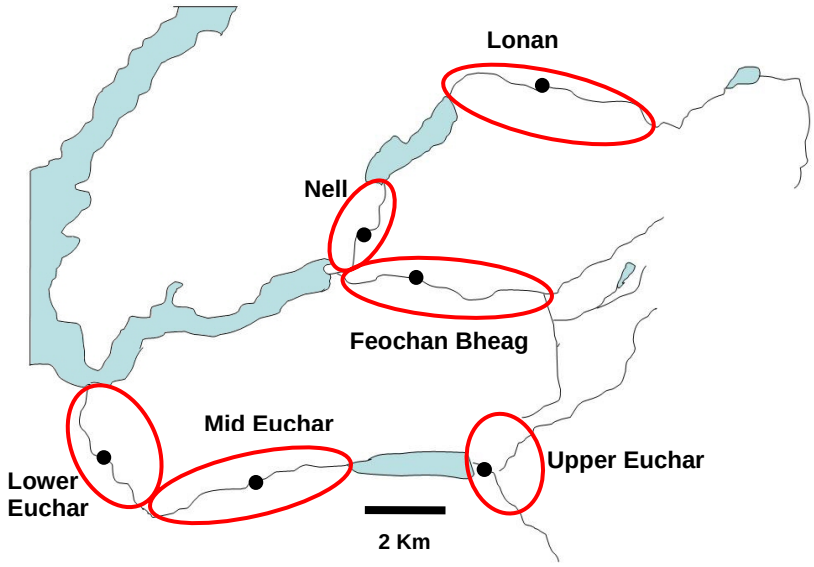
In 2006 the Atlantic Salmon Trust funded a unique, ground breaking study of the genetics of Atlantic salmon in Loch Feochan, on Scotland's West Coast near the town of Oban. The study of the small Dunach net fishery and its three rivers, the Euchar, Feochan Bheag, and Nell/ Lonan represents one of the first practical applications in Scotland of new DNA technology to answer practical management questions. The study undertook an analysis of molecular DNA variation to provide insight into the relative contributions made by the Loch's rivers to the fishery, still prosecuted annually at the head of the Loch. However, not only has the work delivered useful information for managing the fishery, it has also provided valuable new insights into the extent to which the salmon in small West Coast Scottish rivers are structured into multiple distinct breeding populations. Simultaneously, the work has provided a valuable exploration of the potential for gaining critical management information on sizes of these breeding populations and levels of fisheries exploitation. A good understanding of these two issues is crucial to the effective management of salmon stocks, providing a measure of their "health" and helping managers to set sustainable levels of exploitation.

This study builds on a steady stream of advances in molecular biology and statistical analysis, and was carried out collaboratively by the Argyll Fisheries Trust and the FRS Freshwater Laboratory in Pitlochry. It set out to answer two basic questions. The first being "*To what extent are the Atlantic salmon in the rivers around Loch Feochan organised into distinct breeding populations?*" If the rivers had different breeding populations which were sufficiently genetically differentiated at the DNA locations (loci) analysed, then it would be possible to address the second question "*From which rivers do the salmon caught in the Loch's fishery derive?*" If the answer to the first question was that the rivers had separate breeding populations, then the answer to this second question was needed to inform decisions on the most appropriate management of the exploitation of the river stocks by the fishery.

In addition to these main questions, the study set out to answer a number of secondary *questions.* These were: *Was there any evidence that some of the fish caught in the fishery were of farmed origin? Could the analysis of the genetic variation also provide reasonable estimates of the numbers of breeders in each of the populations identified? Could the estimates of numbers of breeders be used to determine the levels of exploitation of each population by the fishery?* According to recent developments in population genetics theory, the answer to these questions should be "Yes". However, what is often possible in theory turns out to be difficult to achieve in practice!

With the help of The Nell & Euchar River Improvement Association, juvenile salmon were collected in 2005 from six locations in three rivers (Figure 4), each fish was anaesthetised and a small piece of caudal fin removed, after which fish were revived and returned to the river. The fin clips were stored in coded vials with preservative and were then sent to the Freshwater Laboratory for genetic typing. Fin clips from salmon caught in the Dunach fishery in 2005 and 2006 were also collected along with their weights and lengths. DNA was

extracted from the fin clips and each fish characterised for genetic variation at 15 locations in its genome known to show differences between salmon where they derive from different populations. Altogether 411 juvenile and fishery-caught adults salmon were genetically typed.



Sampling locations and proposed structuring of the Feochan river stocks into breeding populations

After genetically typing the fish, a statistical analysis was undertaken of the differences in the frequencies of variants within and among the samples of juveniles. These differences were found to be substantial among the locations sampled, demonstrating that the juveniles collected from each of the locations belonged to discreet breeding populations. Thus it was possible to conclude from the analysis that not only did the salmon in the Loch's three rivers belong to different populations, but the salmon stock of the Euchar was composed of at least three distinct populations and the stocks of the Lonan/Nell of at least two populations. Furthermore, the division of the stocks appeared to be related to the physical division of salmon habitat in rivers associated with the presence of freshwater lochs on the Euchar and Lonan/Nell, and also a substantive but passable barrier downstream of the loch on the Euchar.

