Fish Population Surveys

On behalf of the

Loch Fyne Rivers Improvement Association

2020

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Fish Population Survey on behalf of the Loch Fyne Rivers Improvement Association, 2020

Background

Argyll Fisheries Trust (AFT) undertook surveys of fish populations on six rivers; Aray, Shira, Fyne, Kinglas and Leacann Water at the head of Loch Fyne and the Auchalick River in lower Loch Fyne. The objective of the surveys was to assess the status of juvenile salmon and trout populations in the summer of 2020 on behalf of the Loch Fyne Rivers Improvement Association (LFRIA). These surveys continue a time-series of data collected on juvenile salmonid fish in Loch Fyne.

Main findings

- Electrofishing surveys found that although present in most rivers, the distribution of salmon fry has reduced when compared to that found in 2016. No salmon have been found in the Kinglas water since 2017.
- Where found at 70% of sites surveyed in 2020, the classification of salmon fry density was mostly low (42 % of sites) and moderate (16 %) or high (12 %) at fewer sites.
- The classification of trout fry density found at 82% of sites was mostly low (42 % of sites) and moderate (16 %) or high (23 %) of sites..

The following conclusions were reached:

- The trend in juvenile salmon distribution and abundance in Loch Fyne appear to have improved between 1999 and 2016, but more recent surveys in 2019 and 2020 suggest recruitment of salmon has declined once more.
- Following the reintroduction of salmon into the Kinglas Water and evidence of some wild recruitment, no salmon appear to be present in 2020. Similarly, the recovery of salmon in upper River Fyne sites appear to have reversed with very few juveniles recruited in recent years.
- Juvenile trout distribution and abundance, however, appear to have remained relatively stable over recent years.
- There may be some benefit to juvenile recruitment by improving habitat condition.

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1. INTRODUCTION

In Summer 2020 Argyll Fisheries Trust undertook fish population surveys of four rivers; Aray, Shira, Fyne, Kinglas, in Loch Fyne, Argyll on behalf of the Loch Fyne Rivers Improvement Association (LFRIA) to assess the status of juvenile salmon and trout populations.

The migratory salmonids; Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*), which are the focus of local fisheries, and other native fish populations use freshwater habitats for breeding and development of early life-stages. Typically, juvenile salmon and trout spend between one and three years in freshwater before migrating to sea as smolts.

Post-smolt salmon may spend between one and three years in the North Atlantic Ocean before returning to mature and spawn within their natal river, at or close to their original hatching site. Sea trout differ from salmon as they are part of a resident brown trout population and migratory forms are made up of a high proportion of females. Sea trout usually spend less time at sea and unlike salmon are thought to remain in nearby inshore marine waters to feed.

The use of both marine and freshwater habitats during their life-cycle makes migratory salmonids vulnerable to deterioration or loss of accessibility in one or more of a wide range of habitats. Isolated resident brown trout populations are also potentially present upstream of waterfall barriers that prevent access from the sea.

The electrofishing survey technique used in this fish survey are designed to investigate relatively shallow areas of flowing water (< 1m depth) in which juvenile salmonid and other fish frequently inhabit. Juvenile life stages of salmonid fish are targeted by such surveys as unlike adult fish they are generally present throughout the year and provide a history of which species have spawned in the vicinity of the survey site in recent years. No stocking of salmon has been undertaken in Loch Fyne in recent years

2. METHODS

2.1 Juvenile fish surveys

To assess the fish populations sampling of fish was undertaken at 42 sites in six catchments; Aray (9 sites), Shira (7 sites), Fyne (12 sites), Kinglas (6 sites), Leacann Water (3 sites) and River Auchalick (5 sites) (see Appendix I for details). The surveys used an electrofishing technique in accordance with version 2.3 of the Scottish Fisheries Co-ordination Centre (SFCC) protocols (SFCC, 2007). Most sites had been surveyed previously on at least one occasion to enable some comparison between years. To provide a guide to the relative abundance of salmonid fish sampled during the survey, minimum density estimates were classified according to a classification scheme (Godfrey, 2005) for the west coast of Scotland district according to stream width at the survey site (Appendix II).

Electrofishing is used to temporarily stun fish in the close vicinity of the operator, allowing fish to be retained and processed prior to release. Fish surveys were conducted during low-to-medium flow conditions with backpack electric fishing equipment, using smooth direct current between 300 and 400 volts. An assessment of the in-stream and riparian habitat characteristics were undertaken at each site. All fish were returned to the site on completion of the survey.

Digital photographs were taken of each site to aid identification during future surveys. Semi-quantitative sampling technique (i.e. fished one time over a known area) were utilised to estimate the minimum density of fish present within the site at the time of the survey (Zippen, C. 1956). Captured fish were anaesthetised prior to being identified to species level and measured for length. Scale samples were removed from a small number of salmonid fish at each site to provide age information to allow estimates of fry (< 1 year old) and parr (> 1 year old) abundance to be calculated. Other non-salmonid species were recorded for length only.

3. RESULTS

Of the 42 electrofishing surveys conducted, salmon fry were found at 30 sites, salmon parr at 22 sites and trout fry were found at 35 sites and trout parr at 30 sites. Estimates of the density of juvenile salmon and trout are given separately for each river as the minimum number of fish per 100m² of wetted stream bed and classified in relation to the stream width.

