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Water of Fleet Electrofishing Report

2016-2018

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Summary

Water of Fleet Electrofishing Report 2016-2018

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Background

The Water of Fleet is a medium sized catchment which has been degraded by acidification. The salmonid populations of the Water of Fleet have been monitored annually by Galloway Fisheries Trust since 1989. This report determines salmonid population health between 2016 and 2018 by examining the results from electrofishing surveys conducted at 22 monitoring sites.

Main findings

- Electrofishing surveys were conducted at 22 monitoring sites between 2016 and 2018 with eight sites surveyed over multiple years.
- Juvenile salmon were absent from the upper reaches of the Water of Fleet catchment and found in mixed densities lower down the catchment. The upper Water of Fleet has been affected by acidification and although some areas are showing signs of recovery, salmon populations remain fragile.
- The Water of Fleet historically supported a sea trout fishery. Healthy populations of juvenile trout are found with only the very upper reaches of the catchment not supporting juvenile trout. Trout are more tolerant to acidification than salmon and as such it is likely trout populations in the upper reaches are showing a degree of acid tolerance.

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1. INTRODUCTION

The Water of Fleet is a medium sized river catchment in Galloway which supports salmon, brown 'resident' trout and migratory 'sea' trout. Similarly, to other rivers in Galloway, the Water of Fleet headwaters has been impacted by acidification. Since 1989, Galloway Fisheries Trust (GFT) has undertaken annual electrofishing and habitat surveys within the Water of Fleet catchment. It is crucial population dynamics of salmon and trout are surveyed over time to understand fry to parr survival, monitor any recovery of fish stocks and identify areas where populations require additional management.

2. AIMS

This study aimed to identify the distribution and abundance of fish populations, particularly of juvenile salmonids, within the Water of Fleet catchment from 2016 to 2018.

3. METHOD

3.1 Data recording

GFT is a partner in the Scottish Fisheries Co-ordination Centre[1] (SFCC), an initiative involving the Scottish Fisheries Trusts and others, including the Scottish Government Freshwater Fisheries Laboratory, the Tweed Foundation, the Spey Research Trust, the Tay Foundation and the Cromarty Firth Fisheries Trust.

The SFCC has, in partnership, developed a set of agreed methodologies and record sheets for use with the electrofishing surveys and an associated database in which to record information gathered from such surveys.

The electrofishing surveys undertaken by GFT for this study have been completed to the high standards that are required by the SFCC and recorded using the agreed methodologies.

Electrofishing surveys were undertaken by a team of three SFCC accredited GFT staff at all survey sites. It is also policy of the GFT to disinfect all relevant equipment both prior to and following work in each river catchment, to ensure that there is no transfer of disease organisms.

3.2 Quantitative electrofishing techniques

There have been various techniques developed in recent decades to assess fish populations present within a section of river. Electrofishing surveys are the main methodology employed to assess the health of fish populations. Electrofishing surveys involve stunning fish using an electric current which enables the fish to be captured and removed from the water. Specifically, an E-fish backpack electrofishing kit using smooth direct current was used. The backpack is battery powered and linked to a cathode of braided copper and a mobile, single stainless-steel anode ring mounted on a pole with a trigger switch. The anode operator uses the generated electric current to stun the fish and draw them in a downstream direction towards a banner net and hand net operated by assistants. Once the fish are captured, they are removed from the water and influence of the electric current, into a water-filled container. Fish recover quickly after being stunned and are kept in a holding bucket until the survey has been completed. The team continue to survey the stretch of river in an upstream direction, ensuring the whole section has been fished through thoroughly. Once the survey has been completed, the fish are anaesthetised using a specific fish anaesthetic, identified, measured and recorded. Once the fish have recovered from the anaesthetic, they are returned unharmed to the area from which they were captured.

Quantitative electrofishing surveys provide a more accurate estimate of a population density for each species of fish. A 'Zippin' estimation of a fish population can be calculated using a depletion fishing method, whereby each survey site was fished through a number of times (multiple run fishing). A Zippen estimate is an estimate of the fish population density per 100 m^2 of water, including 95% Confidence Intervals. When a Zippen estimate of population density is not possible, a minimum estimate of fish population density is provided for that section of watercourse. The densities of juvenile salmonids recorded are then classified into several categories.

[1] www.sfcc.co.uk/resources/electrofishing.html

A regional classification scheme for salmonid densities was generated by SFCC[2] from which juvenile salmonid densities can be classified (Table 1). The categories are based on quintile ranges for one-run electrofishing events in the Solway region (Solway Salmon Fishery Statistical Region) which enables densities of fish observed to be compared in a regional context. However, the juvenile salmonid density classification scheme is based solely on data collected between 1997 and 2002 and refers to regional conditions at that time. It should only be used as a relative guide and not be used to draw conclusions. The figures for juvenile trout are less reliable due to some surveyed populations of trout being isolated and sea trout contributing to stock in some areas. Therefore, trout densities can only be used as a relative indication of numbers.

Table 1: Quintile ranges for juvenile salmonids (per 100 m^2) based on one-run electrofishing events, calculated on densities >0 over 291 sites in the Solway Statistical Region

	Salmon 0+	Salmon 1++	Trout 0+	Trout 1++
Minimum (Very Low)	0.22	0.38	0.38	0.35
20th Percentile (Low)	5.21	2.86	4.14	2.27
40th Percentile (Moderate)	12.68	5.87	12.09	4.71
60th Percentile (High)	25.28	9.12	26.63	8.25
80th Percentile (Very High)	46.53	15.03	56.49	16.28

3.3 Salmonid age determination

Once each salmonid (Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*)) has been measured, the age of each fish can be determined by examining the distribution of lengths of each salmonid species. The distribution of lengths provides a breakpoint below which each fish is identified as less than a year old (fry) and above which the fish are identified as more than a year old (parr) (Table 2). However, it is more difficult to determine the age of older salmonids using this methodology and scale samples may be taken to verify the age of these fish.

Table 2: Salmonid age classes

Salmon Fry (0+):	Refers to young fish less than one year old as a result from spawning at the end of 2017.
Trout Fry (0+):	Refers to young fish less than one year old as a result from spawning at the end of 2017.
Salmon Parr (1+ and older):	Refers to young fish of greater than one year and greater than two years old (where present) from spawning years 2016 and 2015.
Trout Parr (1+ and older):	Refers to young fish of greater than one year and greater than two years old (where present) from spawning years 2016 and 2015. Trout of up to three or four years old are also included in this category.

3.4 Non-salmonid fish species

At each survey site the presence of non-salmonid fish species was noted. Population densities for non-salmonid fish species were not calculated.

[2] Godfrey, J. D., 2005; Site Condition Monitoring of Atlantic Salmon SACs: Report by the SFCC to Scottish Natural Heritage, Contract F02AC608.

3.5 Site measurements

The total area fished was calculated at each survey site based on the total length of the survey site and average wet width. The average wet width was calculated from five individual widths which were measured at equidistant intervals throughout the site. The average dry widths were also calculated.