More intensive analysis of the genetic variation among individuals within the samples was also informative. The numbers of genetic variants in a sample and their patterns of association are determined by the numbers parents from which the population is derived. Statistical analysis of such genetic data for each sample can provide a range of values within which there is a 95% likelihood the number of parents which produced the population occurs. In studies of many species of freshwater fish it has been found that the actual number of parents is substantially less than the numbers of adults observed, due to the varied mating success of individuals. The estimates obtained by this analysis in the Feochan are set out in Table 1 and are in reasonable accord with the numbers that might be expected rivers the size of the three analysed, based on studies elsewhere in Scotland. Though empirical assessment of the accuracy of the estimates is needed, the results obtained strongly suggest that the genetic method may not only be possible in principle, but that it may actually be able to provide a quicker and more cost-effective way of estimating numbers of spawners than using tags or traps. Though this estimate includes mature male parr, if an adjustment is made for their contribution, the method has the potential to provide a way of estimating

spawning escapement and monitoring how it changes over time either by repeated sampling or the use of archived samples.

Estimates (with 95% confidence limits) of the numbers of breeders for the different genetic populations in the Feochan rivers.

River	Population	Number of Breeders	95% Confidence Limits
Nell / Lonan	**Nell**	118	97-148
	Lonan	43	39-48
Feochan Bheag	**Feochan Bheag**	105	87-130
Euchar	**Lower**	98	82-121
	Mid	85	75-97
	Upper	34	31-38

The genetic differences among the breeding populations in the Feochan rivers proved to be large enough to determine from which of these rivers the salmon caught in the Dunach fishery derived. Using differences in the frequencies of genetic variants it was possible to assign each of the fishery caught adults to its most probable population of origin. The probable success of this statistical method was tested by removing each juvenile from the river samples, one at a time, and blindly assigning it to its most likely population of origin. Almost three-quarters of fish were assigned to the correct river, and over 60% to the correct population within each river.

When the assignment method was applied to adult salmon from the fishery whose origins were unknown, it was found was that the majority of the fish could be confidently assigned and that, of these, most were of Euchar stock (~50% over the two years) rather than from the stocks of the more geographically proximate Nell and Feochan Bheag rivers (Table 2). This was true in both 2005 and 2006, though in 2006 the sample from the fishery was small and the estimate of the proportional stock contribution is likely to be less accurate.

Estimates of the numbers and proportions of salmon in the Dunach fishery which came from the different Feochan populations

Population	**2005** (76 salmon analysed) **Number (%)**	**2006** (25 salmon analysed) **Number (%)**
Nell	**6** (7.9)	**1** (20.0)
Lonan	**9** (11.8)	**4** (16.0)
Feochan Bheag	**15** (19.7)	**4** (16.0)
Lower Euchar	**13** (17.1)	**5** (32.0)
Mid Euchar	**23** (30.3)	**8** (4.0)
Upper Euchar	**10** (13.2)	**3** (12.0)

Interrogating the genetic character of the salmon in the fishery in more detail, no evidence was found of salmon in the fishery with genetic types which might suggest they were of farm origin. Consistent with this view, the estimated numbers of breeders which produced the fish caught in the fishery in 2005 was 337, slightly smaller than the total number of breeders estimated for all the breeding populations in the rivers (Table 1). The disparity in numbers may be because of natural year-to-year variation in the number of breeders, or that fish originated from a few smaller populations in the upper tributaries that were not sampled.

With the results of the analysis, the exploitation rates for each of the rivers entering the Loch could be estimated using the numbers of breeders indicated for each of the river stocks and the indicated numbers of fish netted from each stock in the fishery (Table 3). The estimates obtained are in the range which might be expected and suggest that the populations of the Euchar are the most exploited overall and that populations in the upper reaches of the Lonan, and Euchar are generally more impacted than downstream populations.

The proportion of the estimated numbers of breeders in each population, based on the juvenile samples collected, estimated to be taken in 2005 by the Dunach Fishery

Population	**% N_b in 2005 catch sample**
Nell	4.1 – 6.2
Lonan	18.6 – 23.0
Feochan Bheag	11.5 – 17.2
Lower Euchar	10.7 – 15.9
Mid Euchar	23.8 – 30.5
Upper Euchar	26.0 – 32.1
Σ Feochan	19.0 – 22.5

Given the novelty of this approach, before such methods can be considered for widespread application, it will be necessary to clearly establish that the estimates derived from genetic methods correlate with estimates derived from more traditional counting methods. Toward this end, the possibilities for such corroboration are being explored. However, the results obtained do clearly suggest that the genetic analysis of the DNA of salmon holds the promise of being a way for simply and cost-effectively deriving estimates of exploitation rates as well as numbers of breeders. If so, it would open the door to widespread monitoring the status of Scotland's salmon populations and estimating levels of exploitation, not only in net fisheries, but in recreational angling fisheries as well.

The Feochan study has demonstrated the potential of using the analysis of a salmon's DNA to provide information essential to effective salmon management which is difficult and costly to obtain by conventional methods. Such analyses could also be used to identify individual fish and can be used as a replacement for physical tagging in traditional mark and recapture studies to estimate the census size of a salmon stock. They can also be used to discriminate stocked and wild fish and in the future, if recent work is born out, they may even be able to identify farm fish in the wild and levels of their interbreeding with wild populations. Only a decade ago the possibility of doing these things was difficult to conceive. But as this important AST funded project illustrates, the analysis of salmon DNA provides an important source of insights which can help in the fight to save Scottish salmon stocks.