3.1. River Aray

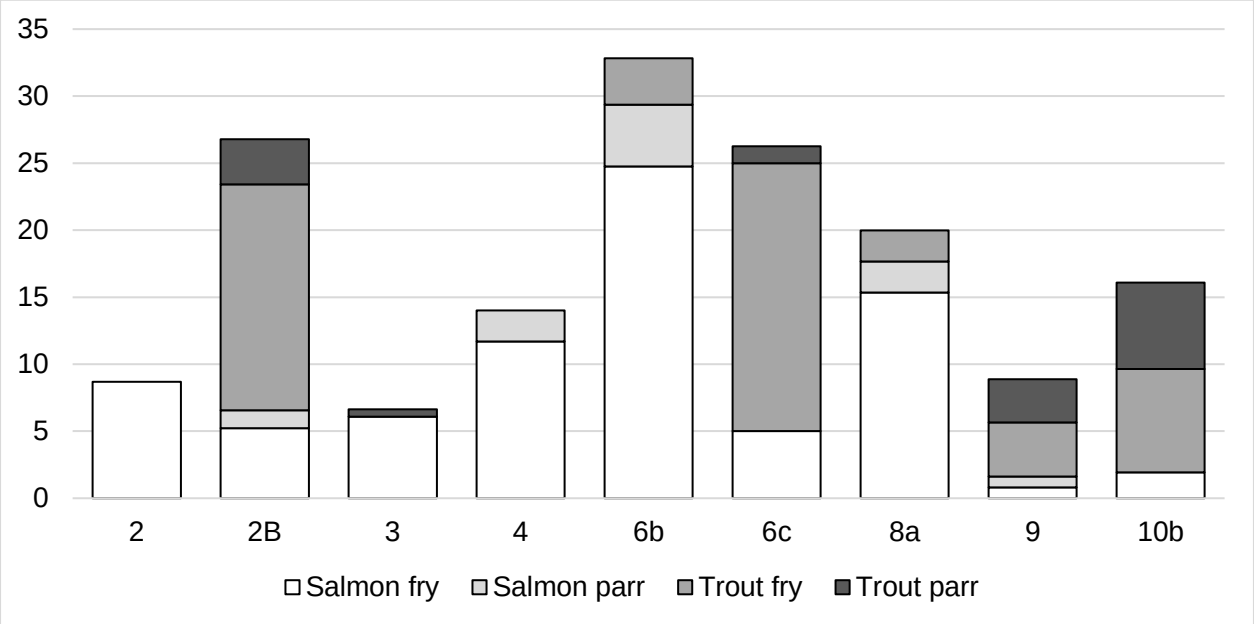
Salmon fry were found at all nine sites surveyed in the River Aray in 2020 (Table 3.1a and Figure 3.1) where minimum estimates of fry density ranged from 0.8 to 24.8 fry per 100 m². Classification of fry density was high (class B) at one site, moderate (class C) at three sites and low at six other sites (classes D & E). Estimates of older salmon (parr) densities found at six sites ranged from 0.8 to 4.6 parr per 100 m². Classification of parr density was low (class D or E) at five sites and relatively high (class B) at one other site.

Table 3.1a River Aray fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout			
	Fry		Parr		Fry		Parr	
	Density	Class	Density	Class	Density	Class	Density	Class
2	8.7	C	0	F	0	F	0	F
2B	5.2	D	1.3	E	16.8	B	3.4	C
3	6.08	D	0	F	0	F	0.6	E
4	11.7	C	2.3	D	0	F	0	F
6b	24.8	B	4.6	B	3.5	B	0	F
6c	5.0	D	0	F	20.0	D	1.3	E
8a	15.4	C	2.3	D	2.3	C	0	F
9	0.8	E	0.8	E	4.0	A	3.2	A
10b	1.9	E	1.9	E	7.7	C	6.4	C

Trout fry were found at six sites where minimum estimates of fry density ranged from 2.3 to 20.0 fry per 100 m². Where found, classification of fry density was low (class D) at one site, moderate (class C) at two sites and high (classes A or B) at three other sites. Estimates of older trout densities found at five sites ranged from 0.6 to 6.4 parr per 100 m². Where found, classification of parr density was low at two sites (class E), moderate (class C) at two sites and higher at one other site (class A).

Figure 3.1 River Aray comparison of fish density (min. no. per 100m²) 2020



The 2020 monitoring sites provide opportunity for comparison of salmon fry density classification over time (Table 3.1b). The 2020 surveys found salmon fry at more sites when compared to 2019 and 2017, but the classification of fry density was lower than that found in 2016, when the highest density were found.

Table 3.1b River Aray classification of salmon fry density (2003-2020)

Site No.	2003	2004	2005	2006	2007	2008	2009	2010	2011	2016	2017	2019	2020
2			-	B	D	B		B	C	A	A	E	E
2b							D		F			F	D
3	D	C	D	B	E	D		A	C	A	D	F	D
4	D	C	C	-	B	C	C	B	C	A	B	B	C
6b	D	B	A	B	D	D		A	B	A	A	B	B
6c													D
7												A	A
8a			F		E		A	A	F	A	A	A	C
9												F	E
10b	B	E	F	F	F	B	A		F	A	F	F	E

Trout fry densities are expected to be higher in tributary stream sites (sites 2b, 6c and 10b) when compared to main river sites (which are usually inhabited mostly by juvenile salmon). The historical surveys found varied densities of trout fry (Table 3.1c) in tributaries. Higher densities of fry (class A or B in most years) were found at site 6c (Allt a Mhagarain in 2011, 2016 and 2017) but fry density was low at this site 2020. However, trout fry remained 'moderate' (class C) at site 10b and were higher than usual at site 2b (class B) at Maltlands. Trout fry density was however slightly higher in some main river sites such as site 6b, site 7 and site 9a in 2020.

Table 3.1c River Aray classification of trout fry density (2003-2020)

Site No.	2003	2004	2005	2006	2007	2008	2009	2010	2011	2016	2017	2019	2020
2				C	D	A		D	C	E	E	A	F
2b									E			E	B
3	E	D	D	D	E	F		D	C	D	F	A	F
4	E	D	D		C	F	D	D	C	F	F	D	F
4d												F	F
6b	A	A	B	B	A	C		A	A	C	C	D	B
6c	B	C	D	B	C				B	B	B	A	D
7												A	A
8a			B		B		A	F	A	C	A	B	C
9a												A	A
10b	A	A	C	D	D	D	B		C	E		C	C

3.2 River Shira

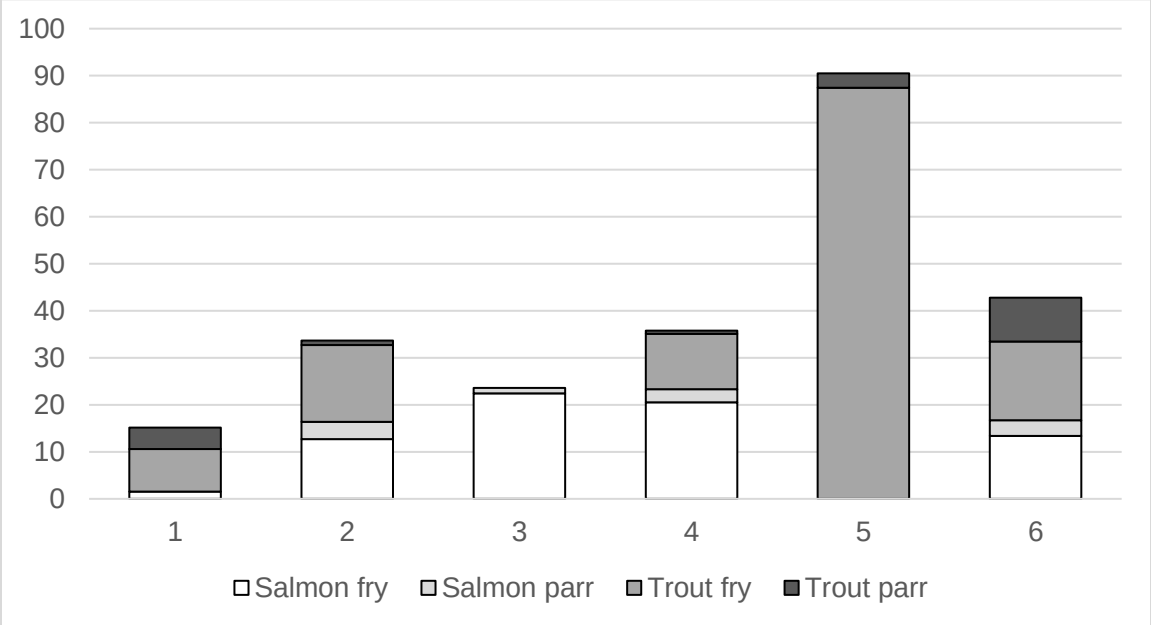
Salmon fry were found at five of the six sites surveyed in the River Shira in 2020 (Table 3.2a and Figure 3.2) where minimum estimates of fry density ranged from 1.5 to 22.4 fry per 100 m². Classification of fry density was relatively high (class B) at two sites and moderate (class C) at two sites and low at one other (class E). Where found at four sites, estimates of older salmon parr densities ranged from 1.1 to 3.6 parr per 100 m². Classification of parr density was low (classes D or E) at three sites and moderate (class C) at one other.

