Viking Energy Wind Farm, fish population monitoring: Post-construction phase, 2025

Commissioned Report to Viking Energy Wind Farm LLP

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Contractor: Waterside Ecology

SUMMARY

Background

This report provides an assessment of fish populations in streams draining the Viking Energy Wind Farm. A pre-construction baseline was set for most (n = 31) sites in 2019. The first round of construction phase monitoring took place in 2020 at a limited series of sites where construction had commenced. Baseline data were collected from three new sites (CR2, CR3 and WE1a) in the same year.

The first full round of construction phase monitoring took place in 2021 and all sites were then re-surveyed annually between 2022 and 2024. The current survey took place in summer 2025 and represents the first post-construction assessment of fish populations. The aim was to assess fish populations in potentially impacted streams and to compare current densities with baseline and other data. A series of control sites has been included each year in order to determine temporal trends in streams outside the wind farm site.

Methods

Electric fishing surveys were carried out at 34 sites in 22 streams across 11 catchments. These comprised 28 impact monitoring sites spread over 9 catchments and 6 control sites in 3 catchments. Sites were harmonised with those used for monitoring of freshwater macroinvertebrates and hydrochemistry, as set out in the Water Quality Monitoring Plan (Viking Energy 2018).

Trout and salmon were the main target species for survey, but all fish caught were recorded. The survey used fully-quantitative methods according to the SFCC (2014) protocol.

Main findings

- Trout were present at 33 out of 34 survey sites. Densities remain highly variable across the study area, as they have been during past surveys. However, relative abundances in the various streams broadly matched those observed during the baseline and other surveys.
- Trout were absent from survey site LU1 and adjacent reaches in Burn of Lunklet. This is the fourth consecutive year when trout have been absent from these reaches.
- At impact monitoring sites, fry density increased compared with baseline at 17 sites, decreased at 10 and remained unchanged at one. Mean density at impact monitoring sites increased slightly from 18.3 during baseline to 22.7 per 100 m2 in 2025, a non-significant change (paired sample T-test, T = 1.47, df = 27, p = 0.16). Mean fry density also increased slightly at the control sites, from 3.8 per 100 m^2 during the baseline to 5.6 per 100 m^2 during 2025. Again, the change was non-significant (T = 0.56, df = 5, p = 0.60).
- Trout parr densities in 2025 were higher than baseline at 15 of the 28 impact monitoring sites, lower at 12 and unchanged at one. Parr densities at control sites in Seggie Burn and Burn of Laxobigging increased a little compared with baseline but substantial declines in parr densities were observed in Burn of Sandgarth (SA1 and SA2), the other control stream. Changes in mean parr density were not statistically significant at impact or control sites.
- Overall, the data continue to suggest that regional factors, perhaps related to climate, are likely to be the main drivers of wide-scale fluctuations in juvenile trout numbers in the study area.
- Juvenile Atlantic salmon remain present in Laxo Burn and South Burn of Burrafirth. Salmon

fry density at LA1 in Laxo Burn was the highest recorded to date.

- Salmon fry and parr were present in Burn of Weisdale, as they have been every year since the 2019 baseline. Salmon fry and parr were also present in Burn of Droswall, a tributary of Burn of Weisdale.
- Trout densities were assessed in relation to hydrochemical and freshwater invertebrate data in order to determine whether any observed declines may be related to construction activities. The chemical changes that have been identified in Burn of Lunklet, along with impacts on physical habitats and invertebrate populations appear to have left this stream unsuited to trout production. Some downstream impact into site BF1 in Burn of Burrafirth may also have occurred, but due to the historically low fish density at this site this is uncertain. Watercourses linked to Burn of Lunklet continue to sustain trout, providing potential sources for recolonisation should conditions improve.
- The increase in trout numbers at WE3 (Burn of Weisdale) in 2024, where observed declines in 2023 may have been related to construction impacts, was sustained into 2025. This is consistent with improved scores on some invertebrate indices of water quality.
- Due to the high degree of variability in time series data prior to any observed changes in water chemistry, it is uncertain whether observed declines in trout densities in Burn of Flamister or Burn of Marrofield Water are related in any way to construction. No substantial changes have been observed in freshwater invertebrate populations at these locations that would suggest any negative water quality impacts. It is likely that the observed changes reflect normal year-to-year variation in trout density and distribution in these watercourses.

The findings are discussed in relation to the wind farm development. It is recommended that efforts to mitigate the impact from runoff from Scallafield Scord into Burn of Lunklet and Burn of Weisdale should continue. In addition, it is recommended that monitoring of the success or otherwise of mitigation measures should continue and be subject to ongoing assessment and review.

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1 Introduction

A series of water quality monitoring programmes has been put in place to assess any impacts from construction or operation of Viking Energy Wind Farm on the watercourses draining the site. The identified sensitive ecological receptors are aquatic macro-invertebrates and fish. Stream hydrochemistry is monitored monthly and aids interpretation of the biological data as well as providing direct measures of water quality. The monitoring programme and sampling locations were agreed with statutory consultees during early 2019, as part of the overall Water Quality Monitoring Plan for the site (Viking Energy 2018).

Baseline data on fish were collected at 31 sites, including six control sites, prior to construction (Waterside Ecology 2020). The construction phase of the Viking Energy Wind Farm started in June 2020, in a limited area. Fish populations in potentially impacted streams and appropriate control sites were surveyed in 2020 (Waterside Ecology 2021a & 2021b) and construction phase monitoring of fish across the full wind farm site was completed annually between 2021 and 2024 (Waterside Ecology 2021, 2022, 2023, 2024). This report presents results of monitoring in late summer 2025.

2 Objectives

The aim was to assess fish populations across the Viking Energy Wind Farm site for comparison with baseline data gathered at the same sites before development works commenced. Most baseline data were collected in 2019. Specific aims were to:

- Re-survey impact monitoring sites in watercourses draining the site;
- Re-survey the control sites, unaffected by construction;
- Assess densities and temporal trends in trout and salmon numbers at impact monitoring and control sites;
- Identify any evidence of changes in fish populations, especially where these might be attributable to construction work at the site or associated changes in water quality.

3 Methods

3.1 Survey area and survey conditions

Sites WE1 and WE4 were surveyed on 29th July 2025. All other sites were surveyed during late August and early September. Surveys were carried out by the same SFCC-qualified electric fishing team that conducted the baseline and other surveys. Survey conditions in 2025 were good. Water level was low at the end of July and very low in August following a prolonged period of dry weather.

Water temperatures during the surveys ranged from 11°C to 18°C (Appendix 8.2).

3.2 Electric fishing methods

Electric fishing was used to assess the densities of salmonids and eels at all survey sites. Sites that had been surveyed in previous years were identified from markers, grid references, site descriptions and site photographs. Multi-run (fully quantitative) electric fishing was conducted at all sites with the exception of FL1 (Burn of Flamister), based on Scottish Fisheries Co-ordination Centre protocols (SFCC 2014). Details of fully quantitative methods are provided by Waterside Ecology (2020), but in essence provide an estimate of total fish numbers based on depletions in catch attained during three or more consecutive survey runs through a site. A single electric fishing run was conducted at FL1.

3.3 Nomenclature and data presentation

Throughout this report, the term fry is used to describe young of the year salmonid fish. This cohort is also referred to as 0+ (i.e. fish in their first year of life). The term parr is used to describe fish of more than one year and at some sites may include one or two mature fish. The shorthand terms 1+ and 2+

refer to parr in their second and third years of life respectively.

For ease of description and consistency with earlier reports the density classifications provided by Godfrey (2006) are used as a guide to relative abundance of salmon fry and parr. The density classification scheme, based on single run electric fishing, is set out in Table 1. As Godfrey did not have access to any density data from Shetland the Scotland-wide scheme is used. Most of the streams included in the current survey are small, so the relative classification for streams of less than 4 m wide is used throughout this report.

Table 1 Quintile range of salmonid densities for rivers up to 4 m in width throughout Scotland (from Godfrey 2006)

	Density (fish.100 m^{-2})			
	Salmon 0+	*Salmon 1++*	*Trout 0+*	*Trout 1++*
Min	0.2	0.7	0.6	0.7
20th percentile	4.3	2.5	4.5	4.5
40th percentile	8.7	5.1	11.0	5.0
60th percentile	15.2	8.3	22.9	8.3
80th percentile	35.2	15.8	49.9	15.3
Max	497.7	79.0	415.7	174.2

Table 2 Descriptive categories for density used in text (see Table 1 for quintile ranges)

Density in regional classification	**Description used in text**
< 20th percentile	Very poor
20th to 40th percentile	Poor
40th to 60th percentile	Fair
60th to 80th percentile	Good
80th to 100th percentile	Excellent

3.4 Analyses

Depletion estimates were calculated for fully quantitative sites using the *Removal Sampling 2* software (Pisces Conservation Ltd., 2007). The estimator used was Maximum Likelihood (ML) also known as the Zippin estimate. *Removal Sampling 2* provides test statistics to determine whether the data depart significantly from the assumption of constant capture efficiency, inherent in the estimate. All fish densities are expressed as fish per 100 square metres (fish.100m^{-2}). Upper and lower 95% confidence intervals are provided for Zippin estimates. These are often asymmetric. Densities are based on wetted areas as measured during the baseline, since wet width can vary depending on water level. Total fish density at FL1, which was surveyed semi-quantitatively, were estimated from the regressions between single run and Zippin densities at the other sites (Appendix 8.5).

3.5 Survey sites

A total of 34 sites were surveyed, 28 impact sites and a further 6 control sites, distributed over 22 streams and 11 catchments (Tables 3 and 4). Thirty-one of these sites were included in the baseline fish survey, conducted during 2019.

Baseline data from additional sites CR2 and CR3 on Burn of Crookadale and WF2 Wester Filla Burn were collected in 2020 (Waterside Ecology 2021). Site WF1 was replaced by WF1a in 2021 as the original had scoured down to such a depth (presumably due to spates) that it was no longer surveyable. WF1a is a short distance upstream of the original location in similar habitat.

Construction work had extended into the catchments of all watercourses by 2020 or 2021 and was largely completed by late 2024. The current survey, conducted in 2025, was the first during the post-construction period.