3.6 Bankside/instream habitat assessment

At each survey site the instream habitat available for older (parr aged) salmonids was graded as poor, moderate, good or excellent. This grading provides an index of instream cover where diverse substrate compositions score more favourably than areas with a uniform substrate composition which provides poor cover.

In accordance with SFCC protocols, percentage estimates of depths, substrate type and flow type were made at each site. Additionally, percentage estimates of the quantity of the bankside features, undercut banks, draped vegetation, bare banks and marginal vegetation were made.

3.7 Site selection

Sites were selected by GFT prior to the surveys taking place and were based on sites previously surveyed for annual monitoring of the Water of Fleet catchment. Sites were chosen to best assess the health of fish populations residing within the Water of Fleet catchment.

In total, 22 sites were surveyed between 2016 and 2018 with eight sites being surveyed over multiple years.

4. RESULTS AND DISCUSSION

The results of the electrofishing surveys outlined in this section are presented in detail in Table 3, which provides information on population densities of juvenile salmonids at each site, site code, watercourse, site location, O.S. grid reference, survey date, non-salmonid species and area fished (m^2).

4.1 Site F1.16: Cardoon Burn

Site F1 was located on the Cardoon Burn, upstream of the forestry plantations and was surveyed in 2016.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles and cobbles (65%), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 40 cm deep, with most depths between 20 cm and 30 cm deep (60%). The average wetted width was 2.3 m. The flow type was dominated by shallow glide (60%) with some riffle, run and deep glide also recorded. Banksides provided some bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No salmon fry or parr were recorded at this site. A low density of trout fry was recorded (9.7 per 100 m^2 water) and a moderate density of trout parr (6.4 per 100 m^2 water). This site is impacted by acidification and it is in the upper reaches of the Water of Fleet. No other fish species were found at this site.

Figure 1: Site F1, looking upstream

4.2 Site F2.18: Water of Fleet

Site F2 was located on the Water of Fleet, downstream of the forestry boundary. It was surveyed in 2018 as part of a national electrofishing program funded by the Scottish Government.

The instream habitat at this site was of a moderate standard. Substrates were dominated by gravel, pebbles and cobbles (90%), with sand and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 50 cm deep, with most

depths between 20 cm and 40 cm deep (80%). The average wetted width was 6.4 m. The flow type was dominated by run and riffle (90%) with some shallow glide also recorded. Banksides provided a moderate level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

Juvenile salmon were absent from this site. A moderate density of trout fry (17.4 per 100 m^2 of water) and trout parr (5.1 per 100 m^2 water) was recorded. This site was in the upper reaches of the catchment and is impacted by acidification. An eel was also found.

Figure 2: Site F2, looking upstream

4.3 Site F3.16: Craiglowrie Burn

Site F3 was located on the Craiglowrie Burn near Hill Faulds and was surveyed in 2016.

The instream habitat at this site was of a poor standard. Substrates were dominated by pebbles and cobbles (80%), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded included some over 50 cm deep, with most depths between 10 cm and 30 cm deep (65%). The average wetted width was 2 m. The flow type was dominated by shallow glide and run (70%) with some pool and deep glide also recorded. Banksides provided a moderate level of bankside cover in the form of undercut banks and draped vegetation. Very little canopy cover shaded the site.

No juvenile salmon were found at this site. Trout fry were recorded at a low density (4.1 per 100 m^2 of water) and trout parr were absent. This site is accessible to migratory salmonids, but acidification does appear to impact this site. This site is of concern as juvenile salmonid numbers had improved in recent years, but it would appear their numbers have declined again. No other fish species were found.

Figure 3: Site F3, looking upstream

4.4 Site F4.16: Water of Fleet

Site F4 was located on the Water of Fleet, upstream of Darrow Knowes and was surveyed in 2016.

The instream habitat at this site was of a moderate standard. Substrates were dominated by pebbles and cobbles (75%), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 30 cm deep, with most depths between 20 cm and 30 cm deep (60%). The average wetted width was 10.5 m. The flow type was dominated by run and riffle (95%) with some shallow and deep glide also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No salmon fry or parr were recorded at this site. A low density of trout fry (7.8 per 100 m^2 of water) was recorded and a very low density of trout parr (2.2 per 100 m^2 of water) was also recorded. This site is impacted by acidification and explains the lack of juvenile salmonids. No other fish species were recorded during this survey.

Figure 4: Trout caught at site F4 in 2016

4.5 Site F5.16: Benmeal Burn

Site F5 was the upper site on the Benmeal Burn and was surveyed in 2016.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles, cobbles and boulders (95%), with gravel also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 40 cm deep, with most depths between 20 cm and 30 cm deep (50%). The average wetted width was 1.7 m. The flow type was dominated by run (70%) with some glide and riffle also recorded. Banksides provided a high level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

Juvenile salmon were absent from this site in 2016. Trout fry was also absent from the site but trout parr were recorded at a high density (9.3 per 100 m^2 of water). This site is impacted by acidification and GFT have carried out some liming in the surrounding area in the past. It would appear any spawning in 2016 was unsuccessful. No other fish species were found.

Figure 5: Site F5, looking upstream

4.6 Site F6.16 and F6.18: Benmeal Burn

Site F6 was the lower site on the Benmeal Burn and was surveyed in 2016 and 2018.

The instream habitat at this site was of a poor standard. Substrates were dominated by gravel, pebbles and cobbles (90% in 2016 and 80% in 2018), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were over 50 cm deep, with most depths between 20 cm and 30 cm deep (55%) in 2016 and less than 20 cm (60%) in 2018. The average wetted width was 2.9 m in 2016 and 2.5 m in 2018. The flow type was dominated by shallow glide and run (65% in 2016 and 60% in 2018) with some deep glide and pool also recorded. Banksides provided a moderate level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

Juvenile salmon were absent from this site in both years. A moderate density of trout fry (20.4 per 100 m^2 of water) and parr (6.3 per 100 m^2 of water) was recorded in 2016 and a very high density of trout (66.4 fry and 18.7 parr per 100 m^2 of water) in 2018. This site is impacted by acidification but GFT undertook liming upstream in the past to decrease the acidity of the watercourse. No other fish species were found at this site.

Figure 6: Site F6, looking upstream

4.7 Site F7.16: Water of Fleet

Site F7 was located on the Water of Fleet near Little Cullendoch Moss and was surveyed in 2016.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles, cobbles and boulders (95%), with gravel also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 50 cm deep, with most depths between 20 cm and 30 cm deep (50%). The average wetted width was 11.6 m. The flow type was dominated by run (65%) with some riffle, shallow and deep glide also recorded. Banksides provided no bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No salmon fry or parr were recorded at this site in 2016. A low density of trout fry (10.8 per 100 m^2 of water) was found and a very low density of trout parr (2 per 100 m^2 of water). Again, this site is impacted by acidification and there are only low numbers of trout successfully spawning at this site. An eel was also found at this site.