Trout fry were found at five of the six sites surveyed where minimum estimates of fry density ranged from 9.1 to 87.4 fry per 100 m². Classification of fry density was low (class E) at one site and high (classes A or B) at four others. Estimates of older trout parr densities found at five sites ranged from 0.9 to 9.4 parr per 100 m². Where found, classification of parr density was low at four sites (classes D or E) and higher at one other site (class A).

Table 3.2a River Shira fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout			
	Fry		Parr		Fry		Parr	
	Density	Class	Density	Class	Density	Class	Density	Class
2	1.5	E	0	F	9.1	E	4.5	D
4	12.7	C	3.6	D	16.4	B	0.9	E
5	22.4	B	1.1	E	0	F	0	F
7	20.6	B	2.8	D	11.8	A	0.7	D
8	0	F	0	F	87.4	A	3.1	E
9	13.4	C	3.3	C	16.7	A	9.4	A

Figure 3.2 River Shira comparison of fish density (min. no. per 100m²) 2020



When compared with previous surveys over time, the classification of salmon fry density suggest fry densities were generally higher in 2017 than in previous surveys (Table 3.2b), but were much lower in 2018 and more moderate in 2019 and 2020. No or few salmon are expected to be found at site 2 or 8 as these are small tributary streams which is generally better suited to trout. However, high densities of salmon fry are regularly found at site 2, possibly due to the lack of optimal spawning habitat in the lower reach of the main river.

Table 3.2b River Shira classification of salmon fry density (1999-2020)

Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2017	2018	2019	2020
2		F		D		C	F	C	A			B	A	A	F	B	E
4		D	F	F	F	E	F	B	A		C		D	B	F	B	C
5						D		C	C	D	B		C	A	D	C	B
7	A	E	B	B	D	E	C	C	B	D	D	C	D	B	E	F	B
8				F	F	F	F	F	E		F		F	F	F	F	F
9						D	E	C	A		D		D	B	E	C	C

When compared with previous surveys over time, the classification of trout fry density at all six sites were generally highest in 2011 and 2019 (Table 3.2c). Trout fry classification appear to vary more in the lower river sites (sites 2, 4 and 5) but have generally remained highest in the upper river sites (sites 7, and 9) In common with salmon fry, fewer trout fry were found at site 2 in 2020 than is usually the case.

Table 3.2c River Shira classification of trout fry density (1999-2020)

Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2017	2018	2019	2020
2		D		B		D	C	B	D			A	A	C	D	B	E
4		D	C	C	A	A	A	C	D		A		B	C	E	A	B
5						B		D	D	F	B		A	E	A	C	F
7	D	A	A	B	A	A	A	A	B	A	A	B	A	A	A	A	A
8				B	A	B	A	A	B		A		A	A	B	B	A
9						A	A	A	A		B		A	A	A	A	A

3.3 River Fyne

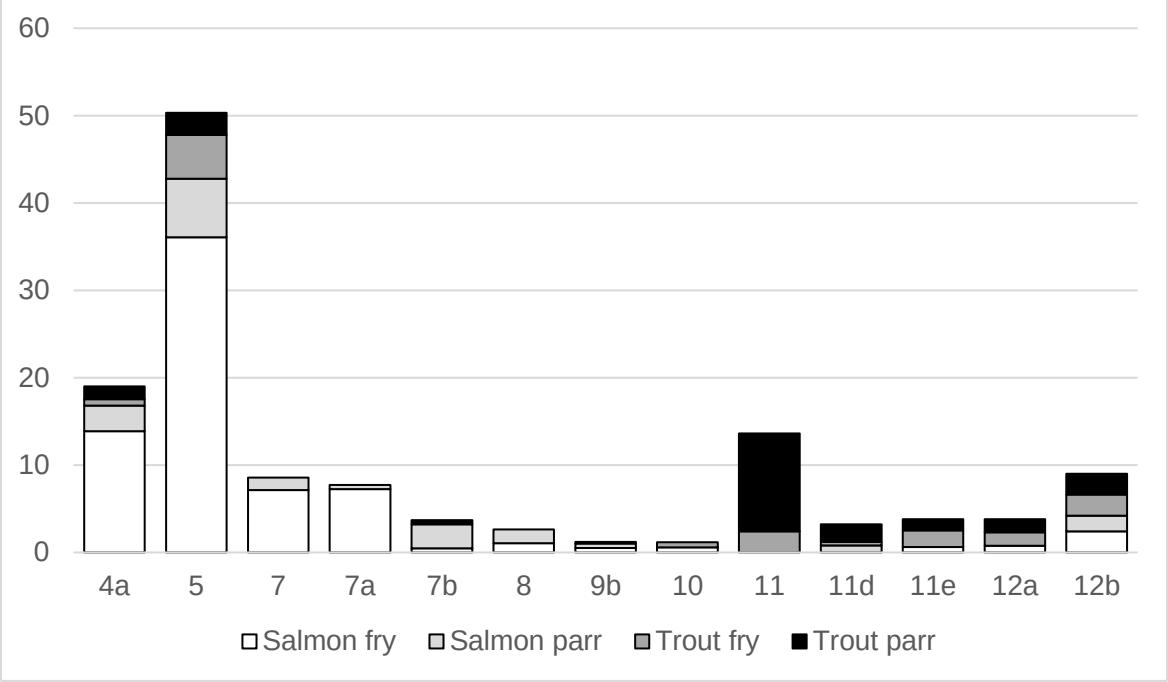
Of the13 sites surveyed in the River Fyne in 2020, salmon fry were found at 11 sites (Table 3.3a and Figure 3.3) and parr were found at nine sites. Where found, estimates of salmon fry density ranged from 0.5 to 36.1 fry per 100 m². Classification of fry density was low (classes D and E) at nine sites and higher (classes A and B) at two sites in the lower river. Estimates of older salmon parr density ranged from 0.5 to 6.7 parr per 100 m². Classification of parr density was low (classes D and E) at eight sites and high (class B) at one other site. Trout fry were found at nine sites where minimum estimates of fry density ranged from 0.2 to 2.4 fry per 100 m². Classification of trout fry density was low (classes D and E) at five sites and moderate (class C) at five sites. Estimates of older trout parr density found at eight sites ranged from 0.5 to 11.2 parr per 100 m².