Table 3 Locations of electric fishing sites (impact sites)

Site	Watercourse	Catchment	NGR	Survey method
LA1	Laxo Burn	Laxo	HU 43942 63020	Fully quantitative
GO1	Gossawater Burn	Laxo	HU 43712 62535	Fully quantitative
CO1	Corgill Burn	Laxo	HU 43551 60235	Fully quantitative
EF1	Easter Filla Burn	Laxo	HU 42424 62324	Fully quantitative
GR1	Burn of Grunnafirth	Grunnafirth	HU 45748 58851	Fully quantitative
GR2	Burn of Grunnafirth	Grunnafirth	HU 45258 58134	Fully quantitative
QU1	Burn of Quoys	Quoys	HU 44688 55292	Fully quantitative
CR1	Burn of Crookadale	Crookadale	HU 43360 53944	Fully quantitative
CR2	Burn of Crookadale	Crookadale	HU 2839 54059	Fully quantitative
CR3	Burn of Crookadale	Crookadale	HU 42839 54059	Fully quantitative
GI1	Gill Burn	Crookadale	HU 43558 54625	Fully quantitative
FL1	Burn of Flamister	Crookadale	HU 43787 55037	Fully quantitative
PW1	Burn of Pettawater	Stromfirth	HU 41593 55531	Fully quantitative
PW2	Burn of Pettawater	Stromfirth	HU 41693 56975	Fully quantitative
WE1	Burn of Weisdale	Weisdale	HU 40128 54283	Fully quantitative
WE2	Burn of Weisdale	Weisdale	HU 40215 55242	Fully quantitative
WE3	Burn of Weisdale	Weisdale	HU 40511 56722	Fully quantitative
WE4	Burn of Weisdale	Weisdale	HU 40526 57788	Fully quantitative
DR1	Burn of Droswall	Weisdale	HU 39956 54987	Fully quantitative
BF1	Burn of Burrafirth	Burrafirth	HU 36687 57505	Fully quantitative
BF2	South Burn of Burrafirth	Burrafirth	HU 36705 56895	Fully quantitative
BF3	South Burn of Burrafirth	Burrafirth	HU 36469 55055	Fully quantitative
LM1	Burn of Lamba Water	Burrafirth	HU 37448 57107	Fully quantitative
LU1	Burn of Lunklet	Burrafirth	HU 37400 57302	Semi quantitative
MA1	B. of Marrofield Water	Burrafirth	HU 37348 57296	Fully quantitative
KI1	Burn of Kirkhouse	Kirkhouse	HU 39830 61701	Fully quantitative
WF1a	Wester Filla Burn	Voe	HU 41561 62202	Fully quantitative
WF2	Wester Filla Burn	Voe	HU 41529 61165	Fully quantitative

*Original site WF1 was moved slightly upstream in 2021

Table 4 Locations of electric fishing sites (control sites)

Site code	Watercourse	Catchment	NGR	Survey method
SE1	Seggie Burn	Laxo	HU 43948 63767	Fully quantitative
SE2	Seggie Burn	Laxo	HU 43642 64667	Fully quantitative
LB1	Burn of Laxobigging	Laxobigging	HU 41710 07271	Fully quantitative
LB2	Burn of Laxobigging	Laxobigging	HU 41421 72398	Fully quantitative
SA1	Burn of Sandgarth	Sandgarth	HU 40796 68070	Fully quantitative
SA2	Burn of Sandgarth	Sandgarth	HU 40869 67447	Fully quantitative

4 Results

4.1 Impact monitoring sites

4.1.1 Laxo catchment

Trout fry were present at all sites in the Laxo catchment (Table 5). Fry densities ranged from poor to good by national standards, with the highest density at CO1 in Corgill Burn, which runs into Gossa Water. This stream appears to provide good spawning opportunities and high trout fry densities have been recorded here during all previous surveys (see Figure 16). Fry density at GO1 in the outflow stream from Gossa Water was fair as was density at EF1, in Easter Filla Burn. Spawning habitat is present close to EF1.

Trout parr were present at all sites. The highest density, classified as good, was at LA1 in Laxo Burn.

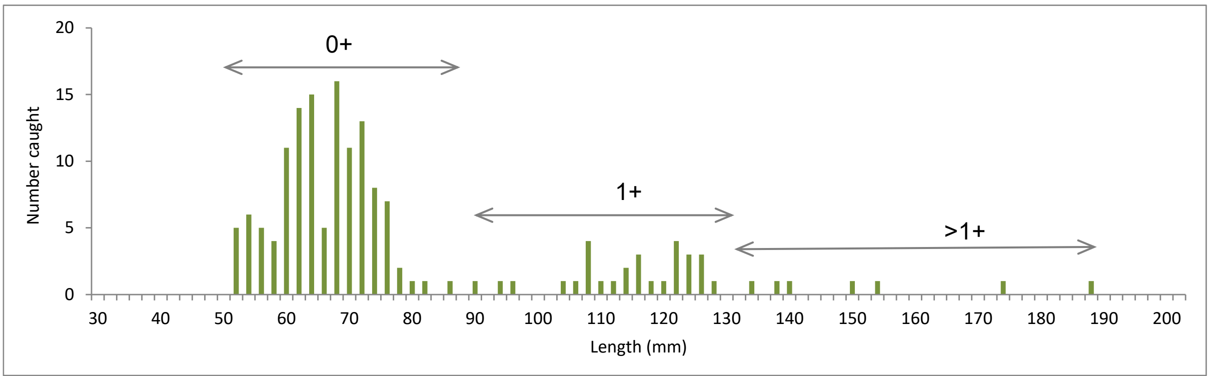
Table 5 Trout densities (fish.100 m^{-2}) and total number of eels, Laxo catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
LA1	5.7	10.0	Poor	Good	9.9 (9.3 - 2.1)	10.0 (10.0 - 10.0)	many
GO1	21.7	6.9	Fair	Fair	28.0 (27.7 - 29.2)	6.9 (6.9 - 6.9)	3
CO1	42.5	2.8	Good	Very poor	76.6 (73.7 - 82.2)	6.1 (5.7 - 8.5)	2
EF1	17.7	5.5	Fair	Fair	24.6 (24.1 - 25.8)	6.5 (6.5 - 6.6)	1

*Data are Zippins with 95% confidence limits or, if italicised, based on single run data and correction factors

Trout size distribution in the Laxo catchment (Figure 1) shows a clear fry year class with lengths ranging from 51 mm to 81 mm (mean = 65.2 mm, σ = 7.0). Length frequencies for each site are provided in Appendix 8.4. Parr ranged in length from 90 mm to 187 mm and scale readings suggested most were aged 1+ with small numbers of older fish also present.

Figure 1. Trout size distribution, Laxo catchment



Salmon fry present only at LA1, where the density was classified as fair (Table 6). The fry ranged in length from 58 mm to 74 mm. No older salmon were captured at LA1 or at other sites in the Laxo catchment

Table 6 Salmon densities (fish.100 m^{-2}) Laxo catchment

Site	**Salmon density** single run		Density classification		Salmon density Zippin with 95% confidence limits	
	Fry	Parr	Fry	Parr	Fry	Parr
LA1	12.9	0.0	Fair	-	15.1 (15.0 -15.6)	0.0
GO1	0.0	0.0	-	-	0.0	0.0
CO1	0.0	0.0	-	-	0.0	0.0
EF1	0.0	0.0	-	-	0.0	0.0

European eels were present at all four sites (Table 5). Small elvers, likely to have entered the system in spring 2025, were very abundant at LA1 and could not be counted. No other fish species was seen or caught at sites in the Laxo catchment.

4.1.2 Grunnafirth catchment

No salmon were recorded in Burn of Grunnafirth but trout were present at both sites (Table 7). Single-run densities for trout fry were both classified as very poor. The Zippin estimates of true densities were 1.3 fry per 100 m^2 and 5.7 fry per 100 m^2 at GR1 and GR2 respectively. Parr density exceeded fry density at both sites, with classifications of good and excellent at GR1 and GR2 respectively.

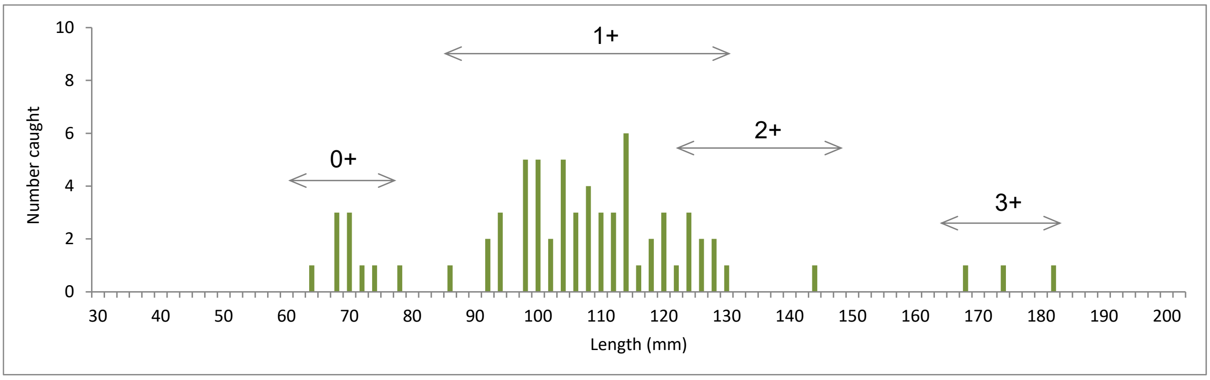
Table 7 Trout densities (fish.100 m^{-2}) and total number of eels, Grunnafirth catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
GR1	1.3	15.1	Very poor	Good	1.3 (1.3 - 1.3)	17.8 (17.8 - 18.2)	20+
GR2	3.3	18.3	Very poor	Excellent	5.7 (5.2 - 7.6)	22.3 (22.2 - 23.0)	7

Trout fry ranged in length from 64 mm to 77 mm (mean = 69.9 mm, σ = 3.7) and there was no length overlap with the 1+ year class. The 1+ year class was strong, reflecting the high fry densities in 2024 (Waterside Ecology 2024) and ranged in length from 90 mm to 130 mm. Scale readings indicated there was substantial overlap in length with the 2+ cohort. The largest 1+ trout from which scales were taken was 130 mm in length, while the smallest 2+ was 120 mm long.