Figure 7: Site F7 looking upstream

4.8 Site F8.18: Water of Fleet

Site F8 was the upstream site on the Water of Fleet near Cullendoch and was surveyed in 2018.

The instream habitat at this site was of a poor standard. Substrates were dominated by gravel and pebbles (95%), with sand also present. Substrates within the site were stable and un-compacted. Water depths recorded were over 50 cm deep, with most depths between 20 cm and 40 cm deep (65%). The average wetted width was 7 m. The flow type was dominated by run and riffle (85%) with some shallow glide and deep pool also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

Juvenile salmon were absent from this site. Trout parr were also absent and trout fry (12.6 per 100 m^2 of water) were recorded at a moderate density. Again, this site is impacted by acid flushes. No other fish species were found.

Figure 8: Site F8, looking upstream

4.9 Site F9.16: Water of Fleet

Site F9 was the downstream site on the Water of Fleet near Cullendoch and was surveyed in 2016.

The instream habitat at this site was of a poor standard. Substrates were dominated by pebbles and cobbles (55%), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 50 cm deep, with the majority of depths less than 20 cm deep (60%). The average wetted width was 3.2 m. The flow type was dominated by run (70%) with some shallow glide and riffle also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No salmon fry or parr were recorded at this site in 2016. A high density of trout fry (30.2 per 100 m^2 of water) and a moderate density of trout parr (6 per 100 m^2 of water) were recorded at this site. Acidification still impacts the water quality at this site although presumably less than further upstream. No other fish species were found.

Figure 9: Site F9, looking upstream

4.10 Site F10.16, F10.17 and F10.18: Water of Fleet

Site F10 was located on the Water of Fleet at the viaduct and was monitored 2016, 2017 and 2018.

The instream habitat at this site was of a moderate standard. Substrates were dominated by pebbles and cobbles (75% in 2016, 75% in 2017 and 65% in 2018), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 40 cm deep, with most depths between 20 cm and 30 cm deep in 2016 and 2017 (70%). Most depths were recorded between 10 cm and 20 cm in 2018 (60%). The average wetted width was 8.1 m in 2016, 8.6 m in 2017 and 8 m in 2018. The flow type was shallow glide, run and riffle. Banksides mostly provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No juvenile salmon were recorded at this site in any year. A high density of trout fry was recorded in 2016 (41 per 100 m^2 of water) and 2018 (38.1 per 100 m^2 of water). Trout fry were recorded at a very high density (59.4 per 100 m^2 of water) in 2017. A high density of trout parr (10.2 per 100 m^2 of water) was recorded in 2016. However, no trout parr were recorded in 2017 and a moderate density of trout parr (7.1 per 100 m^2 of water) was recorded in 2018. Therefore, trout are successfully spawning at this survey site resulting in high trout fry densities. Trout parr densities varied between years. This could indicate that there is little suitable habitat for trout parr and they are dropping further down the catchment or trout survival from fry to parr is still very low in some years. This area of the Water of Fleet is impacted by acidification to some degree. It did show signs of recovery in previous years as salmon spawned in this area. However, it would appear salmon are again not spawning here or there are high mortalities of any juvenile salmon. Therefore, this area appears to be still impacted by acid flushes in some years. One eel was also found in 2016. There were no other fish species found in 2017 and three eels were recorded in 2018.

Figure 10: Site F10, looking upstream

4.11 Site F11.18: Water of Fleet

Site F11 was located on the Water of Fleet near Craigshinging and was surveyed in 2018.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles and cobbles (70%), with gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 50 cm deep, with most depths between 20 cm and 40 cm deep (65%). Wetted width averaged 8.2 m. The flow type was dominated by run and riffle (75%) with some shallow glide and white water also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

A low density of salmon fry (11.7 per 100 m^2 of water) and a very high density of salmon parr (17.5 per 100 m^2 of water) were recorded at this site which is the highest point up the catchment that salmon were found between 2016 and 2018. A very low density of trout fry (3.6 per 100 m^2 of water) and a low density of trout parr (3.6 per 100 m^2 of water) were also recorded. This site would appear to have habitat suitable for fry and parr and no concerns have been raised previously about water quality at this site. Therefore, it would have been expected that there would be good densities of juvenile salmon and trout present. However, as this site only has poor densities of salmon and trout this is a concern and further investigations should be conducted to understand the reason why. Two minnows were found at this site.

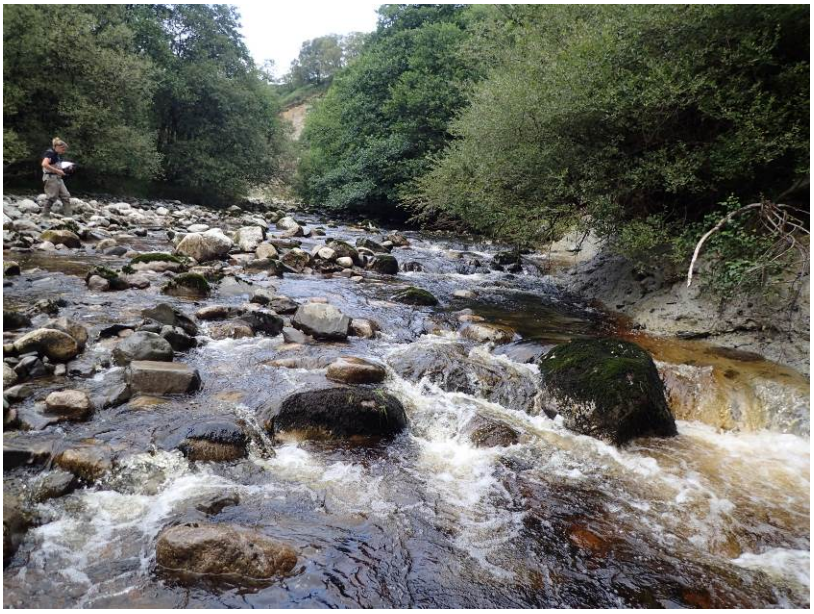


Figure 11: Site F11, looking upstream

4.12 Site F12.17: Water of Fleet

Site F12 was located on the Water of Fleet near Aikyhill Bridge and was surveyed in 2017.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles and cobbles (85%), with gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 40 cm deep, with most depths between 20 cm and 30 cm deep (75%). Wetted width averaged 11.6 m. The flow type was dominated by riffle (80%) with some shallow glide and run also recorded. Banksides provided a moderate level of bankside cover in the form of undercut banks and draped vegetation on the left bank but there was no cover provided on the right bank. Very little canopy cover shaded the site.

Salmon fry were recorded at a high density (26.7 per 100 m^2 of water) and salmon parr were recorded at a very low density (3.2 per 100 m^2 of water). Trout fry were recorded at a low density (10.7 per 100 m^2 of water) and trout parr were absent. This site was located on the mainstem Water of Fleet which tends to support more salmon populations than trout populations which tend to favour the tributaries for spawning. There were good densities of salmon fry but parr densities were poor as the habitat available was not particularly suitable for salmon parr. Two eels, minnows and 120 stoneloach were also recorded.