Classification of parr density was low at two sites (classes D or E), moderate at one site (class C) and high (classes A and B) at five others.

Table 3.3a River Fyne fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout			
	Fry		Parr		Fry		Parr	
	Density	Class	Density	Class	Density	Class	Density	Class
4a	13.9	B	2.9	D	0.7	E	1.5	B
5	36.1	A	6.7	B	5.0	C	2.5	D
7	7.1	D	1.4	E	0	F	0	F
7a	7.2	D	0.5	E	0	F	0	F
7b	0.5	E	2.8	D	0	F	0.5	E
8	1.1	E	1.6	E	0	F	0	F
9b	0.5	E	0.5	E	0.2	E	0	F
10	0.6	E	0	F	0.6	E	0	F
11	0	F	0	F	2.4	E	11.2	B
11d	0	F	0.8	E	0.4	D	2.0	A
11e	0.6	E	0	F	1.9	C	1.3	C
12a	0.8	E	0	F	1.5	C	1.5	B
12b	2.4	E	1.8	D	2.4	C	2.4	A

Figure 3.3 River Fyne comparison of fish density (min. no. per 100m²) 2020



The classification of salmon fry densities from historical surveys (Table 3.3b) suggest an improvement of salmon recruitment at Merk Park (sites 4a and 5) while recruitment has remained

low in the middle and upper river (sites 7 through to 12). When found, salmon fry density has been classed as mostly low (classes D or E) density.

Table 3.3b River Fyne classification of salmon fry density (2003-2020)

Site	2003	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014	2016	2017	2019	2020
4a	D	C	D	D	D		C	C				C		E	B
5	A	C	E	A	D	A						A		C	A
7		B	E	D											D
7a	E	E	D	C	D			C				C		E	D
7b														D	E
8	D	D	D	D	B			C			A		E	C	E
9b														E	E
10	F		F	F	F	F		D							E
11	F	F	F	F	F	F		E							F
11d														F	F
11e													F	F	E
12a						F	D					E	F	F	E
12b									F		E		F	F	E

The classification of trout fry density found on the River Fyne (Table 3.3c) has mostly been low (classes D or E) or moderate (class C) but were not found at four sites in 2020 where they have been found in previous surveys.

Table 3.3c River Fyne classification of trout fry density (2003-2020)

Site	2003	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014	2016	2017	2019	2020
4a	C	C	C	F	F		F	E				E		E	E
5	A	D	C	A	E	A						C		B	C
7		F	E	F											F
7a	E	F	E	D	F			F				D		E	F
7b														E	F
8	E	F	E	F	F			E			F		F	E	F
9b														E	E
10	A		E	B	D	E		F							E
11	D	E	E	D	E	D		F							D
11d														D	D
11e													B	E	C
12a						F	D					E	A	C	C
12b									A		C		D	C	C

3.4 River Kinglas

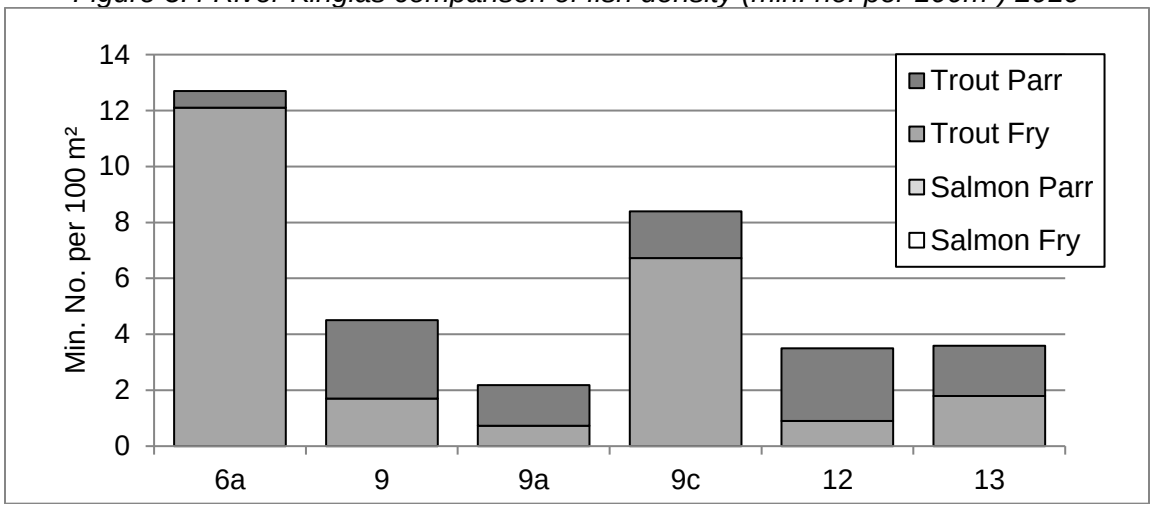
No salmon fry or parr were found at the six sites surveyed in the River Kinglas in 2020 (Table 3.4a and Figure 3.4).

Table 3.4a R.Kinglas fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout			
	Fry		Parr		Fry		Parr	
	Density	Class	Density	Class	Density	Class	Density	Class
6a	0	F	0	F	12.1	C	0.6	E
9	0	F	0	F	1.7	E	2.8	D
9a	0	F	0	F	0.7	E	1.5	E
9c	0	F	0	F	6.7	E	1.7	E
12	0	F	0	F	0.9	E	2.6	E
13	0	F	0	F	1.8	E	1.8	E

Trout fry were found at all six sites where minimum estimates of fry density ranged from 0.7 to 12.1 fry per 100 m². Classification of fry density was moderate (class C) at one site and low (class E) at five others. Estimates of older trout densities found at all sites ranged from 0.6 to 2.8 parr per 100 m². Classification of parr density was low (classes D or E) at all sites surveyed.

Figure 3.4 River Kinglas comparison of fish density (min. no. per 100m²) 2019



The classification of trout fry densities from historical surveys between 2000 and 2019 (Table 3.4a) at the six sites surveyed in the upper Kinglas Water suggest that trout fry were present in the upper river in variable, but have been classified as high (class A or B) at site 6a in 2016 and 2017 but were found at moderate density (class C)in 2019 and 2020. Only low density of fry were found

at all other sites in the upper river sites (Class E) in 2020, which is similar to previous surveys since 2005 but lower than that found at sites 9a and 12 between 2000 and 2004.