Eels were present at both sites and were relatively abundant at GR1, the more downstream site. No other fish species were seen or captured.

Figure 2. Trout size distribution, Grunnafirth catchment



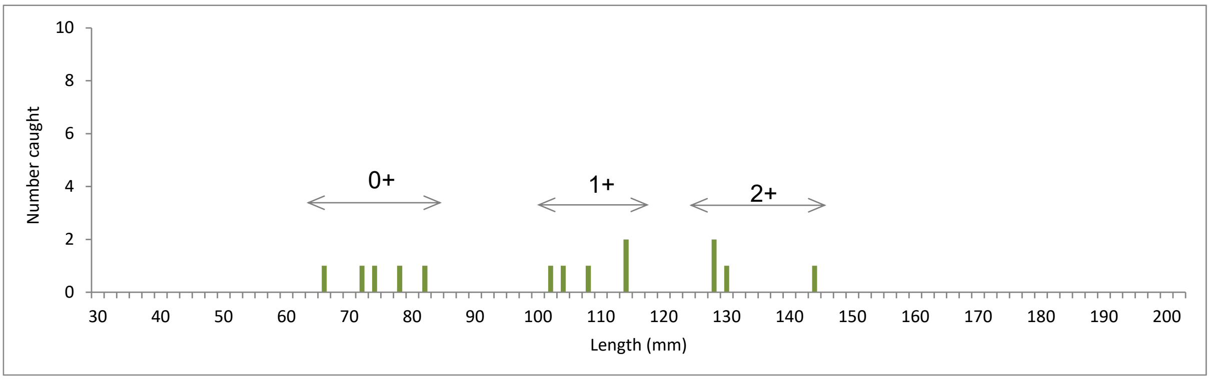
4.1.3 Quoys catchment

As in previous surveys, no salmon were recorded at QU1. Trout fry and parr were present. Fry density was classified as very poor. Two year classes of parr were present (Figure 3) and parr density was classified as fair. Four European eels were captured. No other fish species were seen or caught.

Table 8 Trout densities (fish.100 m^{-2}) and total number of eels, Quoys catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
QU1	3.0	5.3	Very poor	Fair	3.8 (3.8 - 4.1)	6.9 (6.9 - 7.4)	11

Figure 3. Trout size distribution, Quoys catchment



4.1.4 Crookadale catchment

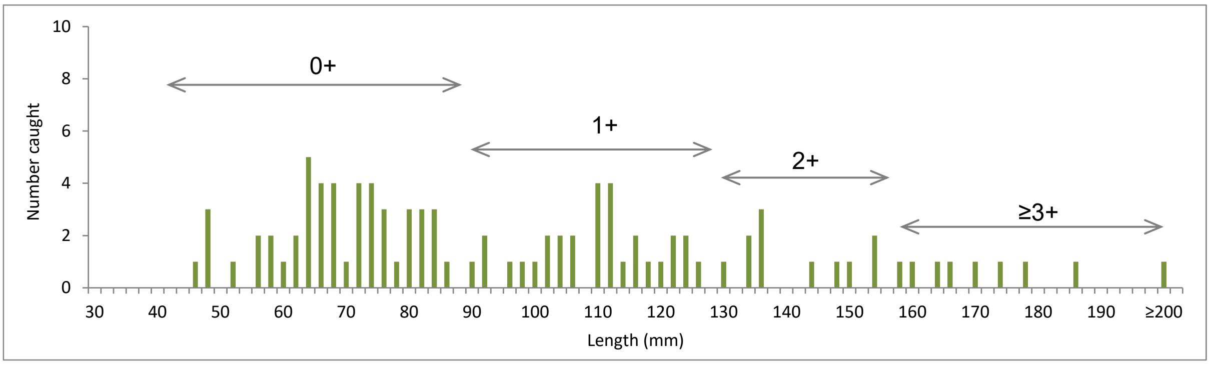
Five sites were surveyed in the Crookadale catchment, three in Burn of Crookadale, one in Gill Burn and one in Burn of Flamister (Table 9). Trout fry were present at all sites, with density classified as poor at three sites and fair at two. The highest fry density was CR2 in Burn of Crookadale, with a Zippin estimate of 19.7 per 100 m^2. Parr densities was excellent at CR1, the most downstream site in Burn of Crookadale and fair at the other two sites in this stream. Parr densities were very poor at the sites in Gill Burn and Burn of Flamister. Water levels were extremely low at both of these sites at the time of survey rendering them largely unsuited to trout parr, which may have emigrated downstream.

Table 9 Trout densities (fish.100 m^{-2}) and total number of eels, Crookadale catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels
	Fry	Parr	Fry	Parr	Fry	Parr	(n)
CR1	11.4	21.0	Fair	Excellent	15.0 (14.9 - 15.8)	26.4 (26.3 - 27.2)	4
CR2	17.3	8.1	Fair	Fair	19.7 (19.7 - 20.0)	8.1 (8.1 - 8.1)	0
CR3	8.9	6.7	Poor	Fair	8.9 (8.9 - 8.9)	9.0 (8.9 - 9.7)	5
GI1	5.6	1.4	Poor	Very poor	12.1 (11.1 - 16.2)	1.4 (1.4 - 1.4)	3
FL1	4.7	1.2	Poor	Very poor	6.6 (4.7 - 8.5)	2.0 (1.2 - 3.1)	0

Trout fry in the Crookadale catchment ranged in length from 46 mm to 86 mm (mean 68.1 mm, σ = 10.5). The 1+ year class had lengths ranging from 91 to 128 mm. The smallest 2+ parr from which scales were taken was 130 mm long and the largest was 154 mm. Larger and presumably older trout were also present.

Figure 4. Trout size distribution, Crookadale catchment



The waterfall near the tidal limit on Burn of Crookadale has not been fully assessed. It is uncertain whether it is passable to salmon or sea trout. As such it is not known if the trout population has a sea trout component or not. Small numbers of European eels were captured at four of the five sites, demonstrating that the waterfall is passable for this species. No other fish species was captured.

4.1.5 Stromfirth catchment

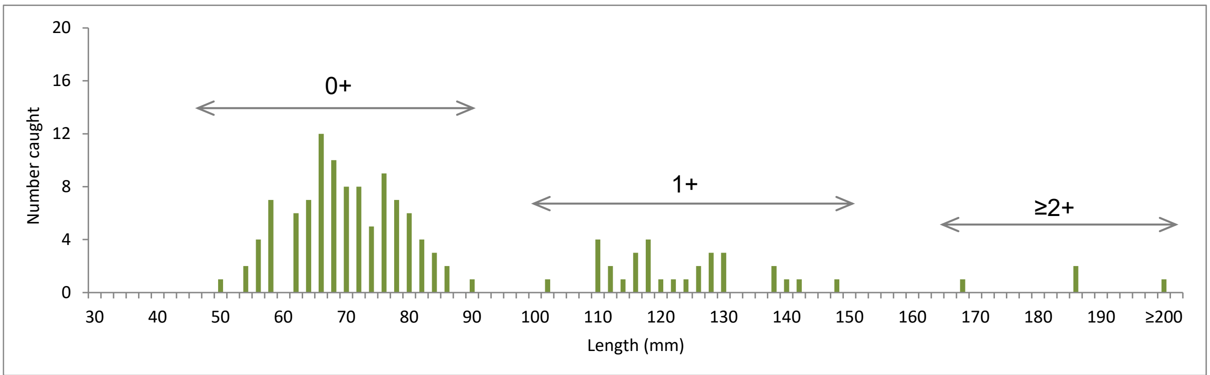
Trout and European eels were recorded in Burn of Pettawater (Table 10), no other fish species were captured. Trout fry density was classified as good at PW1 and fair at PW2. Fry density at PW1 was among the highest recorded during the 2025 survey, with a Zippin estimate of 60.7 fry per 100 m^2. Trout parr density at PW1 was also classified as excellent, while at PW2 it was fair. PW1 is known to be accessible to sea trout and salmon, as well as to resident trout in Sand Water. A waterfall just downstream of PW2 may present a partial or full barrier to upstream migrating salmonids.

Table 10 Trout densities (fish.100 m^{-2}) and total number of eels, Stromfirth catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
PW1	43.1	13.2	Good	Good	60.7 (59.2 - 63.1)	15.0 (15.0 - 15.2)	11
PW2	19.6	6.8	Fair	Fair	22.7 (22.6 - 23.0)	7.6 (7.5 - 7.7)	9

Trout fry in the Burn of Pettawater were between 50 mm and 90 mm in length and there was no size overlap with the 1+ year class (Figure 5). Scale reading indicated that some of the 1+ parr were very fast growing and the largest 1+ parr from which scales were taken was 147 mm long.

Figure 5. Trout size distribution, Stromfirth catchment, Burn of Pettawater



European eels were present at both sites, with the highest density at PW1 where macrophytes provide good cover.

4.1.6 Weisdale catchment

Salmon were caught at four of the five sites surveyed in the Burn of Weisdale catchment (Table 11). They were absent from WE4, the furthest site upstream. Salmon fry densities declined with distance upstream and, where present, density classifications ranged from excellent at WE1 to very poor at WE3 and DR1. This suggests that most of the salmon spawning takes place downstream of the wind farm site and at its periphery. Salmon parr were scarce other at than at WE1, where density was classified as good.