6.3.2. Brown trout

Species	Studies	Summary Findings
Brown Trout	Loch Awe (1999-2003) Loch Avich (1999)	Loch Awe & Avich populations discrete and also Ferox in Loch Awe

The Population Genetics of Scottish Brown Trout - Alistair Duguid, Queen's University of Belfast

Brown trout samples from various locations throughout the Loch Awe catchment have been analysed for genetic variation. The aims of these studies have been to examine and account for the genetic diversity within and among brown trout populations, and assess the possible effect of management proposals on this diversity.

Several interesting results have been found during the course of this study. Firstly, there is evidence from protein based studies to suggest that there is at least two races of brown trout living in Loch Awe itself. However, there is a need for further detailed sampling of the loch to confirm this, and to investigate the possibility that these genetically distinguishable trout also display ecological and morphological characteristics. This work is planned for the coming year.

Secondly, this work has shown that a high proportion of the Loch Avich brown trout population display a form of Lactate dehydrogenase which is rare in North West Europe. Previous work has shown that trout containing this protein variant are modern day representatives of an ancestral race of trout. This ancestral group was the first to colonise North West Europe, following the retreat of the ice cap at the end of the last ice age. As the ice continued retreating, the landscape changed, and some of these ancestral trout, including the Loch Avich population, became isolated above impassable falls. This protected them from genetic displacement by a second wave of colonising trout, which are characterised by a different form of Lactate dehydrogenase. Present day populations of these ancestral trout are rare, and, in terms of the conservation of genetic diversity within the brown trout species, the Loch Avich population can be considered important on a national or international scale.

Finally, samples from above and below impassable falls on the Cladich and Leiver rivers were analysed. This was done to assess the effect of isolation on the genetic differentiation between these populations, with a view to advising on proposed plans to destroy the falls, thus opening up additional habitat to Loch Awe fish for spawning and nursery grounds. The two Leiver populations were found to be surprisingly similar to one another, indicating that they may interbreed with each other occasionally. It is possible that the "impassable" falls have been passable in recent times, possibly during years with extreme spate conditions. Therefore, removal of the spawning barrier on this river would not create unnatural gene flow between two highly divergent populations.

The genetic distance between the two populations on the Cladich River showed a very different pattern though. These two populations were extremely divergent from one another. Indeed the upstream population, which had a very low level of genetic variation, was very different from any other so far examined from Scotland. However, these trout do not contain the "ancestral" Lactate dehydrogenase protein variant, and therefore do not represent a relict population. The large genetic differences are more likely to be due to a small number of unusual individuals founding this population, followed by severe inbreeding. This small founding population may have come from natural sources. However, high frequency of a Creatine kinase protein variant, which is extremely rare throughout the rest of the Awe catchment, suggests that these fish are more likely to be the descendants of artificially stocked trout. If this is the case, these trout are not a locally adapted native population and

are of low priority in conservation terms. However, more work should be carried out to clearly establish the origin of this population before the falls are removed.

6.3.3. Arctic charr

Species	Studies	Summary Findings
Arctic charr	Loch Awe net sampling (1997-8)	Identification of pelagic & benthic morphs
	Spring-spawning char identification (2000)	Ova successfully fertilized and hatched (Glasgow Uni.)
	Genetic survey 2006 (Glasgow Uni.)	Summary below

Populations structures of Arctic Charr in Loch Awe - Colin Adams, Glasgow University

The presence of spring and autumn spawning period morphs, first reported by AFT in 1999 has been confirmed by studies undertaken by Glasgow University. There are also small but significant differences in morphology between the two forms (not so obvious that you could discriminate them in the hand) but large enough to be detectable. Also the genetics analysis that has been undertaken to date has shown that on the basis of the mictochondiral DNA that here are significant but very small differences between the two morphs. Microsatelite DNA analysis is likely to demonstrate how much gene flow there is between the populations.

At present indications from the data are;
a) That the charr in Awe are pretty much pristine
b) That the two forms originally described by AFT have diverged very recently in evolutionary terms

As part of a review of the trout and charr populations of Scotland for SNH and that on the basis of the polymorphism it is likely that Awe charr will be recommended as one of the top 10 most important charr sites in Scotland.