Table 3.4a River Kinglas classification of trout fry density (1999-2020)

Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2010	2011	2012	2013	2016	2017	2019	2020
6a						A	A	-	A	B	D	E	A	C	A	A	C	C
9							C	-	C		C	E	C		E	F	C	E
9a	E	C		D	A	A					E							E
9c																		E
12		C	A	D	F	E	E				F	E				D		E
13							D	-	E		F	E						E

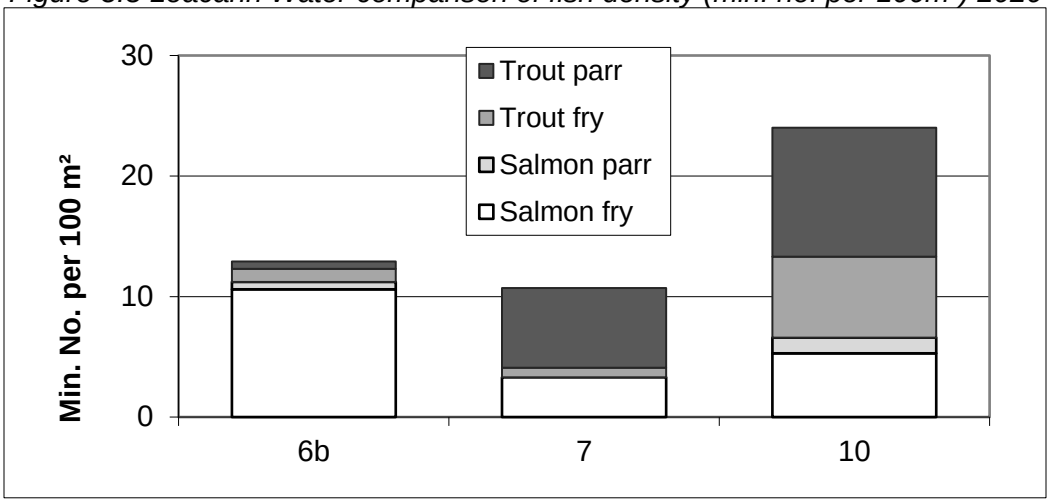
3.5 Leacann Water

Salmon fry were found at all three sites surveyed in 2020 (Table 3.3a and Figure 3.3) and parr were found two sites. Estimates of salmon fry density ranged from 3.3 to 10.6 fry per 100 m². Classification of fry density was low (class E) at one site and moderate (class C) at two other sites. Estimates of older salmon parr density ranged from 0.6 to 1.3 parr per 100 m². Classification of parr density was low (classes D and E) at eight sites and high (class B) at one other site. Trout fry were found at nine sites where minimum estimates of fry density ranged from 0.2 to 2.4 fry per 100 m². Classification of trout fry density was low (classes D and E) at five sites and moderate (class C) at five sites. Estimates of older trout parr density found at eight sites ranged from 0.5 to 11.2 parr per 100 m². Classification of parr density was low (class E).

Table 3.5a Leacann Water fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout				Total density
	Fry		Parr		Fry		Parr		
	Density	Class	Density	Class	Density	Class	Density	Class	
6b	10.6	C	0.6	E	1.1	D	0.6	E	12.8
7	3.3	E	0	F	0.8	E	6.6	B	10.8
10	5.3	C	1.3	E	6.7	E	10.7	B	24.1

Figure 3.5 Leacann Water comparison of fish density (min. no. per 100m²) 2020



The classification of salmon fry densities from historical surveys (Table 3.3b) suggest an continuation of salmon recruitment at sites 7 and 10 in tributary streams while recruitment was moderate in the main river site (sites 6b).

Table 3.5b Leacann Water classification of salmon fry density (1995-2020)

Site	2003	2004	2005	2006	2007	2009	2010	2011	2012	2017	2020
6b											C
7	F	F	F	F	F	F	D	F		F	E
10			-	-			F	E			E

The classification of trout fry density in the Leacann Water (Table 3.3c) was low (classes D or E) in 2020 compared to more moderate (class C) sometimes found previously at site 7 but were similar to that found previously at site 10.

Table 3.5c Leacann Water classification of trout fry density (1995-2020)

Site	2003	2004	2005	2006	2007	2009	2010	2011	2012	2017	2020
6b											D
7	D	E	C	D	E	C	B	C		C	E
10			-	-			F	E			E

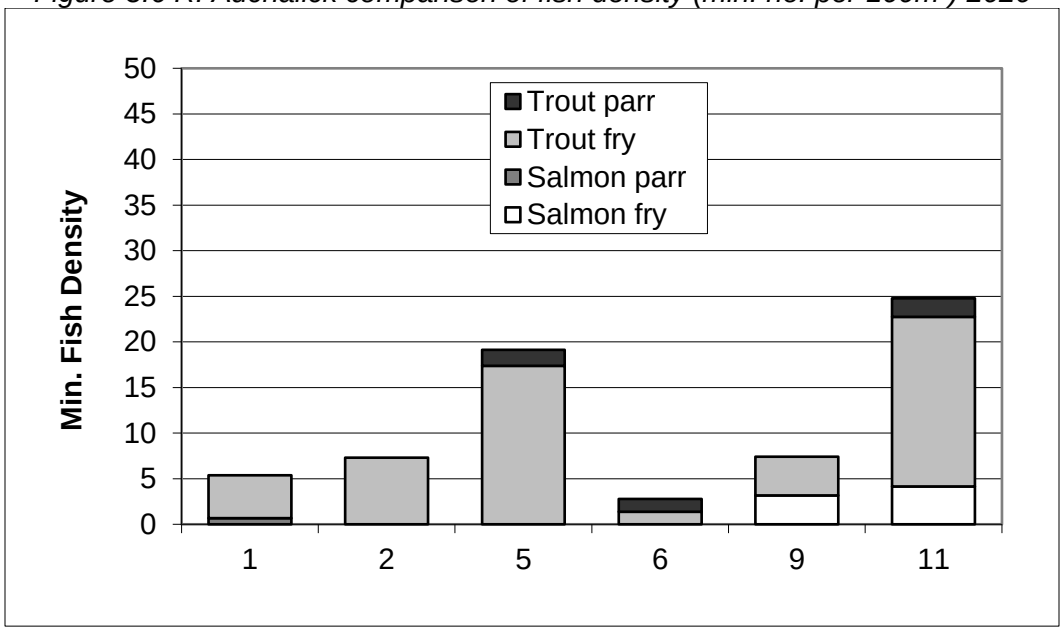
3.6 River Auchalick

A total of six sites were surveyed in the River Auchalick in 2020. Salmon fry were found at two sites (Table 3.6a and Figure 3.6) and parr were found at one site. Where found, estimates of salmon fry density ranged from 3.2 to 4.1 fry per 100 m². Classification of fry density was low (class D) at both sites. The estimate of older salmon parr density at site 1 was 0.7 parr per 100 m² which was classified as low (class E). Trout fry were found at all six sites where minimum density estimates ranged from 1.4 to 18.6 fry per 100 m². Classification of trout fry density was low (classes D and E) at three sites and high (classes A and B) at three sites. Estimates of older trout parr density found at three sites ranged from 1.4 to 2.1 parr per 100 m². Classification of parr density was low (class E).