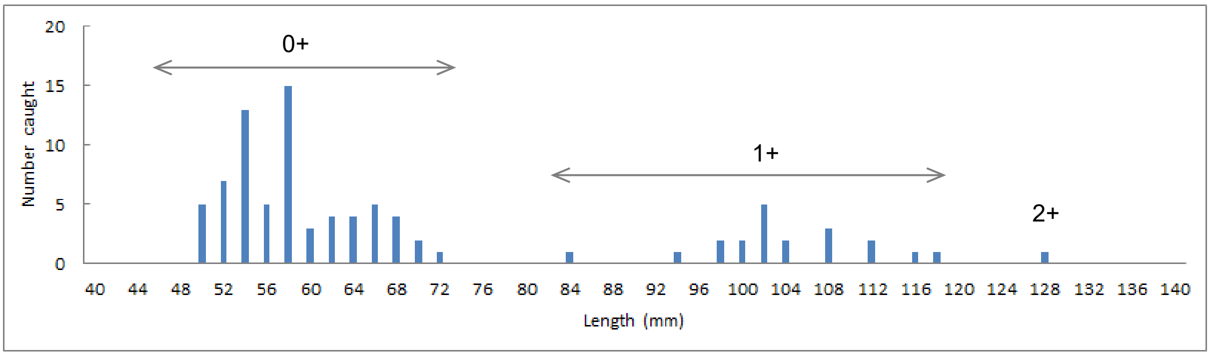
Salmon fry ranged in length from 48 mm to 72 mm (Figure 6). The bimodal length distribution arose largely because fry at WE2 were larger (range 61 mm to 72 mm) than those at WE1 (range 49 mm to 63 mm).

Salmon parr ranged from 93 mm to 127 mm. The majority were aged 1+ but scale reading indicated that small numbers of 2+ parr were also present. These data, in common with those from previous years, suggests that the majority of salmon migrate to sea as smolts during their third year (i.e. aged 2+).

Table 11 Salmon densities (fish.100 m^{-2}), Weisdale catchment

Site	Salmon density single run		Density classification		Salmon density Zippin with 95% confidence limits	
	Fry	Parr	Fry	Parr	Fry	Parr
WE1	37.6	12.2	Excellent	Good	70.1 (66.4 - 76.2)	16.8 (16.6 - 17.9)
WE2	10.3	1.7	Fair	Very poor	15.0 (14.6 - 16.6)	3.7 (3.4 - 5.5)
WE3	1.5	0.7	Very poor	Very poor	1.5 (1.5 - 1.5)	0.7 (0.7 - 0.7)
WE4	0.0	0.0	-	-	0.0	0.0
DR1	1.3	0.0	Very poor	-	5.0 (-)	0.0

Figure 6. Salmon size distribution, Weisdale catchment



Trout fry were present at all five sites in the Weisdale catchment (Table 12). Densities varied widely and classifications ranged from very poor to fair. The highest density was at WE4, where the depletion gave a Zippin estimate of 43.6 fry per 100 m^2. This site also had the highest trout parr density. This site has some long deep glides with undercut banks that are well-suited to 1+ and older trout.

Table 12 Trout densities (fish.100 m^{-2}) and total number of eels, Weisdale catchment

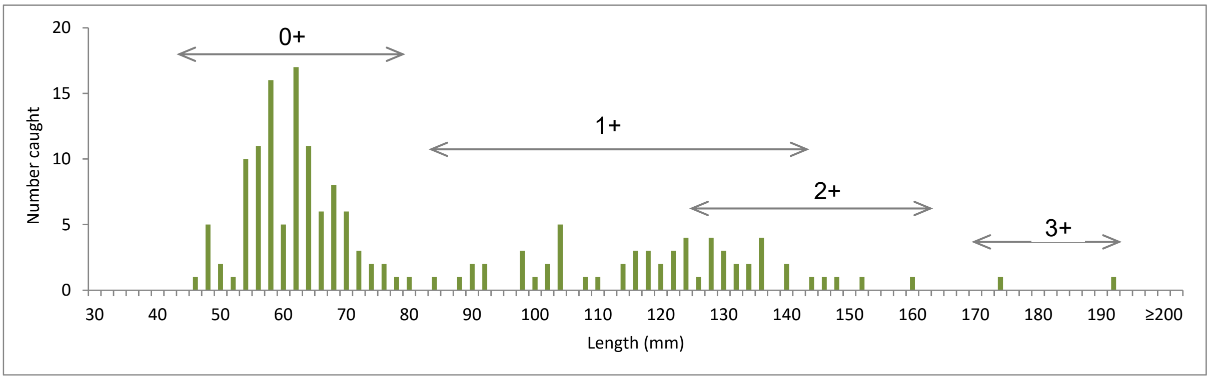
Site	**Trout density** single run		**Density classification**		**Trout density** Zippin with 95% confidence limits		**European eels** (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
WE1	10.0	5.5	Poor	Fair	17.7 (15.5 - 24.1)	11.3 (10.0 - 15.9)	>100
WE2	0.9	12.0	Very poor	Good	5.0 (3.4 - 14.1)	12.8 (12.8 - 13.0)	14
WE3	17.8	3.7	Fair	Very poor	26.7 (26.0 - 28.5)	6.1 (5.9 - 7.2)	8
WE4	20.3	10.7	Fair	Good	43.6 (38.8 - 51.9)	18.1 (17.4 - 20.4)	Present*
DR1	15.8	13.1	Fair	Good	31.6 (31.5 - 32.1)	14.5 (14.5 - 14.7)	6

*No realistic count of eels possible due to dense filamentous agal growth

The relatively strong fry (0+) cohort is clear in Figure 7, with lengths ranging from 45 mm to 75 mm (mean 60.8 mm, σ = 6.8). Three parr year classes were present in the sample. As in other streams that are accessible from the sea it is likely that many juvenile trout migrate to become 'sea trout'.

Eels were present at all sites and were very abundant at WE1. Most of these were very small and it was not possible to obtain a realistic count but field notes suggested "several hundred". These were mainly recent immigrants but a range of sizes was present. Good cover is present at WE1 in macrophytes and stones. No other fish species were seen or caught in the Weisdale catchment.

Figure 7. Trout size distribution, Weisdale catchment



4.1.7 Burrafirth catchment

Juvenile salmon were present only at BF2, where a single fry of 72 mm in length was caught. Salmon parr were absent from all sites.

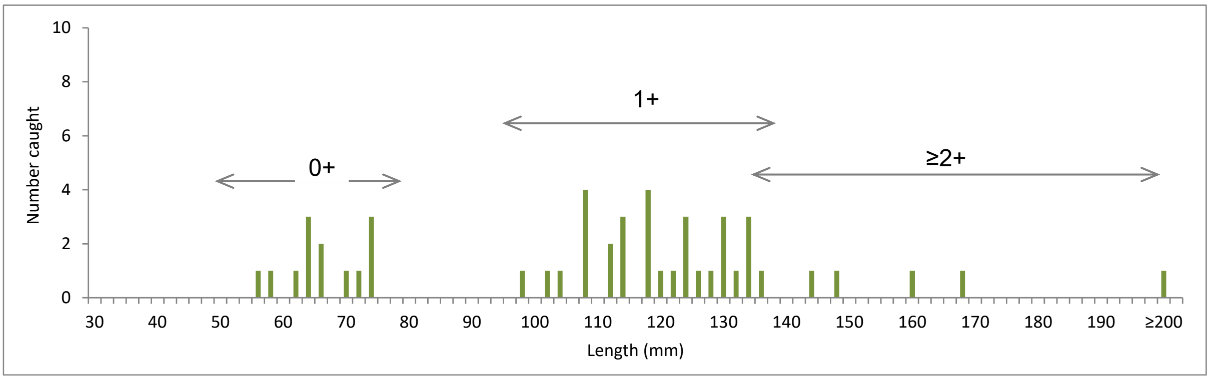
Trout were present at all sites with the exception of LU1 on Burn of Lunklet (Table 13). The survey of Burn of Lunklet extended for over 100 m upstream of the standard monitoring site but no trout or other fish could be found. Trout fry were absent at two further sites, BF2 and BF3 in Burn of Burrafirth but parr were present at both these sites. Trout fry densities at the three sites where they were present were all very low and classified either as poor or very poor. As all of the fry were caught during the first electric fishing runs, Zippin fry densities equalled single-run densities. The trout fry cohort had a mean length of 66.2 mm (σ = 6.2) and lengths did not overlap with the 1+ year class (Figure 8). Trout parr were present at low or moderate densities other than at LU1 in Burn of Lunklet where, as noted above, they were absent. Parr densities ranged from 4.5 per 100 m^2 at MA1 to 10.4 per 100 m^2 at BF3. Most of the trout parr were aged 1+ (Figure 8), reflecting the higher fry abundance that was present in 2024 (see Figure 17). At least two further parr age classes, 2+ and 3+ were present.

Eels were present at four of the six sites and were most abundant at BF1, where the majority were small elvers that would have migrated into the stream in the months before sampling took place.

Table 13 Trout densities (fish.100 m^{-2}) and total number of eels, Burrafirth catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
BF1	0.6	3.8	Very poor	Very poor	0.6 (0.6 - 0.6)	5.2 (5.1 - 6.2)	20+
BF2	0.0	7.1	-	Fair	0.0	8.0 (8.0 - 8.2)	8
BF3	0.0	8.6	-	Good	0.0	10.4 (10.0 - 15.9)	21
LM1	7.0	6.0	Poor	Fair	7.0 (7.0 - 7.0)	6.0 (6.0 - 6.0)	2
LU1	0.0	0.0	-	-	0.0	0.0 ()	0
MA1	4.5	3.4	Poor	Very poor	4.5 (4.5 - 4.5)	4.5 (4.5 - 5.1)	0

Figure 8. Trout size distribution, Burrafirth catchment



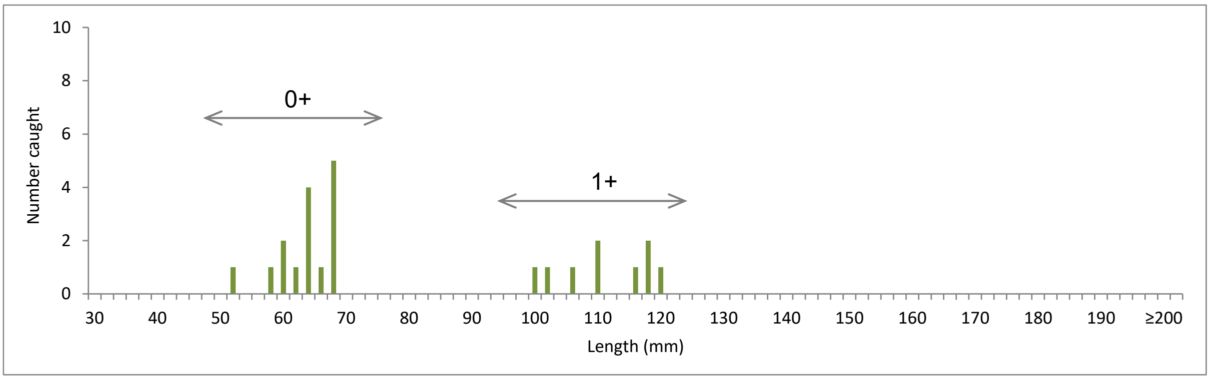
4.1.8 Kirkhouse catchment

Trout fry and parr were present at KI1. The site is inaccessible to salmon or sea trout due to waterfalls and a man-made obstacle, both a short distance upstream of the tidal limit. Single run trout fry and parr densities were classified as poor and fair respectively (Table 14). Zippin density estimates were 12.2 fry and 7.8 parr per 100 m^2. Only two trout year classes were present, all of the parr in the sample being aged 1+. One eel was captured but no other fish species were seen.