6.4. Trends in abundance

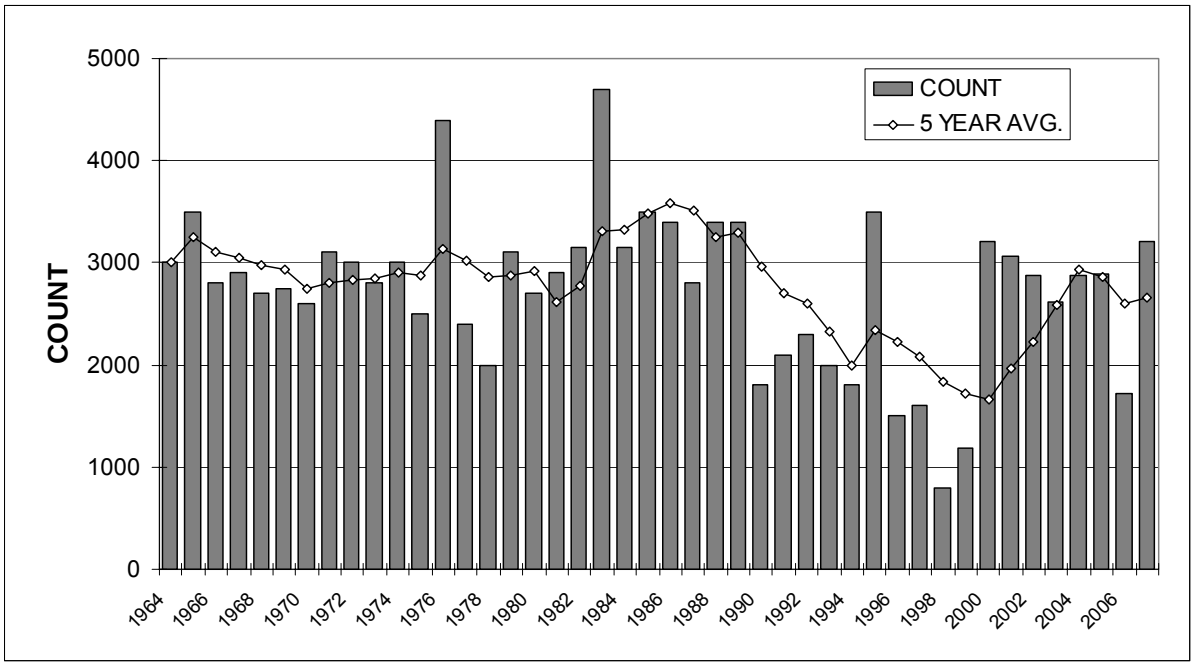
Information on the trends in abundance of salmon and trout populations has been collated by AFT to inform fishery management initiatives. The longest data-sets are established on the Awe catchment (since 1997) and the upper Loch Fyne rivers (since 1999), which are given here to assess trends in fish abundance.

6.4.1. Awe catchment

Atlantic salmon

The count data supplied by Scottish & Southern Energy Plc provide reliable information on the trends in abundance of salmon returning to the Awe catchment.

Fish counts at the Awe baggage (1964-2007)



Longer-term trends in count data indicate that after a slight increase in abundance in the 1980s, a significant decrease in counts was recorded throughout the 1990s. Similar declines are noted in other areas of Argyll in rod catch data. Stark improvements in the number of returning salmon were counted in 2000, which has remained relatively stable to date with the exception of 2006. Despite a relatively buoyant run of summer salmon in 2006, the total count (1,719) was the poorest since 1999 due to the relatively low number of grilse returning. Lower numbers of summer salmon were counted in 2007, which is probably a consequence of the poor sea survival of the same year class of fish that returned as grilse in 2006. Conversely, the grilse run in 2007 was comparatively strong with a total of 3,206 fish counted at the barrage.

Juvenile fish surveys

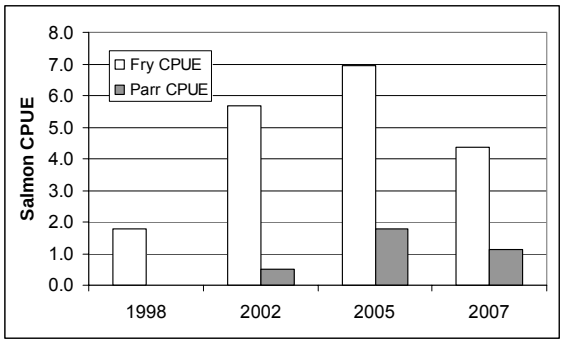
Electrofishing surveys have been conducted on the Awe catchment between 1997 and 2007 to monitor trends in fish distribution and trends in abundance. The trends in juvenile fish abundance for three main areas of the catchment of the River Awe, Loch Awe and River Orchy are described;

<u>River Awe</u>

Timed electrofishing surveys were conducted at six sites on the River Awe in October 1998, 2002, 2005 & 2007. The catch per unit effort (no. sampled per minute of sampling) data on juvenile salmon abundance sampled is compared;

Juvenile salmon abundance (1998-2007)

Year	Fry CPUE	Parr CPUE
1998	1.8	
2002	5.7	0.5
2005	6.9	1.8
2007	4.4	1.1
Change	**-0.4**	**0.0**



River Orchy

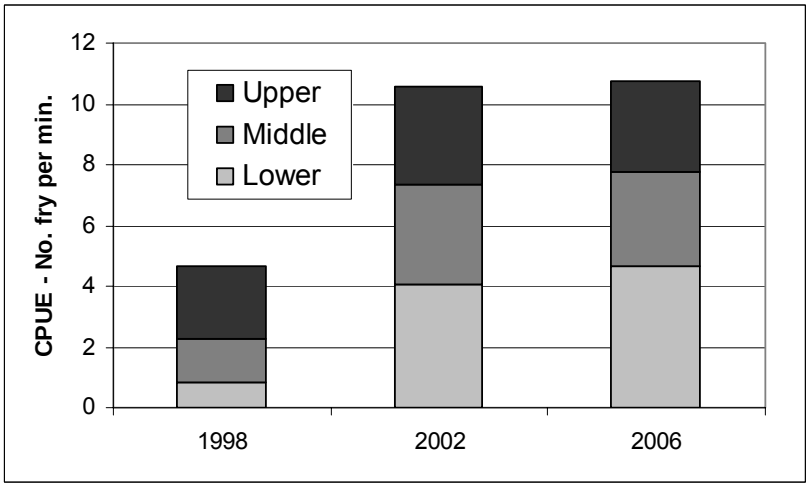
Comparisons of the numbers of salmon fry and parr sampled between the 2006 data and previous surveys;

Salmon fry

The numbers of salmon fry samples in 2006 appeared to be similar to that sampled in 2002, but remained much improved over the 1998 numbers. In 2006 there were slightly higher abundances of fry in the lower sites and slightly lower abundance in the middle and upper reaches when compared to the 2002 numbers.