Figure 12: Site F12, looking upstream

4.13 Site F13.16: Little Water of Fleet

Site F13 was located on the upper Little Water of Fleet at a forestry road bridge and was surveyed in 2016.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles and cobbles (75%), with sand, gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were over 50 cm deep, with most depths between 10 cm and 30 cm deep (70%). The average wetted width was 2.1 m. The flow type was dominated by shallow glide and run (80%) with some deep glide and riffle also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. No canopy cover shaded the site.

No salmon fry or parr were found at this site in 2016. A very low density of trout fry (2.7 per 100 m^2 of water) and a moderate density of trout parr (8 per 100 m^2 of water) were recorded. No salmon or migratory 'sea' trout can access this site due to an impassable waterfall in the lower reaches of the Little Water of Fleet. This watercourse is also acidified which explains the low density of trout fry at this site. This site is a concern as there are few trout successfully spawning. An eel was also found at this site.

Figure 13: Site F13, looking upstream

4.14 Site F14.16: Little Water of Fleet

Site F14 was located on the Little Water of Fleet upstream of a dis-mantled railway line and was surveyed in 2016.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles, cobbles and boulders (90%), with sand and gravel also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 30 cm deep, with most depths between 20 cm and 30 cm deep (75%). The average wetted width was 4.4 m. The flow type was dominated by slow glide (60%) with some riffle and run also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. Little canopy cover shaded the site.

Juvenile salmonids were absent from this site in 2016. Again, this site is located above an impassable barrier to migratory salmonids and the site is also impacted by acidification. Two eels were found.

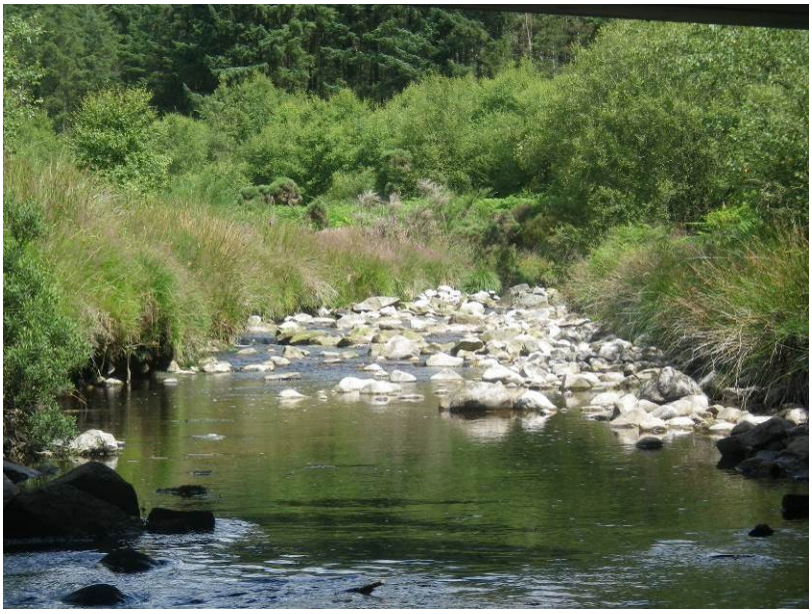


Figure 14: Site F14, looking upstream

4.15 Site F15.17 and F15.18: Little Water of Fleet

Site F15 was located on the Little Water of Fleet near Drumshangan Bridge and was surveyed in 2017 and 2018.

The instream habitat at this site was of a good standard. Substrates were dominated by pebble, cobble and boulder (95% in 2017 and 100% in 2018), with gravel also present in 2017. Substrates within the site were stable and un-compacted. Water depths recorded were over 50 cm deep in 2017, with the majority of depths between 20 cm and 50 cm (90%). In 2018, water depths were recorded up to 40 cm deep, with most depths between 10 cm and 30 cm (60%). The average wetted width was 6.7 m in 2017 and 3.1 m in 2018. The flow type was a predominantly run (70%) in 2017 and shallow glide (50%) in 2018. Banksides provided little to no bankside cover in the form of undercut banks and draped vegetation. There was a good percentage of canopy cover.

A high density of salmon fry (29.4 per 100 m^2 of water) was recorded in 2017 but a very low density (2.4 per 100 m^2 of water) was recorded in 2018. A very low density of juvenile salmon parr (1.7 per 100 m^2 of water) was recorded in 2017 and a very high density (33.7 per 100 m^2 of water) was recorded in 2018. The variation in salmon fry reflects the difference in spawning success between years. Salmon fry densities in 2017 where a result of very successful spawning in 2016. Salmon fry recorded in 2017 where then recorded as salmon parr in 2018. Salmon fry where recorded at a very low density in 2018, which indicates poor spawning in 2017. Trout fry (8.4 per 100 m^2 of water) and parr (6.7 per 100 m^2 of water) were found at a moderate density in 2017 and a high density (48.1 fry per 100 m^2 of water and 9.6 parr per 100 m^2 of water) in 2018. The lower reaches of the little Water of Fleet have been recovering from past acidification. However, these electrofishing results could indicate that there are still some impacts on the population from acidification flushes in some years. Two eels were also recorded at this site 2017 and five eels and a lamprey in 2018.

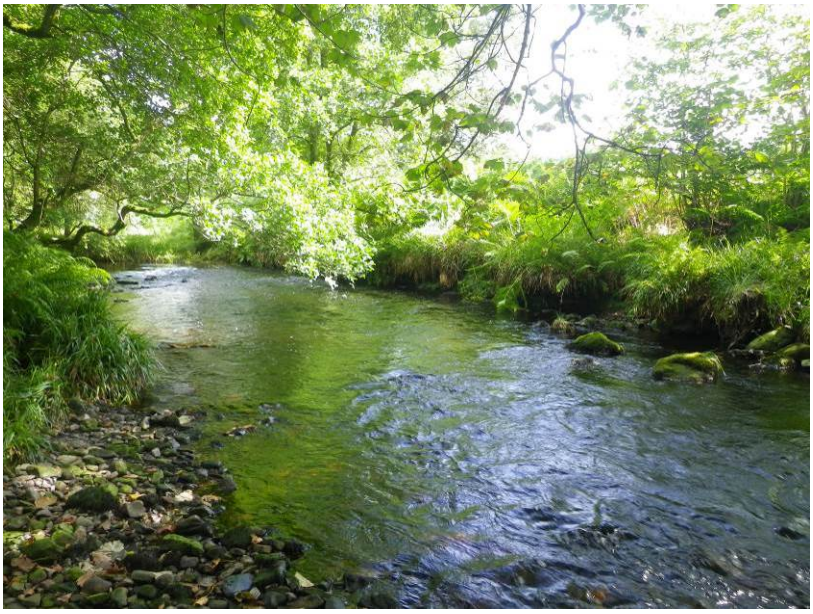


Figure 15: Site F15, looking upstream

4.16 Site F16.18: Little Water of Fleet

Site F16 was located on the Little Water of Fleet near Drumshangan Isle. It was surveyed in 2018 as part of a national electrofishing program funded by the Scottish Government.