Table 3.6a R. Auchalick fish density (min. no. per 100m²) and classification 2020

Site	Salmon				Trout				Total density
	Fry		Parr		Fry		Parr		
	Density	Class	Density	Class	Density	Class	Density	Class	
1	0.0	F	0.7	E	4.7	D	0.0	F	5.4
2	0.0	F	0.0	F	7.3	A	0.0	F	7.3
5	0.0	F	0.0	F	17.4	B	1.7	E	19.1
6	0.0	F	0.0	F	1.4	E	1.4	E	2.8
9	3.2	D	0.0	F	4.2	D	0.0	F	7.4
11	4.1	D	0.0	F	18.6	B	2.1	E	24.8

Figure 3.6 R. Auchalick comparison of fish density (min. no. per 100m²) 2020



The classification of salmon fry densities from historical surveys (Table 3.6b) suggest a peak in salmon recruitment in the winter of 2015-16, but the lack of fry in the 2017 survey and the low density found in the upper river in 2020 suggest the range of habitat used by salmon for recruitment has reduced.

Table 3.6b R. Auchalick classification of salmon fry density (2011-2020)

Site	2011	2012	2013	2016	2017	2020
1	F					F
2		A		D	F	F
5	F		F	D	F	F
6		F		C	F	F
9		F	F	B	F	D
11		F		E	F	D

The classification of trout fry density in the R. Auchalick (Table 3.6c) was mixed in 2020 but was generally similar to previous surveys. The range of habitat utilised for recruitment of trout however appear to be widespread through the study period.

Table 3.6c R. Auchalick classification of trout fry density (1995-2020)

Site	2011	2012	2013	2016	2017	2020
1	F					D
2		B		E	C	A
5	F		B	A	B	B
6		A		C	D	E
9		C	F	C	E	D
11		D		B	A	B

4. DISCUSSION

The findings of the electrofishing surveys conducted in 2020 are discussed below in relation to previous surveys and the trends in abundance of salmon and trout in Loch Fyne rivers.

4.1 Salmon populations

The juvenile fish surveys undertaken in six catchments during 2020 found salmon fry at only 30 of the 43 sites surveyed (70 % of sites) (Table 4.1). Where found, the density of fry was classified as relatively low at 18 (42 %) of sites, moderate at 7 (16 %) of sites and high at 5 (12 %) of sites.

Table 4.1 Number, percentage of sites and salmon fry classification (2020)

River	No. sites	Low Class	% sites	Mod Class	% sites	High Class	% sites	Total	% sites
Aray	9	5	55.6	3	33.3	1	11.1	9	100
Shira	6	1	20.0	2	40.0	2	40.0	5	83
Fyne	13	9	81.8	0	0.0	2	18.2	11	85
Kinglas	6	0	0.0	0	0.0	0	0.0	0	0
Leacann	3	1	33.3	2	66.7	0	0.0	3	100
Auchalick	6	2	100.0	0	0.0	0	0.0	2	33
Total	43	18	41.9	7	16.3	5	11.6	30	69.8

This summary results suggest that while salmon distribution remains relatively wide except for the River Kinglas and River Auchalick, but where present are mostly of relatively low density. Higher densities were only found at a small number of sites in the Rivers Aray, Shira and Fyne. These data indicate that the number of adult salmon returning to spawn in loch Fyne in 2019 remained relatively low and were not sufficient to fully repopulate the available freshwater habitat.

The surveys also found a relatively diminished distribution of salmon parr at only 22 of the 43 sites surveyed (51 % of sites) (Table 4.2). Where found, the density of parr was classified as relatively low at 19 (44 %) of sites, moderate at one (2.3 %) of sites and high at two (4.7 %) of sites.

Table 4.2 Number, percentage of sites and salmon parr classification (2020)

River	No. sites	Low Class	% sites	Mod Class	% sites	High Class	% sites	Total	% sites
Aray	9	5	83.3	0	0.0	1	16.7	6	67
Shira	6	3	75.0	1	25.0	0	0.0	4	67
Fyne	13	8	88.9	0	0.0	1	11.1	9	69
Kinglas	6	0	0.0	0	0.0	0	0.0	0	0
Leacann	3	2	100.0	0	0.0	0	0.0	2	67
Auchalick	6	1	100.0	0	0.0	0	0.0	1	17
Total	43	19	44.2	1	2.3	2	4.7	22	51.2

The relatively poor distribution and mostly low density of salmon parr indicate that the production of smolts is currently less than optimal and is likely to contribute the poor number of adult salmon returning. Angling catches of salmon in Loch Fyne and other rivers in the region, suggest there has been a decline in sea returns of adult salmon since 2016, which have also been observed in counts of fish at the Awe barrage. The survey data from 2020 suggest that this decline is having an effect on juvenile recruitment and consequently smolt production.

Remedial management actions previously employed in response to the decline in salmon abundance (as a result of declines in sea survival) have been centred around limited fishing effort and catch and release fisheries as well as the use of a hatchery facility for the Rivers Aray and Fyne between 2003 and 2012. The hatchery attempted to maximise the number of families present and increase juvenile recruitment by promoting a higher egg fertilisation and survival rate over-winter as well as broadening the distribution of unfed fry in the spring of each year. Additionally, a small number of unfed fry were transferred from the River Fyne into to the River Kinglas between 2006 and 2012.

While the re-opening of hatchery facilities, to support the small salmon populations, may be considered as a response to the more recent decline, changes in the regulation of the use of hatcheries, principally the licensing of the removal of broodstock may now limit the potential to adopt this approach. Marine Scotland Science, currently will issue licenses where the number of broodfish do not exceed 1 % of the adult population estimate. Given that the most recent survey of the River Fyne found some 25 salmon, it is not now feasible to intervene with hatchery support for small populations. Therefore, at this time, local efforts to support the salmon (and trout) populations need to be centred on protecting the returning stock from inappropriate exploitation and ensuring the habitat is in the best possible condition to maximise smolt production. It is also

noted that improvements in trout populations in Loch Fyne Rivers recorded over the same time-frame as salmon are largely thought to be as a result of improvements in survival of post-smolts in Loch Fyne rather than any hatchery initiative. While better understanding of the decline in salmon numbers is a priority, future management actions should not discount the use of hatcheries to support salmon populations.