CPUE of salmon fry sampled in three reaches of the River Orchy

year	Lower	Middle	Upper
1998	0.83	1.45	2.38
2002	4.08	3.23	3.27
2006	4.64	3.13	2.96
Change	**+0.56**	**-0.10**	**-0.31**

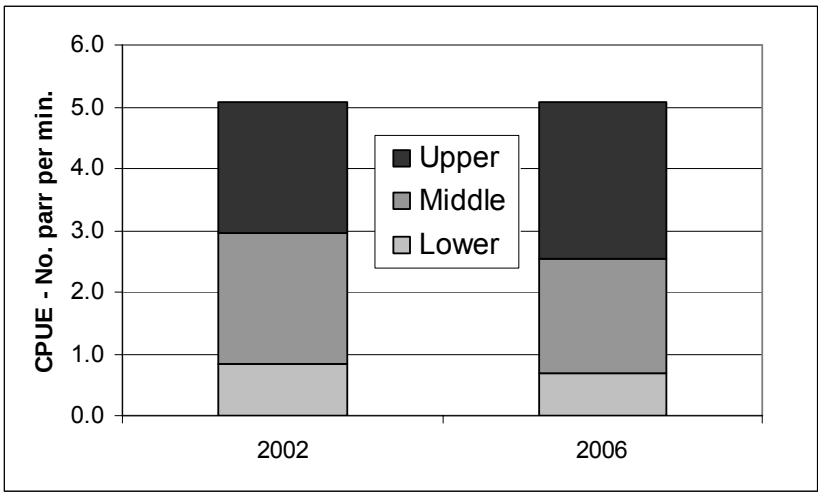


Salmon parr

The number of salmon parr sampled in the 2006 survey appeared slightly lower in the lower and middle reaches, but slightly higher in the upper reaches of the Orchy.

CPUE of salmon fry sampled in three reaches of the River Orchy

year	Lower	Middle	Upper
2002	0.9	2.1	2.1
2006	0.7	1.8	2.6
Change	**-0.2**	**-0.3**	**+0.4**



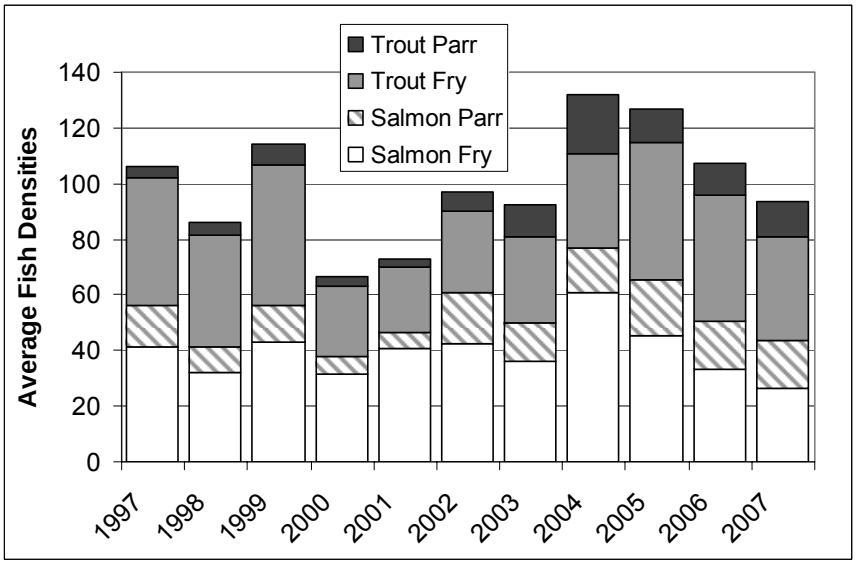
Loch Awe tributary streams

Sampling was conducted at ten survey sites around Loch Awe repeating the annual survey undertaken since 1997. Loch Awe tributary streams support juvenile salmon, but are principal habitats for juvenile brown trout. The average juvenile fish numbers sampled each year are described;

Annual Averages (1997 to 2007) - minimum juvenile fish numbers per 100m²

YEAR	Salmon Fry	Salmon Parr	Salmon Total	Trout Fry	Trout Parr	Trout Total	Site Total
1997	41	15	56	46	4	50	106
1998	32	9	41	41	4	45	86
1999	43	13	56	50	8	58	114
2000	31	6	38	25	4	29	66
2001	41	6	47	24	3	26	73
2002	42	18	61	29	7	36	97
2003	36	14	50	31	12	42	93
2004	61	16	77	34	21	55	132
2005	45	20	65	49	12	62	127
2006	33	17	50	45	12	57	107
2007	**27**	**17**	**43**	**37**	**13**	**50**	**93**
Mean	39.4	13.7	53.1	37.4	9.0	46.3	99.5

Average juvenile fish density (min. no. per 100m²) 1997 - 2006



Salmon fry averaged 39 fish per 100m² over the sample period and unlike the Awe and Orchy samples, remained relatively stable through the decline of the 1990s. In 2007, which was 11 fry below the average of 39 fry, fry numbers mirrored the relatively low number of adult salmon returning to the Awe catchment in 2006. Trout fry numbers in 2007 were similar to the average for the study period at 37 fry per 100m². Trout parr numbers were slightly higher than the average for the study period in 2007.