The instream habitat at this site was of a poor standard. Substrates were dominated by cobbles (60%), with sand, gravel, pebbles and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were over 50 cm deep, with most depths between 30 cm and 50 cm deep (55%). The average wetted width was 9.8 m. The flow type was dominated by deep glide (75%) with some shallow glide also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. There was also 100% canopy cover which shaded the site.

Salmon fry were absent from this site but salmon parr were recorded at a low density (3.1 per 100 m^2 of water). Trout fry was recorded at a low density (2 per 100 m^2 of water) and trout parr were recorded at a very low density (2 per 100 m^2 of water). This site was surveyed as part of a national electrofishing program. The site is not suited for juvenile salmonids as the water is deeper and the site is over shaded. Therefore, it is unlikely trout or salmon would spawn in this area and fish densities found were as expected. Two lamprey and 58 minnows were also found at this site.

Figure 16: Site F16, looking upstream

4.17 Site F17.17 and F17.18: Castramont Burn

Site F17 was located on the Castramont Burn near road from Aikyhill and was surveyed in 2017 and 2018.

The instream habitat at this site was of a moderate standard. Substrates were dominated by a mix of pebbles, cobbles and boulders (85% in 2017 and 90% in 2018). Substrates within the site were stable and un-compacted. Water depths recorded were up to 30 cm deep, with most depths up to 20 cm deep (85% in 2017 and 100% in 2018). The average wetted width was 4.1 m in 2017 and 2.6 m in 2018. The flow type was run, riffle and shallow glide (100%). Banksides provided no bankside cover in the form of undercut banks and draped vegetation. The site was shaded by a high percentage of canopy cover.

Juvenile salmon were absent from this site. Trout fry was recorded at a very high density (67.8 per 100 m^2 of water) and parr were recorded at a moderate density (7.8 per 100 m^2 of water) in 2017. A moderate density (14.1 per 100 m^2 of water) of trout fry and a very high density (19.8 per 100 m^2 of water) of trout parr were recorded in 2018. Good densities of trout were recorded in 2017 and 2018. Therefore, this stretch of the Castramont Burn supports a good population of trout. However, this burn is a concern due to the lack of juvenile salmon even though it is accessible for spawning fish. No other fish species were found.

Figure 17: Site F17, looking upstream

4.18 Site F18.17 and F18.18: Water of Fleet

Site F18 was located on the Water of Fleet, downstream from Nether Rusko Bridge and was surveyed in 2017 and 2018.

The instream habitat at this site was of a good standard. Substrates were dominated by pebbles and cobbles (90% in 2017 and 65% in 2018), with gravel and boulders also present. Substrates within the site were stable and un-compacted. In 2017, most water depths recorded were between 20 cm and 30 cm deep (50%). However, in 2018 most water depths recorded were less than 20 cm deep (60%). This is due to differences in weather conditions with a lot more rain fall in 2017. The average wetted width was 6.6 m in 2017 and 6 m in 2018. The flow type was a mixture of run and riffle (85% in 2017 and 80% in 2018) with some shallow glide. Banksides provided no bankside cover in the form of undercut banks and draped vegetation. Little canopy cover shaded the site.

Salmon fry was recorded at a high density (90.1 per 100 m^2 of water) in 2017 and a very high density (396 per 100 m^2 of water) in 2018. Salmon parr were absent from the site in 2017 and recorded at a very high density (18.4 per 100 m^2 of water) in 2018. This site has a good mixture of substrates and flows to support juvenile salmon, with similar habitats being recorded in 2017 and 2018. Therefore, the absence of salmon parr in 2017 could be due to either poor spawning in 2016, using different habitats or high mortalities and will need to be monitored in the future. Trout fry was recorded at very low densities (5.6 per 100 m^2 of water) in 2017 and a moderate density (25.8 per 100 m^2 of water) in 2018. Trout parr were absent from this site in both 2017 and 2018. Again, trout in the Water of Fleet catchment tend to inhabit the tributaries instead of the main stem. One eel and one stoneloach were recorded at this site in 2017 but no other fish species were recorded in 2018.

Figure 18: Site F18, looking upstream

4.19 Site F19.17 and F19.18: Lagg Burn

Site F19 was located on the Lagg Burn near Lagg Bridge and was surveyed in 2017 and 2018.

The instream habitat at this site was of a good standard. Substrates were a mixture of gravel, pebble, cobbles and boulders (85% in 2017 and 100% in 2018). Substrates within the site were stable and un-compacted. Water depths recorded were up to 30 cm deep. There was more rain in 2017 and most water depths were recorded between 10 cm and 30 cm, where as 2018 was a drier year with most water depths less than 10 cm. The average wetted width was 4.2 m in 2017 and 3.5 m in 2018. The flow type was a mixture of run and riffle (90% in 2017 and 70% in 2018), with some shallow glide also recorded. Banksides provided little bankside cover in the form of undercut banks and draped vegetation. A large area of this site was shaded by canopy cover.

Juvenile salmon were absent from this site. Trout fry were recorded at very high densities (103.7 per 100 m^2 in 2017 and 70.9 per 100 m^2 of water in 2018) and trout parr were recorded at moderate densities (5.9 per 100 m^2 in 2017 and 6.4 per 100 m^2 of water in 2018). No other fish species were recorded at this site. In the Water of Fleet catchment, salmon tend to spawn in the mainstem whereas trout tend to spawn in the tributaries. There are also access problems for salmon due to natural waterfalls in the lower burn. Good densities of trout were recorded each year. Therefore, this stretch of the Lagg Burn supports a good population of trout and is important spawning habitat.

Figure 19: Site F19, looking upstream

4.20 Site F20.17: Water of Fleet

Site F20 was located on the Water of Fleet near Low Barlay and was surveyed in 2017.

The instream habitat at this site was of a poor standard for salmon parr. However, this site did contain excellent spawning/fry habitat. Substrates were dominated by pebble (70%), with sand, gravel and cobbles also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 40 cm deep, with most depths between 11 cm and 20 cm deep (60%). The average wetted width was 17.4 m. The flow type was dominated by run (70%) with some riffle and shallow glide also recorded. Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. Little canopy cover shaded the site.

Salmon fry were recorded at a moderate density (18.4 per 100 m^2 of water). Salmon parr, trout fry and parr were absent from this site. The substrate and flow characteristics of this site were suitable for spawning and fry habitat and there was a lack of larger substrates suitable for parr. The lower Water of Fleet catchment tends to lack suitable habitat for salmonid parr due to the movement of substrates, particularly gravel, within the system. Therefore, it is unlikely salmon or trout parr would be found at this site. Six stoneloach were also recorded.

Figure 20: Site F20, looking upstream

4.21 Site F21.17 and F21.18: Barlay Burn

Site F21 was located on the Barlay Burn near Old Bridge of Barlay and was surveyed in 2017 and 2018.