4.2 Trout populations

The juvenile fish surveys undertaken in six catchments during 2020 found a trout fry found at 35 of the 43 sites surveyed (81 % of sites) (Table 4.3). Where found, the density of fry was classified as relatively low at 18 (42 %) of sites, moderate at 7 (16 %) of sites and high at 10 (23 %) of sites.

Table 4.3 Number, percentage of sites and trout fry classification (2020)

River	No. sites	Low Class	% sites	Mod Class	% sites	High Class	% sites	Total	% sites
Aray	9	1	16.7	2	33.3	3	50.0	6	67
Shira	6	1	20.0	0	0.0	4	80.0	5	83
Fyne	13	5	55.6	4	44.4	0	0.0	9	69
Kinglas	6	5	0.0	1	0.0	0	0.0	6	100
Leacann	3	3	100.0	0	0.0	0	0.0	3	100
Auchalick	6	3	50.0	0	0.0	3	50.0	6	100
Total	43	18	41.9	7	16.3	10	23.3	35	81.4

This summary results suggest that trout fry distribution remains relatively wide but where present are mostly of relatively low density. Higher densities were only found in three catchments; Rivers Aray, Shira and Auchalick. These data indicate that the number of adult sea trout returning to spawn in Loch Fyne rivers in 2019 remained relatively low and were not sufficient to fully repopulate the available freshwater habitat.

The surveys also found a relatively wide distribution of trout parr at 31 of the 43 sites surveyed (75.6 % of sites) (Table 4.4). Where found, the density of parr was classified as relatively low at 19 (46 %) of sites, moderate at three (7.3 %) of sites and high at nine (22.0 %) of sites.

Table 4.4 Number, percentage of sites and trout parr classification (2020)

River	No. sites	Low Class	% sites	Mod Class	% sites	High Class	% sites	Total	% sites
Aray	9	2	40.0	2	40.0	1	20.0	5	56
Shira	6	4	80.0	0	0.0	1	20.0	5	83
Fyne	13	2	25.0	1	12.5	5	62.5	8	62
Kinglas	6	6	0.0	0	0.0	0	0.0	6	100
Leacann	3	2	50.0	0	0.0	2	50.0	4	133
Auchalick	6	3	100.0	0	0.0	0	0.0	3	50
Total	43	19	44.2	3	7.0	9	20.9	31	72.1

The wider distribution of trout fry and parr and higher proportion of sites where densities were either moderate or high suggest that the production of trout smolts may be higher than that of salmon. However, this may not currently be optimal due to the low productivity of some habitats. The survey data from 2020 suggest that while smolt production and adult sea returns may not be optimal, juvenile recruitment and consequently smolt production appears to remain at a level where the populations of sea trout are being maintained.

Most of the survey sites are located in the main channels where salmon are expected to be present at higher densities. Where surveys were undertaken in tributary streams or where there was sufficient bank cover trout were found at higher densities, suggesting that there is a sampling bias that will inevitably project trout numbers to be lower than they may actually be across the catchment.

5. CONCLUSIONS

Interpretation of the data collected by the surveys undertaken in 2020 provides some conclusions related to fish populations and fish habitat in upper Loch Fyne rivers.

5.1 Fish populations

In correlation with the River Awe fish counter, there have been very low numbers of adult salmon returning to many rivers in Argyll during recent years (2016-19). The low numbers of adult salmon returning to spawn appear to be reflected in the reduced distribution and lower densities of juvenile salmon found in electrofishing surveys of rivers in Loch Fyne. In contrast, the results of the 2020 survey suggest that recruitment of juvenile trout remains widespread, but fry densities vary considerably between sites and between years at individual sites. As expected, low densities were generally found in the larger river channels and higher densities in most smaller tributaries.

5.2 Marine survival

The electrofishing surveys of juvenile fish show a decline in abundance of salmon in Loch Fyne rivers between 2017 and 2020. This decline appears to be related to a lower proportion of smolts returning from the sea as adults. There is some evidence that the poor survival of salmon at sea may be widespread with many rivers across Scotland reporting declines in catches. However, the salmon populations in Argyll appear to be particularly badly affected suggesting that there may be additional local impacts on the populations. The disclosure of sea lice burdens of farm fish in Loch Fyne (and other areas of Argyll) and monitoring of infestations of sea lice on sea trout in Loch Fyne suggest there may be some significant effect on sea trout but any effect on the salmon smolts migrating through Loch Fyne remain unknown.

5.3 Freshwater habitat

The underlying geology and diversity of riparian habitat found in each catchment appears to have some influence on the densities of juvenile salmonid fish found by the surveys. The habitats found in the River Aray and the River Shira are generally productive for fish with diverse riparian habitat compared to the base poor geology and low diversity of riparian habitat found in the upper reaches of these catchments. Improving the diversity of riparian habitat, through the reestablishment of native trees and other vegetation in the River Fyne and the River Kinglas will improve productivity and provide some protection against the effects of climate change. Other implications for habitat

productivity are related to fine sediment in the River Shira. The survey data suggest that habitat improvement work undertaken on the River Shira utilising large woody debris to improve cover for young fish has had some positive benefit for fish production and may be utilised in other areas.

5.3 Fisheries management

In addition to the existing limitations on the productivity of some freshwater habitats there appear to be changes in the North Atlantic Ocean, likely to be linked to climate change, that require fishery managers to continue to maximise the number of salmon able to spawn by controlling access to the fishery and operating on a catch and release basis for both salmon and trout. Further to this, more information is required to fully evaluate the status of trout populations. As it is no longer feasible to utilise hatcheries to support small populations of salmon, directing resources to further improving the productivity of the habitat is a priority in attempts to maintain and improve recruitment of smolts.

6. APPRASIAL OF METHODOLOGY AND DISCUSSION OF FUTURE WORK

The electrofishing methodology utilised in the survey is appraised in relation to a number of factors affecting the efficiency and interpretation of electrofishing survey data;

6.1 Location and timing of surveys

The location and seasonal timing of sampling is likely to be reflected in the abundance of fish sampled at survey sites. Sampling of fish close to spawning sites are likely to record higher densities of juvenile fish than sites further away. Additionally, sampling relatively early in the summer may yield a higher density of juveniles compared to samples taken later in the summer as juveniles grow and disperse and effects of dependant mortality reduce density over time. Therefore, the sampling undertaken in late summer is likely to reflect juvenile population abundance at a time where initial high rates of early density dependant mortality or dispersal have taken place but the likely carrying capacity of the site may not have been reached. It would be expected that further mortality or emigration would arise depending on the suitability of the habitat for over-wintering juveniles.