Conclusions
In general, the sampling conducted in the River Awe and River Orchy tributaries suggest that the abundance of juvenile salmon sampled between 1997 and 2007 appear to follow that of the trends in the numbers of adult fish counted at the Awe Barrage. Salmon fry numbers sampled in the tributaries of Loch Awe demonstrated less variation over the study period, but did fall below average, which is consistent with the relatively poor numbers of adult salmon counted at the Awe barrage in 2006.

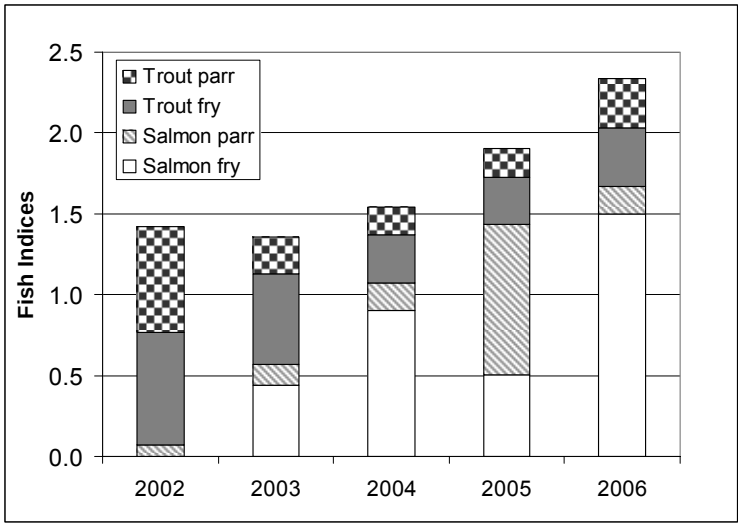
6.4.2. Loch Fyne

River Fyne
Longer term trends in total juvenile fish abundance in the mainstem of the River Fyne are described for the period 2002 to 2006;

River Fyne trends in juvenile fish indices

Year	Salmon fry	Salmon parr	Trout fry	Trout parr
2002	0.00	0.07	0.70	0.65
2003	0.44	0.13	0.56	0.23
2004	0.90	0.17	0.30	0.17
2005	0.51	0.93	0.29	0.18
2006	1.50	0.17	0.37	0.30
Mean	0.7	0.3	0.4	0.3
Min.	0.0	0.1	0.3	0.2
Max.	1.5	0.9	0.7	0.7

Fyne mainstem juvenile fish Indices



Fish numbers appear to have improved between 2002 and 2006, particularly for salmon fry, which have increased year-on-year with the exception of 2005 when lower number of fry were stocked (when compared to the number stocked in 2004). The increases in fry numbers detected in 2006 are thought to be due to a limited amount of stocking (lower than 2004 and 2005) and increases in the spawning of wild fish.

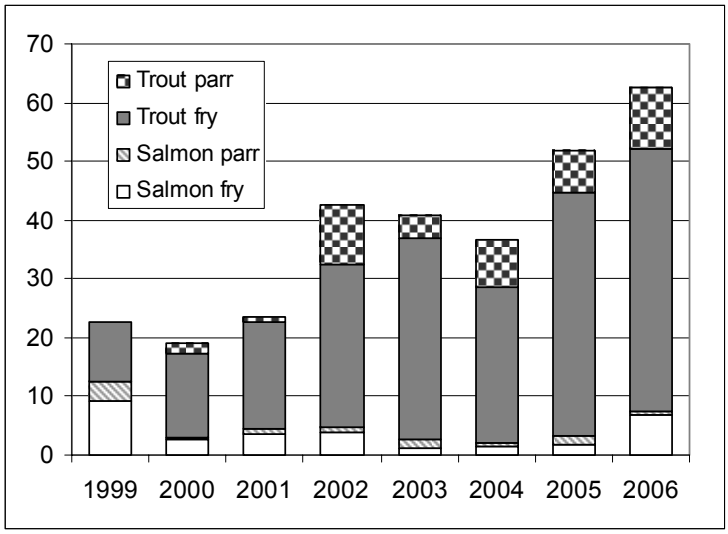
River Shira

Longer term trends in total juvenile fish abundance in the tributary stream and upper mainstem sites are described in table 17 and figure 20 for the period 1999 to 2006.

Long-term trends in juvenile fish densities (1999-2006)

Year	Salmon fry	Salmon parr	Trout fry	Trout parr
1999	9	3	10	0
2000	3	0	14	2
2001	4	1	18	1
2002	4	1	28	10
2003	1	1	34	4
2004	2	1	26	8
2005	2	1	42	7
2006	7	1	45	11

Trends in fish density (1999 – 2006)



Average fish numbers present in tributary stream sites appear to have increased between 1999 and 2006, particularly for trout fry and parr, which have increased year-on-year with the exception of 2004. Salmon fry and parr numbers have remained relatively low throughout the study period.