Table 14 Trout densities (fish.100 m^{-2}) and total number of eels, Kirkhouse catchment

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
KI1	9.5	6.9	Poor	Fair	12.2 (12.1 - 12.8)	7.8 (7.8 - 8.0)	1

Figure 9. Trout size distribution, Kirkhouse catchment



4.1.9 Manse Burn (Voe) catchment

Trout fry were abundant at both sites on the Wester Filla Burn, with densities classified as excellent by national standards (Table 15). The single-run and total density estimates for trout fry were the highest recorded during the current survey, as was the case in 2024. High fry densities are consistently found in this watercourse, reflecting the quality of spawning habitats and accessibility for resident adult trout in Loch of Voe. Trout fry lengths ranged from 43 mm to 87 mm, with a mean of 60.6 mm (σ = 9.4).

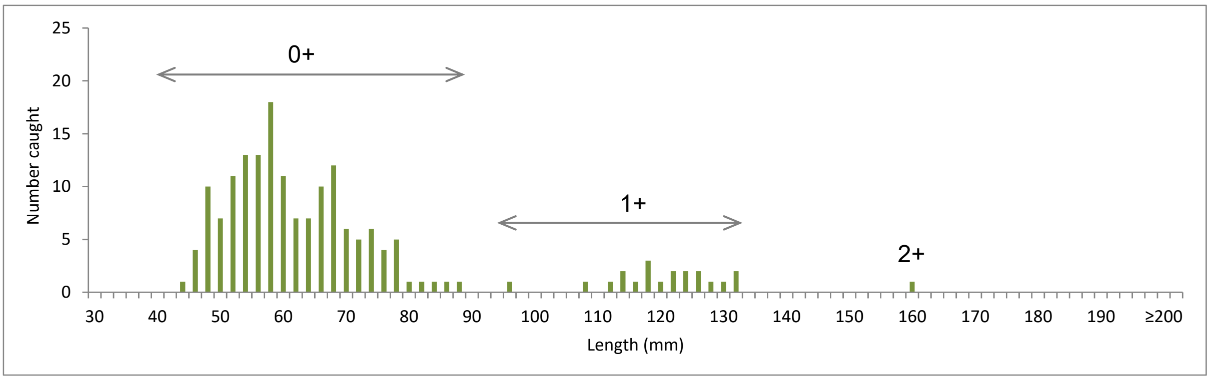
Moderate numbers of 1+ and a single 2+ trout parr were also present. The 1+ parr ranged in length from 95 mm to 131 mm.

European eels were present in small numbers at both sites. Salmon and sea trout are not found in this watercourse, as access is not possible due to cascades downstream of Loch of Voe. Due to their ability to climb over suitable wet substrates, eels may often be found where migratory salmonids are not.

Table 15 Trout densities (fish.100 m^{-2}) and total number of eels, Manse Burn (Voe) catchment

Site	**Trout density** single run		**Density classification**		**Trout density** Zippin with 95% confidence limits		**European eels** (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
WF1a	59.1	7.4	Excellent	Fair	86.5 (83.7 - 91.5)	11.7 (11.1 - 14.5)	1
WF2	60.6	9.9	Excellent	Good	104.9 (96.9 - 114.8)	14.9 (14.3 - 17.0)	9

Figure 10. Trout size distribution, Manse Burn (Voe) catchment



4.2 Control sites

4.2.1 Seggie Burn (Laxo catchment)

Trout were present at both sites on Seggie Burn but salmon were absent, consistent with previous surveys. The burn is accessible from the sea via Laxo Burn so some sea trout may be present in the trout population. Trout fry density was poor at SE1 and fair at SE2. Zippin estimates of true densities were 10.6 and 17.1 fry per 100 m^2 at SE1 and SE2 respectively. Trout parr densities exceeded fry densities at both sites and were classified as good by national standards.

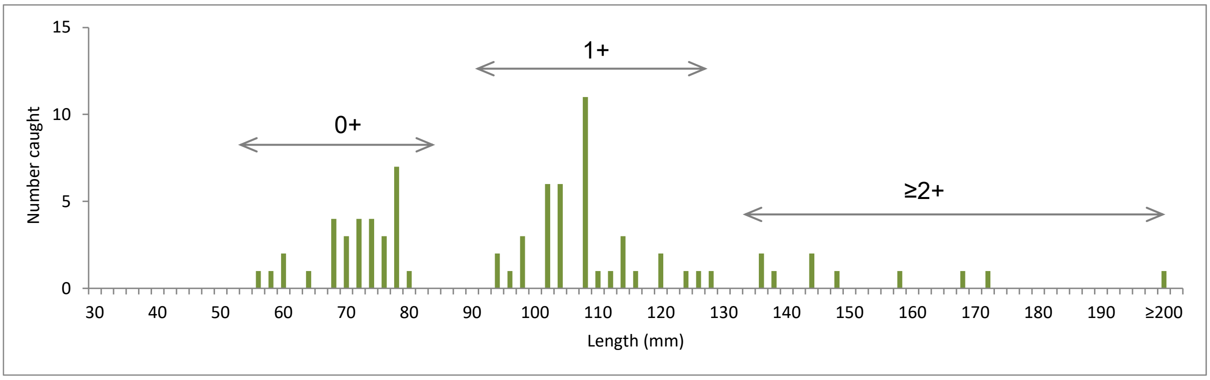
Table 16 Trout densities (fish.100 m^{-2}) and total number of eels, Seggie Burn

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
SE1	6.7	16.0	Poor	Good	10.6 (10.1 - 12.5)	20.4 (20.2 - 21.4)	8
SE2	13.3	17.8	Fair	Good	17.1 (16.9 - 18.1)	21.4 (21.3 - 21.9)	0

Mean fry length was 71.1 mm (σ = 6.4). At least three older age classes of trout were present. The 1+ cohort ranged from 93 mm to 128 mm. Scales from a trout of 143 mm showed it to be 2+ years of age.

Eels were present in small numbers atSE1 but none were seen or caught at SE2.

Figure 11. Trout size distribution, Seggie Burn



4.2.2 Laxobigging catchment

Small numbers of salmon parr have occasionally been caught at LB1, but salmon were absent during the current survey. LB2 is inaccessible to salmon or sea trout due to an old water intake dam. The rough, moss-covered surface of the dam makes LB2 accessible for eels.

Trout fry were present only at LB1, where a single specimen was captured giving an estimated density of 0.7 per 100 m^2, very poor by national standard. This low density and the absence of fry at LB2 indicates extremely low spawning success and recruitment. The reasons for this are unknown. In contrast, trout parr densities at both sites were good at 22.2 and 16.7 per 100 m^2 at LB1 and LB2 respectively. As LB1 is accessible from the sea, it is probable that the trout population at LB1 has a migratory component while that at LB2 is resident.

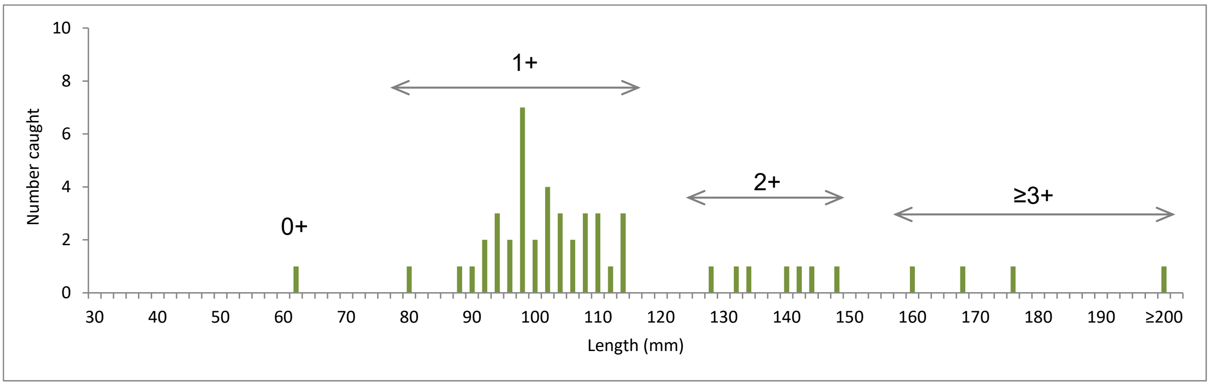
Table 17 Trout densities (fish.100 m^{-2}) and total number of eels, Burn of Laxobigging

Site	Trout density single run		Density classification		Trout density Zippin with 95% confidence limits		European eels (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
LB1	0.7	16.8	Very poor	Good	0.7 (0.7 - 0.7)	22.2 (21.7 - 23.7)	30+
LB2	0.0	13.9	-	Good	0.0	16.7 (16.6 - 17.2)	9

The majority of the trout parr in the samples were aged 1+, with lengths ranging from 80 mm to 114 mm (Figure 12). Scales from trout of 128 mm and 132 mm clearly showed them to be aged 2+. Comparisons with length-frequency data from other catchments described above indicates that these are relatively slow growth rates.

European eels were abundant at LB1 and present in moderate numbers at LB2.