6.2 Sampling error

The minimum density estimates of juvenile abundance are also likely to vary between sites depending on the relative complexity of the habitat being sampled. Those habitats with relatively poor potential to provide cover for fish are likely to yield a higher percentage of the fish present in the first run as there are lower numbers of fish present and fewer features for them to become lodged or trapped and visibility of fish to the survey workers to become impaired. Conversely, it is expected that fewer of the total number of fish present will be sampled in complex habitat in the first sampling run and therefore confidence limits generated at these sites are likely to be significantly larger than for sites with less diverse fish cover.

The survey was also primarily aimed at the primary shallow water habitats of juvenile salmonids during the summer period, therefore non-salmonid species may be less abundant in the shallow faster flowing habitats surveyed may be underrepresented in this study.

6.3 Interpretation of data

The results of the electrofishing survey indicate that the methodology used provided adequate data to identify the salmonid fish present at sampling sites and an indication of their relative abundance at the time of survey. However, the frequency, distribution and degree of accuracy of the fish sampling programme may not be sufficient to fully describe the distribution of all fish species. The current interpretation of the classification of juvenile fish abundance used in this study may misrepresent some fish data as the assessment is based on a limited number of previously surveyed sites from all over the west of Scotland region and therefore may not reflect accurately the status of this fish population.

7. REFERANCES

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Appendix I - Electrofishing survey sites

River Aray electrofishing sites

Site	Sub catchment	Site	Easting	Northing	Alt. (m)
2	Lower mainstem	D/S Maltlands Bridge	209179	709853	10
2bi	Allt Riabhachan	50 m upstream of confluence	208889	710240	15
3	Middle mainstem	D/S Fish hatchery	208564	711090	35
4	Middle mainstem	Three bridges at old shed	208946	712262	55
6b	Middle mainstem	Stronmagachan U/S of trib.	208739	714182	80
6c	Allt a Mhagarain	20m U/S confluence	208611	714263	80
8a	Ladyfield Bridge	D/S bridge	208881	715530	95
9a	North Tullich	U/S dear fence	209126	716461	115
10b	Drochaidean	West tributary	209309	718008	145

River Shira

Site	Sub catchment	Site	Easting	Northing	Alt (m)
2	Allt Buidhe	D/S of road	212249	712570	6
4	Kilblaan Burn	D/S of road	212829	713477	7
5	Kilblaan mainstem	D/S of bridge	212566	713447	8
7	Ellerig More	D/S of stepping stones	213794	715120	11
8	Creag Bhan trib.	U/S of track	213754	715162	12
9	Upper Mainstem	Eilean an Eagaill at Island	213859	715203	13

River Fyne

Site	Sub catchment	Site	Easting	Northing	Alt. (m)
4a	Lower Mainstem	D/S Merk Burn confluence	220766	714436	26
5	Merk Burn	U/S of track bridge	220802	714517	27
7	Middle Mainstem	U/S Glen Fyne Lodge	222254	715473	29
7a	Middle Mainstem	D/S Glen Fyne Lodge weir	221977	715407	30
7b	Middle Mainstem	LB Channel Braid	222594	715782	40
8	Middle Mainstem	Braid at Power Stn	223002	716359	55
9b	Middle Mainstem	U/S of Swing Bridge	223083	716802	64
10a	Middle Mainstem	U/S of RB trib conf.	222890	717794	95
11d	Upper Mainstem	U/S of pool	223212	718442	105
11e	Upper Mainstem	200 m u/s pool	223362	718841	110
12a	Upper Mainstem	20m U/S from Allt Ruadh	223717	719383	130
12b	Upper mainstem	u/s of cliff pool	223600	719150	120

Kinglas Water

Site	Sub catchment	Site	Easting	Northing	Alt. (m)
6a	Middle mainstem	Island U/S of butter bridge	223434	709518	180
9	Upper mainstem	Mature Island braid	224200	710100	198
9a	Upper mainstem	U/S of tributary at sheepfold	224300	710300	200
9c	Upper tributary	RB trib U/S of sheepfold	224300	710300	205
12	Upper mainstem	D/S of Abyssinia	225446	711749	245
13	Upper tributary	Allt Uaine at confluence	225469	711744	250

Leacann Water

Site	Sub Catchment	Site	Easting	Northing	Alt. (m)
6b	Middle mainstem	D/S of Abh. Dubhan conf.	202348	701873	39
7	Abhainn Dubhan	U/S of footbridge	202250	701844	40
10	Eas a Corabha	Below Auchundrain bridge	202706	702655	75

River Auchalick

Site	Sub Catchment	Site	Easting	Northing	Altitude (m)
2a	Lower mainstem	U/S of lower weir	191918	674821	5
5	Middle mainstem	U/S road bridge	192903	675965	34
6	Middle mainstem	D/S of upper weirs,	193378	676564	56
9	Upper mainstem	50m u/s of Lochan	193583	676736	60
11	Upper mainstem	U/S of Acharossan bridge	193971	677068	71

Appendix II - Quintile ranges for juvenile salmonid density for sites for different classes of river width for West Region (Godfrey, 2005)

	Stream width Class				
Min. Percentile	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
Salmon fry (0+)					
0th	1.3	1.6	0.8	0.6	E
20th	2.4	3.5	1.6	2.7	D
40th	5.3	6.0	10.4	8.1	C
60th	10.7	14.0	14.0	15.9	B
80th	17.2	35.5	21.1	45.1	A
100th	60.0	27.3	44.7	29.4	
(%) zero density	**40.0%**	**27.8%**	**22.8%**	**14.1%**	
Salmon parr (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	1.4	0.8	0.5	0.5	E
20th	2.3	2.0	1.9	1.7	D
40th	3.3	5.0	4.4	3.2	C
60th	6.9	6.6	5.9	4.2	B
80th	12.2	10.8	10.9	6.6	A
100th	30.9	40.4	22.0	24.0	
(%) zero density	48.8%	24.2%	26.3%	11.8%	
Trout fry (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	1.4	0.7	0.5	0.2	E
20th	9.9	3.0	1.1	0.8	D
40th	28.5	5.0	1.8	1.5	C
60th	44.7	12.4	2.7	2.6	B
80th	74.4	19.0	5.3	4.0	A
100th	181.3	103.5	94.6	9.8	
(%) zero density	5.0%	12.1%	18.4%	41.2%	
Trout parr (1++)	**<4m**	**4-6m**	**6-9m**	**>9m**	**Class**
0th	0.9	0.9	0.8	0.5	E
20th	3.9	2.3	1.5	0.7	D
40th	5.6	3.3	2.1	0.9	C
60th	7.6	5.4	3.2	1.5	B
80th	12.1	8.4	4.9	1.8	A
100th	66.7	30.3	10.8	6.0	
(%) zero density	13.8%	12.1%	18.4%	26.5%	