3.7. River Aray

3.7.4. Trends in juvenile fish Indices (2002-2006)

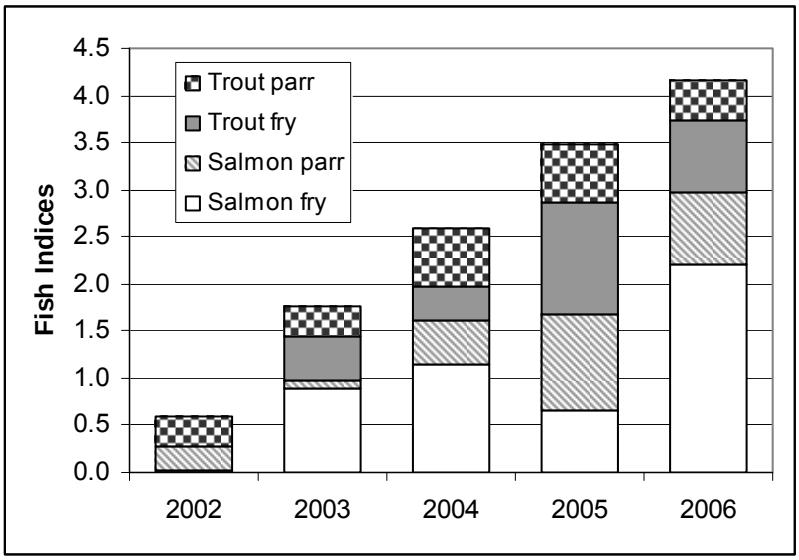
Longer term trends in total juvenile fish abundance in the main river sites are described in table 22 and figure 25 for the period 1999 to 2006.

Long-term trends in juvenile fish Indices

Year	Salmon fry	Salmon parr	Trout fry	Trout parr
2002	0.0	0.3	0.0	0.3
2003	0.9	0.1	0.5	0.3
2004	1.2	0.5	0.4	0.6
2005	0.7	1.0	1.2	0.6
2006	2.2	0.8	0.8	0.4
Mean	1.0	0.5	0.6	0.5
Min.	0.0	0.1	0.0	0.3

Max.	2.2	1.0	1.2	0.6

Trends in fish Indices (2002 – 2006)



Average fish numbers present in main river sites appear to have increased between 2002 and 2006, particularly for salmon fry and parr, which have increased year-on-year with the exception of 2005. Trout fry and parr numbers have also increased throughout the study period.

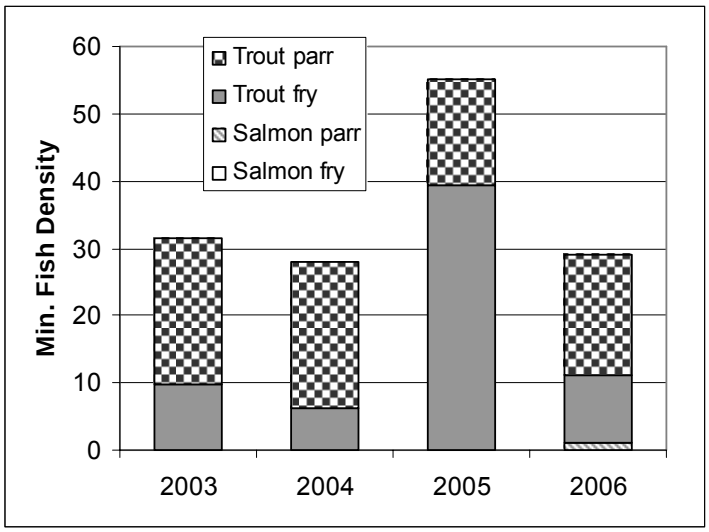
Leacann Water

Longer term trends in the minimum estimates of juvenile fish present at site seven of the Leacann Water are described in table 30 and figure 33 for the period 2002 to 2006.

Trends in juvenile fish density at site seven (2003-06)

Date	Salmon fry	Salmon parr	Trout fry	Trout parr
2003	0	0	10	22
2004	0	0	6	22
2005	0	0	39	16
2006	0	1	10	18
Mean	0.0	0.3	16.4	19.2
Min.	0	0	6	16
Max.	0	1	39	22

Trends in fish density (2003 – 2006)



Juvenile salmon were not present at site seven between 2003 and 2005, but one salmon parr was present in 2006. Trout fry abundance averaged 16 trout fry per 100m² over the study period and were highest in 2005 (39) and lowest in 2004 (6). Numbers of trout parr present at site seven appear to have remained relatively stable between 2003 and 2006.

Loch Fyne Summary

The general trends in fish abundance in the upper Loch Fyne area in 2006 appear to have been varied with increases and decreases in fish abundance recorded for trout and salmon in all rivers.

Salmon

Despite declines in the numbers of salmon fry in the River Leacann and a continued virtual absence from the Kinglas and Douglas, fry abundance has increased in 2006. The mainstem surveys in the Fyne, Shira and Aray indicated that a combination of wild spawning and hatchery reared un-fed fry in the winter of 2005 was improved over the average recorded between 2002 and 2005. Similar improvements in salmon fry numbers were also noted in tributary stream sites. Parr numbers remained relatively stable in the upper Loch Fyne area.