Figure 12. Trout size distribution, Laxobigging catchment



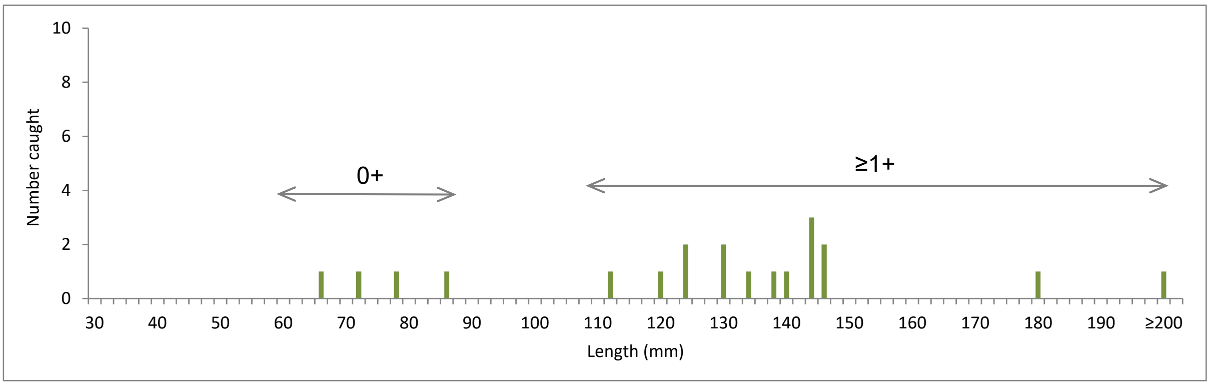
4.2.3 Sandgarth catchment

Trout were present at both sites but salmon were absent. Both sites are accessible from the sea and sea trout have been captured in the burn during some previous surveys. Trout fry densities at both sample sites were classified as very poor (Table 18). Only one fry was caught at SA1 and three at SA2. Trout parr densities exceeded fry densities at both sites and were classified as fair and good at SA1 and SA2 respectively. Scales were taken from too few trout to split age classes, but a trout of 133 mm was aged at 1+ andnother of 144 mm was aged at 2+. It is likely that the larger trout of 180 mm and 205 mm were at least 3+ years of age.

Table 18 Trout densities (fish.100 m^{-2}) and total number of eels, Burn of Sandgarth

Site	**Trout density** single run		**Density classification**		**Trout density** Total density estimate		**European eels** (n)
	Fry	Parr	Fry	Parr	Fry	Parr	
SA1	1.2	7.1	Very poor	Fair	1.2 (1.2 - 1.2)	10.9 (10.7 - 12.4)	5
SA2	2.5	8.8	Very poor	Good	3.8 (3.8 - 4.7)	8.8 (8.8 - 8.8)	8

Figure 13. Trout size distribution, Sandgarth catchment



European eels were found in moderate numbers at both sites. No other fish species were captured.

5 Discussion

5.1 Data quality and data interpretation

Survey conditions were good with low flows and good light. The extreme low flows rendered large parts of sites GI1, FL1 and MA1 unsuited to fish and this may have resulted in some emigration from these sites. In general, however, data are considered comparable with those from other years of monitoring.

The low flows and associated high conductivities resulted in high capture efficiency and rapid depletions of fish numbers at many sites, with the majority of fish captured during the first electric fishing run (Appendix 8.3). This resulted in relatively small confidence limits around most of the density estimates. Zippin density estimates remain comparable across years, but care should be taken comparing single run estimates (and density classifications) as these be influenced by changes in capture efficiency resulting from sampling conditions.

Baseline fish data were collected at some sites for more than one year prior to construction. These data are summarised by Waterside Ecology (2020). An important finding of the 2020 survey was that substantial changes in fish abundance occurred at many sites before any perturbation took place from construction or any other identifiable anthropogenic activity. This natural background variability strongly suggests that changes in fish numbers are to be expected during the monitoring period and that these should not be interpreted as "impacts" unless corroborating evidence from other sources is available. Such evidence would include data from control sites, hydrochemical monitoring data, assessments of other stream biota (primarily freshwater invertebrates) or direct observations of pollution incidents or dead fish by an Ecological Clerks of Works or others.

Taking the above into account, the following sections first look at overall (site-wide) changes in trout abundance compared to baseline. Trout are the main focus of such assessments as salmon presence in streams has already been shown to be patchy and sporadic (Waterside Ecology 2020). Section 5.4 then goes on to look in more detail for any identifiable impacts on fish populations in streams where hydrochemical changes have occurred as a result of construction.

5.2 All sites: comparisons with baseline

5.2.1 Trout fry

Trout fry densities during the baseline (mainly 2019) and current surveys are shown on Figure 14. Data are total density estimates with 95% confidence intervals. Trout fry densities during 2025 showed no consistent change compared with baseline. Mean fry density at impact monitoring sites increased slightly from 18.3 during baseline to 22.7 per 100 m^2 in 2025, a non-significant change (paired sample T-test, T = 1.47, df = 27, p = 0.16). Mean fry density also increased slightly at the control sites, from 3.8 per 100 m^2 during the baseline to 5.6 per 100 m^2 during 2025. Again, the change was non-significant (T = 0.56, df = 5, p = 0.60).

At impact monitoring sites, fry density increased at 17 sites, decreased at 10 and remained unchanged at one. Based on the 95% confidence limits, not all of the density changes at individual sites were statistically significant. The most substantial (and significant) increases in fry numbers were at GO1 (Burn of Gossawater), WF2 (Burn of Wester Filla), CR1 (Burn of Crookadale), PW1 (Burn of Pettawater), WE4 (Burn of Weisdale) and control site SE2 (Seggie Burn). The most notable decreases compared with baseline were at QU1 (Burn of Quoys), KI1 (Burn of Kirkhouse) and control site LB2 (Burn of Laxobigging) where fry density declined to zero.

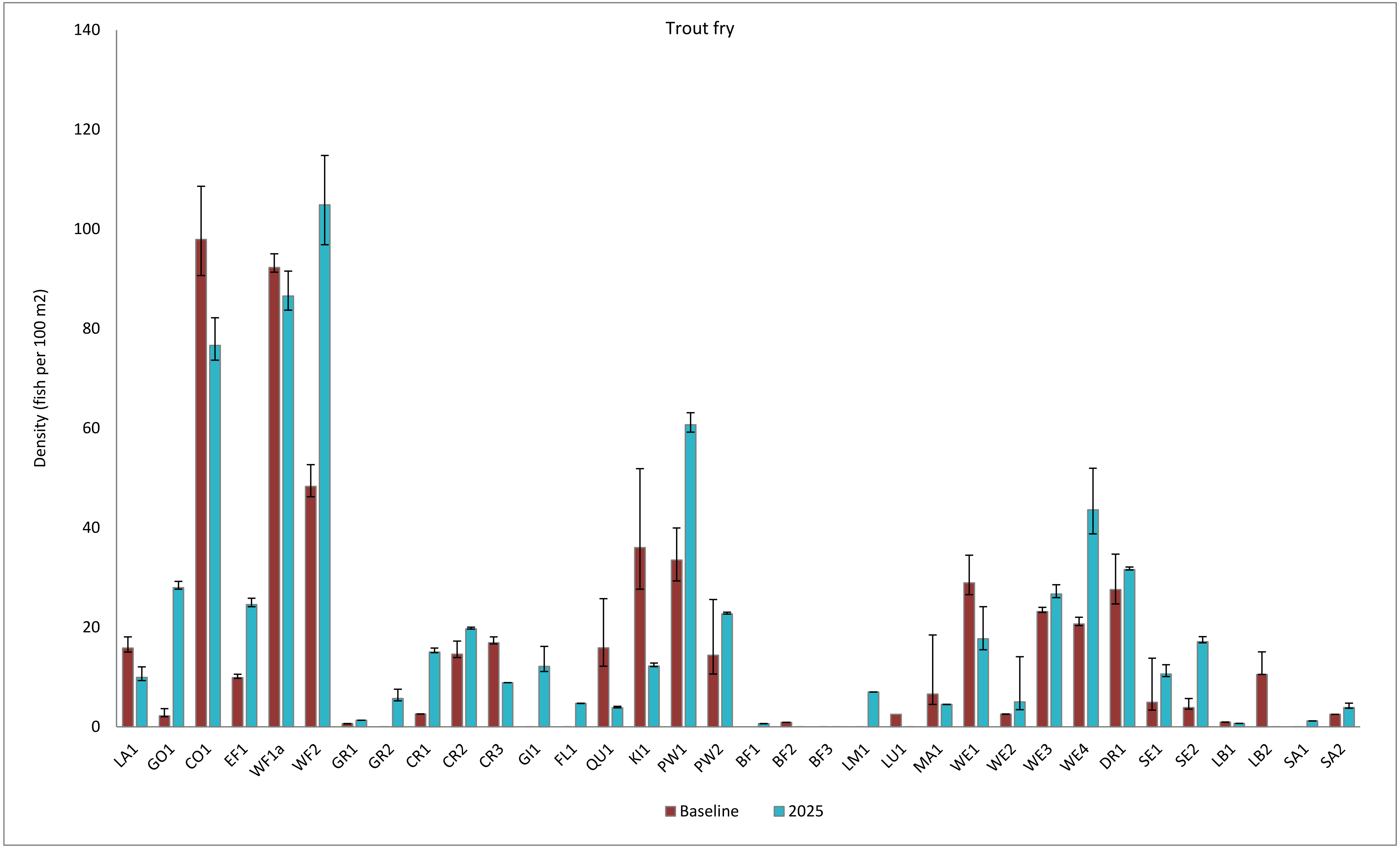
5.2.2 Trout parr

Densities during baseline and 2025 are shown on Figure 15. Trout parr densities in 2025 were higher than baseline at 15 of the 28 impact monitoring sites, lower at 12 and unchanged at one. Parr densities at control sites in Seggie Burn and Burn of Laxobigging increased a little compared with baseline but substantial declines in parr densities were observed in Burn of Sandgarth (SA1 and SA2).

Mean parr density at impact monitoring sites decreased slightly from 11.0 during baseline to 9.9 per 100 m^2 in 2025. The change was non-significant (T = 0.90, df = 27, p = 0.376). A similar trend was observed at control sites with a small and non-significant decline in mean density from 23.3 per 100 m^2 during baseline to 16.7 in 2025 (T = 0.92, df = 5, p = 0.398).