The instream habitat at this site was of a moderate standard. Substrates were dominated by pebbles and cobbles (65% in 2017 and 80% in 2018), with gravel and boulders also present. Substrates within the site were stable and un-compacted. Water depths recorded were up to 30 cm deep, with most depths between 10 cm and 20 cm deep (55%) in 2017 and less than 10 cm deep (70%) in 2018. The average wetted width was 5.7 m in 2017 and 3.5 m in 2018. The flow type was dominated by riffle and run in 2017 (90%) and shallow glide and run in 2018 (80%). Banksides provided a low level of bankside cover in the form of undercut banks and draped vegetation. Some canopy cover shaded the site.

Salmon fry were recorded at a moderate density (13.7 per 100 m^2 of water) in 2017 and a low density (10.1 per 100 m^2 of water) in 2018. Salmon parr were absent from this site in 2017 and 2018. Trout fry were recorded at a high density (65.1 per 100 m^2 of water) in 2017 and a very high density (238.7 per 100 m^2 of water) in 2018. Trout parr were recorded at a very low density (1.7 per 100 m^2 of water) in 2017 and were absent from this site in 2018. Again, this site was located on a tributary of the Water of Fleet which trout tend to use for spawning whereas salmon tend to spawn in the mainstem river. There were good densities of trout fry at this site but low densities of parr. This can be explained by the lack of suitable habitat for parr due to substrate composition and depths of the burn. A stoneloach was also recorded in 2017 and an eel in 2018.

Figure 21: Site F21, looking upstream.

4.22 Site F22.17 and F22.18: Pulcree Burn

Site F22 was located on the Pulcree Burn near Pulcree and was surveyed in 2017 and 2018.

The instream habitat for salmon parr at this site was a poor standard. The substrate was dominated by gravel, pebbles and cobbles (80% in 2017 and 85% in 2018), with silt, sand and boulders also present. The substrate within the site was also stable and un-compacted. Water depths recorded were up to 30 cm deep, with most depths between 10 cm and 20 cm deep (50%) in both 2017 and 2018. Wetted width averaged 4.1 m in 2017 and 2.4 m in 2018. The flow type was dominated by shallow glide and run (80%) in 2017 and slow pool and run (70%) in 2018. Banksides provided little bankside cover in the form of undercut banks and draped vegetation but there was 100% canopy cover which shaded the site.

A low density (5.0 per 100 m^2 of water) of salmon fry was recorded in 2017 but in 2018 salmon fry were absent from the site. Salmon parr were absent from the site in 2017 and 2018. A very high density of trout fry (119.8 per 100 m^2 of water) and parr (12.5 per 100 m^2 of water) was recorded at this site in 2017. In 2018, trout fry was again found at a very high density (191.8 per 100 m^2 of water) and trout parr were found at a high density (9.1 per 100 m^2 of water). This is an important trout spawning burn which supports a healthy population of juvenile trout. Juvenile salmon were only found as a low density of fry in 2017. In the Water of Fleet catchment salmon tend to spawn in the mainstem river whereas trout tend to spawn in the tributaries. In 2017 five eels, three lampreys and five minnows were also found at this site and in 2018 four lampreys were recorded.

Figure 22: Site F22, looking upstream

6. SUMMARY

This report has discussed the results from electrofishing monitoring surveys on the Water of Fleet between 2016 and 2018. A total of 22 sites were monitored with some of these survey locations being monitored multiple times.

The lower reaches of the Water of Fleet catchment typically supports healthy populations of salmon in the mainstem. This report has shown that there are healthy densities of salmon fry but lower densities of salmon parr. The lower reaches of the Water of Fleet catchment have few areas particularly suitable as parr habitat due to the hydrology of the river and the movement of substrates. In the lower reaches of the Water of Fleet, trout tend to inhabit the tributaries and healthy populations of trout were found in these tributaries. Some tributaries surveyed are susceptible to drying out during summer months which often results in lower parr densities. In comparison, the upper reaches of the Water of Fleet catchment are impacted by acidification which has resulted in salmon stocks declining or being absent from this area of the catchment. Trout are slightly more tolerant to acidification and a few adults have successfully managed to spawn in the upper catchment. However, the distribution of trout in this area is sporadic due to the small number of successful spawners. The mid reaches of the Water of Fleet catchment have started to show encouraging signs of recovery. However, it would appear from the results presented in this report that this improvement has halted at some sites and once again the densities of juvenile salmon have declined. This indicates that acidification remains an issue in the upper river. The Little Water of Fleet, which is a major tributary of the Water of Fleet, is also affected by acidification as it drains Loch Fleet. There is also an impassable waterfall in the lower reaches of this tributary. Therefore, the populations of trout within the Little Water of Fleet are resident populations. Despite being more tolerant than salmon to acidification, the density of trout within the Little Water of Fleet remains low and it is important to monitor this population and to undertake further mitigation works, including forestry restructuring, to ensure its survival.