Trout

Although slight declines were detected in juvenile trout numbers in main river sites of most rivers (with the exception of the Aray), surveys in tributary streams and the upper reaches of rivers indicated that trout fry abundance was higher than average in 2006. Parr numbers remained relatively stable in the upper Loch Fyne area.

When compared with other rivers in the upper Loch Fyne area, the juvenile fish surveys indicate the larger systems of the Fyne, Shira and Aray show the most consistent progress in restoring salmon and trout populations. This, in part, appears to be due to the salmon fry stocking programme in the Fyne and Aray, although the most improved abundance of fry was the River Shira which was not stocked in 2006. The relatively smaller catchments of the Kinglas, Douglas and Leacann Waters appear to be less consistent, year-to-year in juvenile fish abundance. This may be due to the ability of larger populations to be able to regenerate their numbers more quickly compared to these relatively small populations.

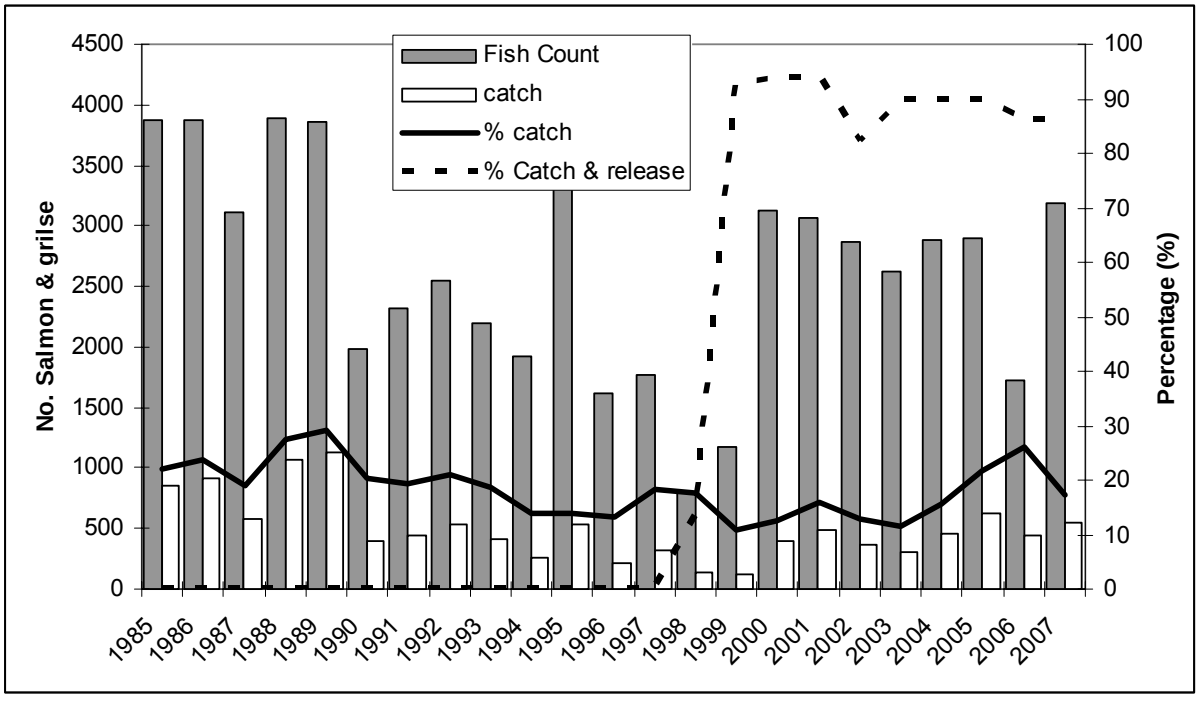
6.5. Exploitation of stocks

There is one fishery for Atlantic salmon in Argyll where it is possible to make robust estimates of exploitation. The fish counter and rod catch data provides estimates of the percentage of the Awe salmon population exploited by the fishery.

Estimates of % exploitation of Awe catchment salmon populations

Year	Fish Count	catch	% catch	% C&R	Year	Fish Count	catch	% catch	% C&R
					1996	1619	212	13.1	0
1985	3871	858	22.2	0	**1997**	1768	322	18.2	0
1986	3875	916	23.6	0	**1998**	793	139	17.5	14
1987	3106	587	18.9	0	**1999**	1180	129	10.9	93
1988	3894	1074	27.6	0	**2000**	3129	395	12.6	93
1989	3856	1129	29.3	0	**2001**	3066	490	16.0	94
1990	1978	404	20.4	0	**2002**	2872	372	13.0	82
1991	2314	447	19.3	0	**2003**	2620	305	11.6	90
1992	2547	532	20.9	0	**2004**	2880	453	15.7	90
1993	2197	411	18.7	0	**2005**	2894	624	21.6	90
1994	1929	265	13.7	0	**2006**	1719	448	26.1	86
1995	3827	531	13.9	0	**2007**	3185	555	17.4	86

Trends in fish abundance, rod catch and exploitation of Awe salmon



Rod fishery exploitation rates have varied between 13 and 29% and averaged ?% over the study period. The consequence of relatively high rates of exploitation have been diminished by high rates of release for rod-caught fish, which has increased since 1998 when the run had declined in abundance to its lowest point on record.