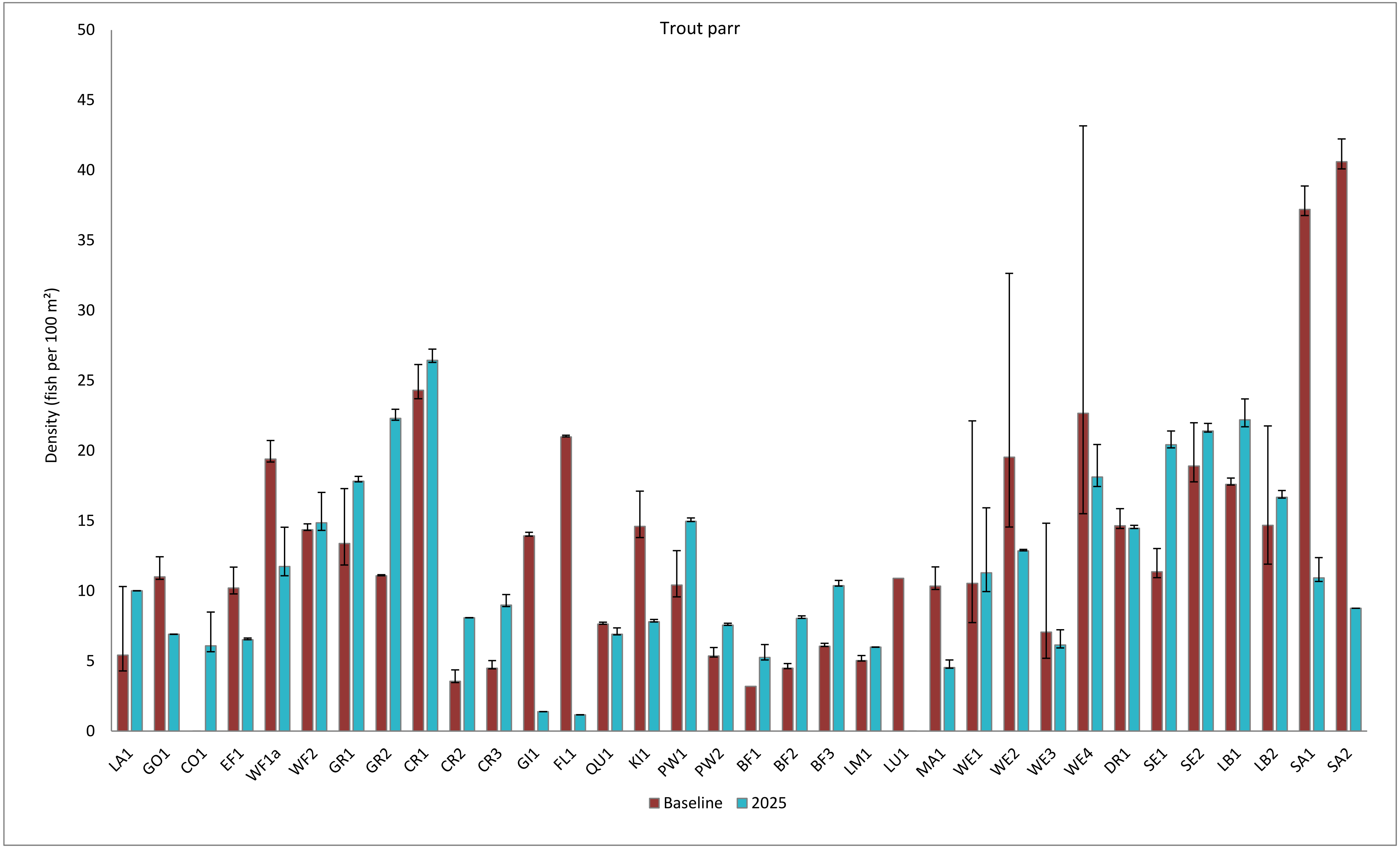
The most substantial declines in parr numbers were at GI1 (Gill Burn), FL1 (Burn of Flamister), LU1 (Burn of Lunklet) and at control sites SA1 and SA2 both of Burn of Sandgarth.

Figure 14. Trout fry Zippin densities baseline and 2025



Baseline surveys conducted 2019 except for CO2, CO3 and WF2 (2020)

Figure 15. Trout parr Zippin densities baseline and 2024



Baseline surveys conducted 2019 except for CO2, CO3 and WF2 (2020)

5.3 Annual trends in trout numbers

There has been substantial year-to-year variation in juvenile trout densities at many impact and control sites over the course of the monitoring period (Figures 16 & 17). These suggest that the baseline surveys of 2019 probably took place in a year of relatively low trout fry abundance but high abundance of parr. The 1+ parr cohort was particularly abundant during the 2019 baseline, suggesting that fry abundance was probably high in 2018 (Waterside Ecology 2020).

Increases in fry density over baseline occurred at many sites in 2021, 2022 and 2024 (see Waterside Ecology 2022a, 2024) and it is likely that most of the observed fluctuations were driven largely by regional factors. Conversely, trout parr densities declined compared to baseline at many sites, including controls, during some years. Slight declines in parr populations compared to baseline are not of themselves a cause for undue concern, unless they can be clearly linked to changes in environmental quality. The very substantial fluctuations observed in parr densities at control sites in Seggie Burn and Burn of Sandgarth show the degree to which fish densities can shift in the absence of any apparent change to habitat or water quality. No changes have occurred in water quality that could account for widespread reduction in trout parr numbers against baseline and most observed changes are likely to reflect natural year-to-year variations in recruitment.

Over the site as whole, trout densities in 2025 remain broadly comparable with baseline with few changes that seem likely to be a result of construction impacts on water quality or stream habitats. Changes in fish densities in each of the watercourses potentially influenced by construction work are considered further in section 5.4 below.

5.4 Trends in water quality and trout populations in potentially impacted watercourses

The following sections briefly summarise observed hydrochemical changes identified during the construction period, based on Headley et al. (in prep.), and compare these with fluctuations in trout densities over the monitoring period. Freshwater invertebrate data, collected annually, are also considered where they are relevant to interpreting trends.

5.4.1 Laxo catchment

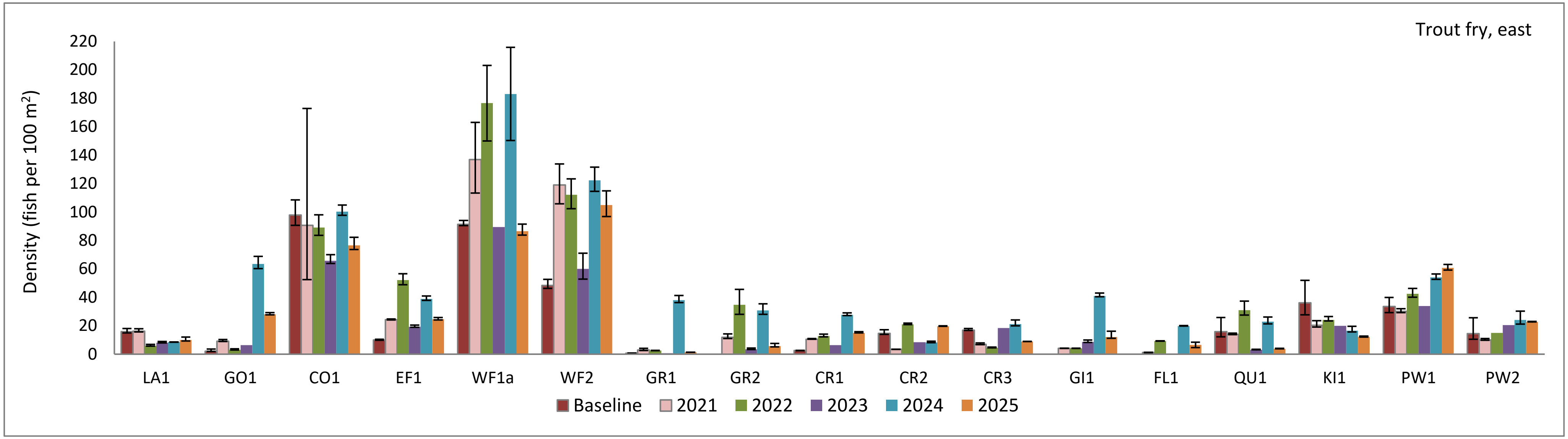
Increases in total oxidised nitrogen (TON) total ammoniacal nitrogen (TAN) were observed in Burn of Laxo and Easter Filla Burn during construction, peaking in the period 2020-21. Episodic increases in turbidity/suspended solids were reported in Easter Filla Burn during 2022 and 2023. Despite these changes trout fry density at EF1 in Burn of Easter Filla has remained significantly above baseline throughout the monitoring period (Figure 16). Parr densities at EF1 were lowest in 2021 and have increased since. A dip in trout numbers was observed in Laxo Burn during 2022 but numbers have increased since. Substantial fluctuations were observed in trout numbers in Burn of Gossawater, which appear unrelated to any known water quality changes. During the past two surveys, trout fry densities in this stream greatly exceeded baseline while parr numbers were broadly similar to baseline.

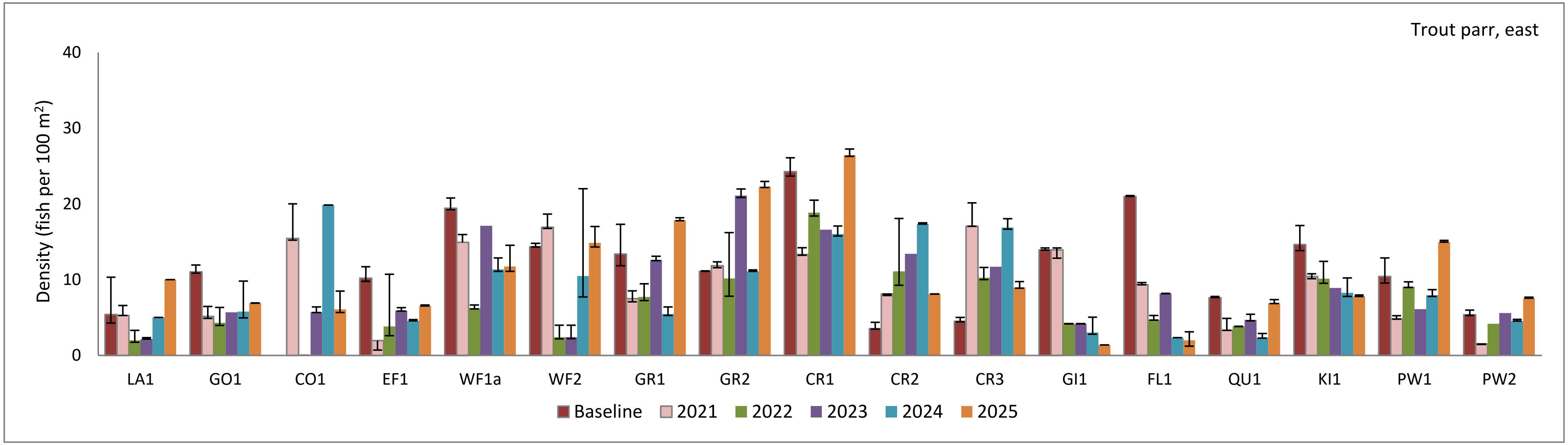
The data suggest that observed changes in water quality have not affected trout densities in the Laxo catchment. This is consistent with invertebrate monitoring data, which suggest ongoing good water quality (Emes & Watt 2023 to 2025).