7. Appendix 1: Table 3 Results from the 2016- 2018 electrofishing surveys on the Water of Fleet

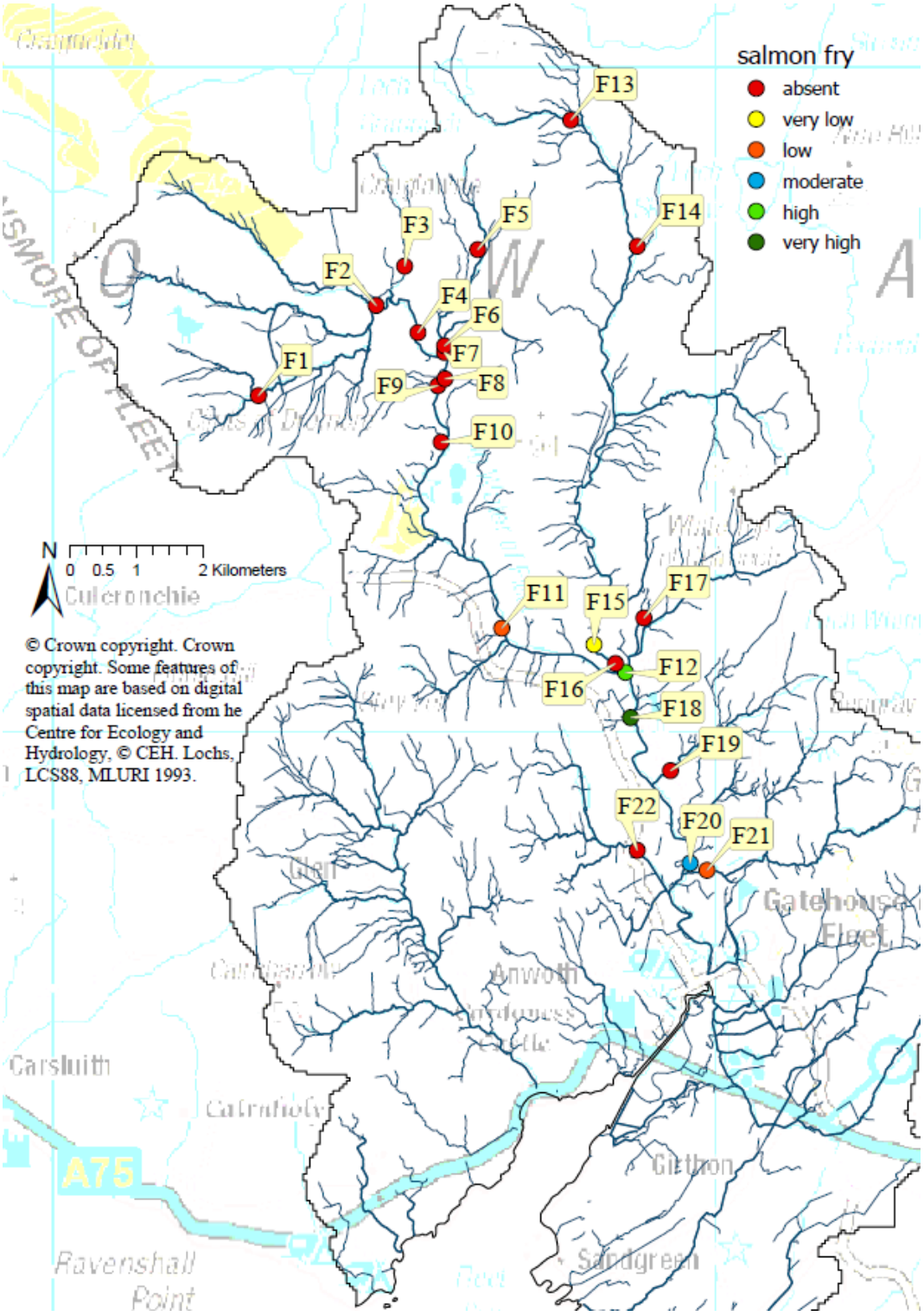
Site	Watercourse	Grid Ref	Survey Date	Presence of Non-Salmonids	Area Fished (m^2)	Minimum estimate of density per 100 m^2			
						Salmon Fry (0+)	Salmon Parr (1+ and older)	Trout Fry (0+)	Trout Parr (1+ and older)
F1.16	Cardoon Burn	253100 565050	08/08/2016	None	62.2	0	0	9.7	6.4
F2.18	Water of Fleet	254872 566408	17/09/2018	Eel	97.6	0	0	17.4	5.1
F3.16	Craiglowrie Burn	255300 567000	19/07/2016	None	48.5	0	0	4.1	0
F4.16	Water of Fleet	255500 566000	08/08/2016	None	90.1	0	0	7.8	2.2
F5.16	Benmeal Burn	256400 567250	08/08/2016	None	43	0	0	0	9.3
F6.16	Benmeal Burn	255900 565800	08/08/2016	None	63.8	0	0	20.4	6.3
F6.18	Benmeal Burn	255900 565800	13/07/2018	None	58.8	0	0	66.4	18.7
F7.16	Water of Fleet	255900 565700	08/08/2016	Eel	101.8	0	0	10.8	2.0
F8.18	Water of Fleet	255907 565303	17/09/2018	None	222.7	0	0	12.6	0
F9.16	Water of Fleet	255800 565200	19/07/2016	None	82.9	0	0	30.2	6.0
F10.16	Water of Fleet	255850 564350	19/07/2016	Eel	87.9	0	0	41.0	10.2
F10.17	Water of Fleet	255870 564296	08/08/2017	None	48.8	0	0	59.4	0
F10.18	Water of Fleet	255850 564350	06/07/2018	Eel	84	0	0	38.1	7.1
F11.18	Water of Fleet	256762 561546	06/08/2018	Minnow	137	11.7	17.5	3.6	3.6
F12.17	Water of Fleet	258623	08/08/2017	Eel	93.7	26.7	3.202	10.7	0

		560881		Stoneloach					
F13.16	Little Water of Fleet	257800 569200	19/07/2016	Eel	74.9	0	0	2.7	8.0
F14.16	Little Water of Fleet	258800 567300	19/07/2016	Eel	48	0	0	0	0
F15.17	Little Water of Fleet	258150 561344	08/08/2017	Eel	119.2	29.4	1.7	8.4	6.7
F15.18	Little Water of Fleet	258150 561300	13/07/2018	Lamprey Eel	41.5	2.4	33.7	48.1	9.6
F16.18	Little Water of Fleet	258473 561015	24/09/2018	Minnow Lamprey	98.2	0	3.1	2.0	2.0
F17.17	Castramont Burn	258921 561534	28/07/2017	None	38.3	0	0	67.8	7.8
F17.18	Castramont Burn	258900 561700	12/07/2018	None	35.4	0	0	14.1	19.8
F18.17	Water of Fleet	258775 560100	08/08/2017	Eel Stoneloach	71.0	90.1	0	5.6	0
F18.18	Water of Fleet	258700 560200	12/07/2018	None	54.3	395.9	18.4	25.8	0
F19.17	Lagg Burn	259360 559473	28/07/2017	None	33.8	0	0	103.7	5.9
F19.18	Lagg Burn	259300 559400	13/07/2018	None	46.6	0	0	70.9	6.4
F20.17	Water of Fleet	259595 558006	08/08/2017	Stoneloach	130.5	18.4	0	0	0
F21.17	Barlay Burn	259921 557883	28/07/2017	Stoneloach	58.4	13.7	0	65.1	1.7
F21.18	Barlay Burn	259850 557900	13/07/2018	Eel	29.8	10.1	0	238.7	0
F22.17	Pulcree Burn	258863 558122	28/07/2017	Minnow Lamprey Eel	40.1	5.0	0	119.8	12.5
F22.18	Pulcree Burn	258800 558200	12/07/2018	Lamprey	32.9	0	0	191.8	9.1

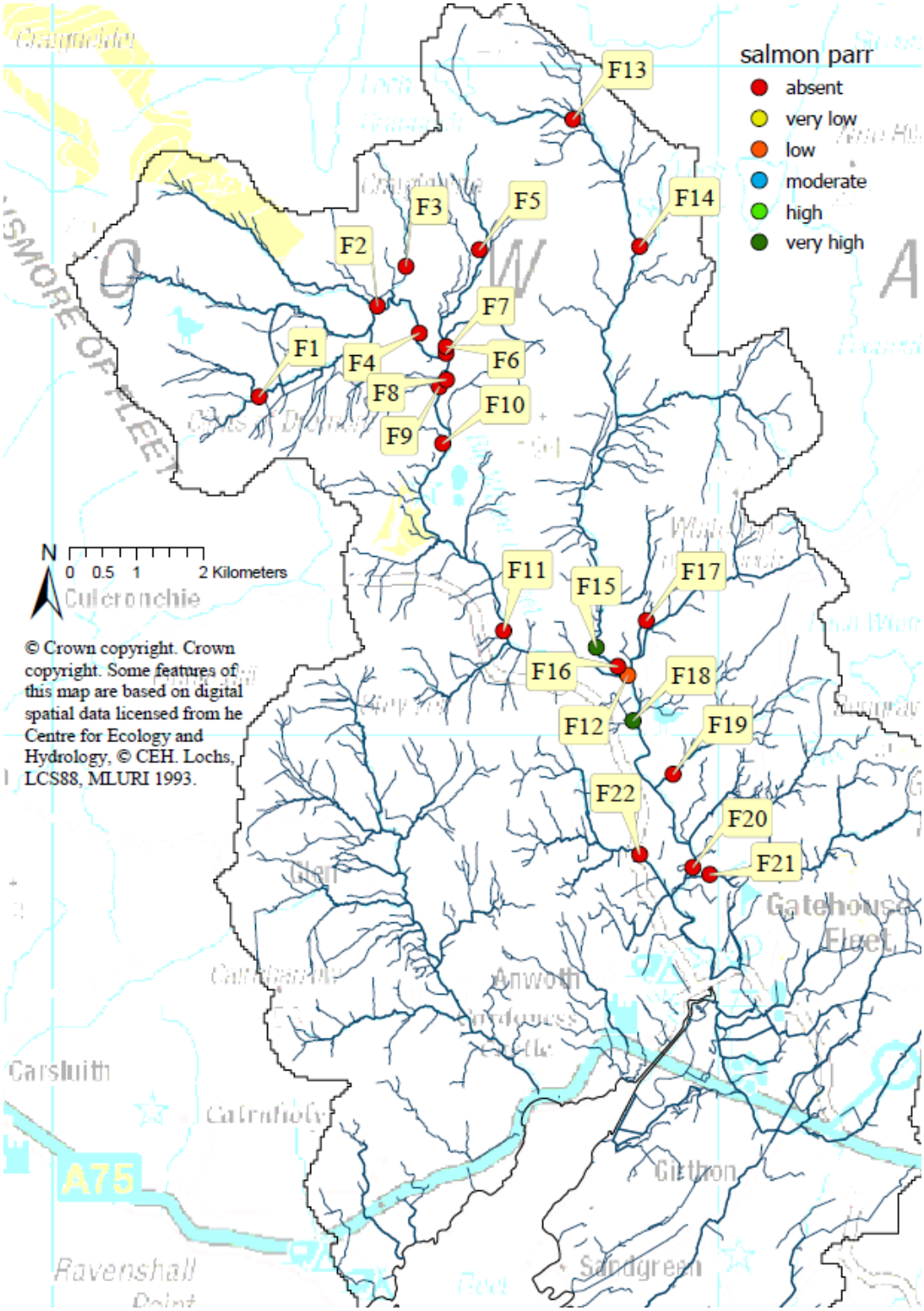
8. Appendix 2: Density of salmonids caught at 22 sites on the Water of Fleet catchment 2016-2018

Salmonid densities calculated during the 22 electrofishing surveys conducted between 2016 and 2018 are presented below. The densities presented for each site are from the most recent electrofishing survey at each site. Detailed electrofishing results can be found in Table 3.

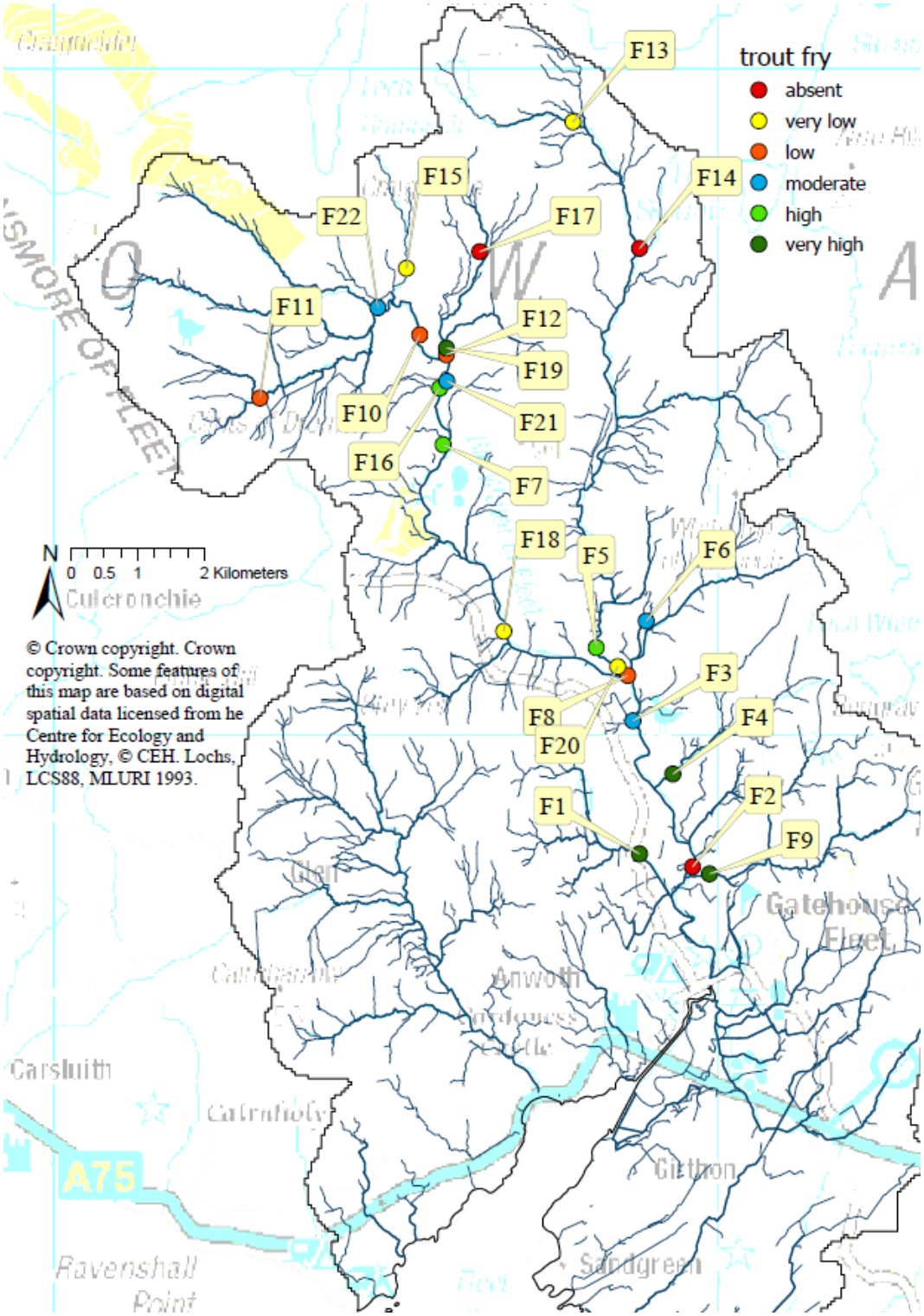
8.1 Figure 23: Density of salmon fry



8.2 Figure 24: Density of salmon parr



8.3 Figure 25: Density of trout fry



8.4 Figure 26: Density of trout parr