5.4.2 Grunnafirth catchment

Changes to water quality recorded in Burn of Grunnafirth have been limited to increases in TON during the period 2020 to 2022 and increases in calcium concentrations in the same period. Both are likely to have resulted from runoff during road construction and neither is likely to have posed a significant risk to fish populations. Trout fry numbers have fluctuated greatly at GR1 and GR2 (Figure 16) and were high at both sites during 2024, falling in the current survey. Parr numbers at both sites currently exceed baseline. The data do not suggest any negative impacts on fish due to construction.

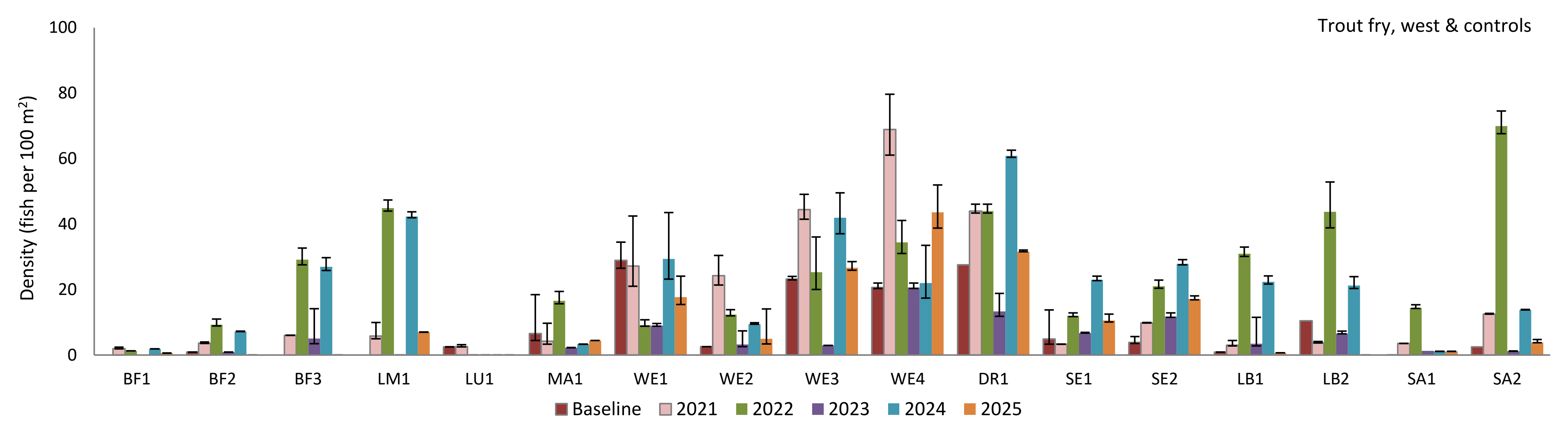
Figure 16. Juvenile trout densities eastern streams, baseline to present

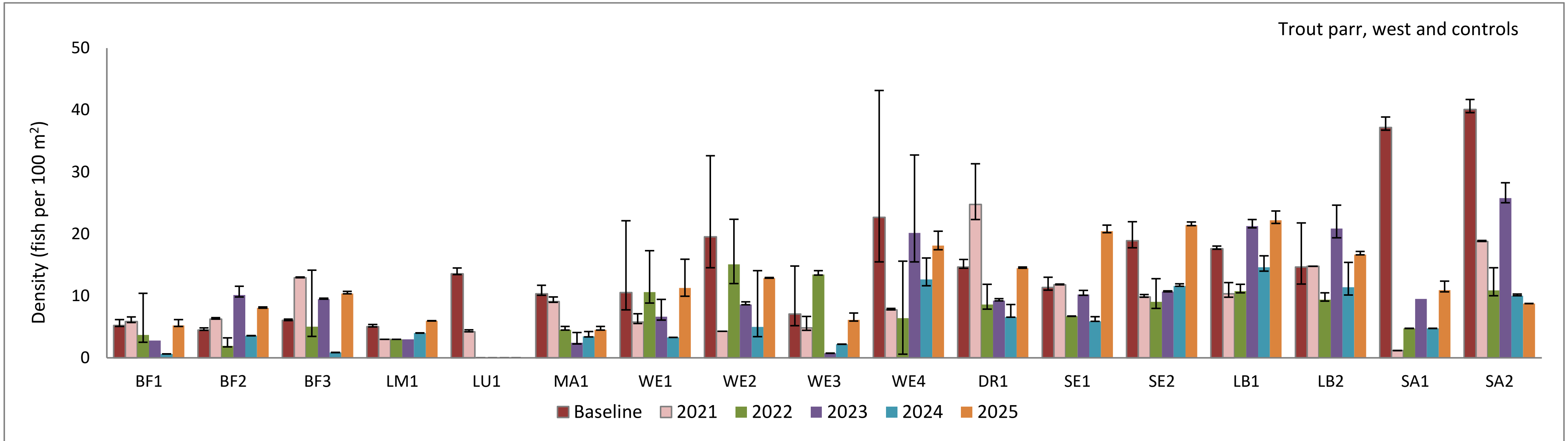




Control sites are: SE1, SE2, LB1, LB2, SA1 and SA2.
Baseline surveys conducted 2019 except for CO2, CO3 and WF2 (2020)

Figure 17. Juvenile trout densities western streams and control streams, baseline to present





Control sites are: SE1, SE2, LB1, LB2, SA1 and SA2.
Baseline surveys conducted 2019 except for CO2, CO3 and WF2 (2020)
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5.4.3 Quoys catchment

Increased TON was observed at QU1 during 2021 to 2022 and there were exceedances of iron targets between 2020 and 2023. High background levels of iron are present but there is though to have been some additional contribution from construction activities. Trout fry numbers peaked at QU1 during 2022, when the exceedances noted above were ongoing. Fry densities were low during the current survey, but this was the case at many sites including some controls. Parr numbers during the current survey were similar to baseline. Invertebrate data from spring 2025 (Emes & Watt 2025) indicated good water quality and there were no substantial changes in the invertebrate indices compared with baseline. Overall, no construction impact on fish is apparent in the available data.

5.4.4 Crookadale catchment

5.4.4.1 Burn of Crookadale

Detectable impacts on the hydrochemistry of Burn of Crookadale arose largely from site preparation for the main construction compound. These impacts were elevated TON and increases in dissolved calcium. Sites CR1 and CR2 are both downstream of the main compound while CR3 is upstream. Trout fry density at CR1 has increased compared to baseline and parr density remains similar. Fry densities at CR2 have fluctuated but remain similar to baseline, while parr densities have increased. Trout densities at CR3 have been similar to those at CR2. The data do not suggest any detrimental impact on the trout population in Burn of Crookadale as a result of changes to water quality.

5.4.4.2 Burn of Flamister and Gill Burn

Detectable impacts on water quality in these streams were similar to those in Burn of Crookadale i.e. TON and Ca. TON concentration in Burn of Flamister was particularly high during the period 2021 to 2023. Trout fry densities have remained above baseline during most years of monitoring. Trout parr densities have declined steadily since baseline in both streams. As the changes to water quality in these streams were similar to those in other monitored streams described above, there is no evidence to attribute declining trout parr numbers to the development. Invertebrate indices continue to suggest good to high water quality both in Burn of Flamister and Gill Burn (Watt & Emes 2025).

5.4.5 Stromfirth catchment

Increased concentrations of TON were recorded in Burn of Pettawater during first three years of construction. Levels were not so high as to be likely to directly impact fish. Increases in calcium were recorded here, as in many other catchments. Both impacts are likely to have resulted from spreading of rock removed from borrow pits. Trout fry densities have increased over the construction period at PW1 and PW2 (Figure 16). Parr densities remain at or above baseline. The data indicate no impact on fish densities in the watercourse.

5.4.6 Weisdale catchment

5.4.6.1 Burn of Weisdale

Increased concentrations of both TAN and TON during the period 2021 to 2023 can be attributed to the use of explosives in the excavation of the Kergord HDVC converter platform and to runoff from Scallafield Scord (turbine bases and borrow pit). Increases in calcium, aluminium and other metals at WE4 and WE3 were likely to have been due to runoff from turbine base T026, entering via a small tributary just upstream of WE4. Potential impacts on freshwater invertebrates were evident in spring and autumn 2023, particularly at WE3 (Emes & Watt 2023, Watt & Emes 2023). These impacts may have been associated with visible ochre and silt deposition at these sites.

Trout fry densities in Burn of Weisdale have fluctuated markedly over the years (Figure 17). Fry densities were generally low during 2023 and the decline at WE3 was particularly severe. Annual parr densities were variable and parr densities at WE3 were also very low in 2023. During the current survey, trout fry and parr densities at all sites were similar to baseline and recent sampling of freshwater invertebrates also suggests a return to baseline conditions at WE3 and WE4.

5.4.6.2 Burn of Droswall

The main changes to water quality were increased concentrations of TON, dissolved calcium, sodium and aluminium from minerals washed off the rock used in construction. Episodic contamination with fine sediment occurred during the early years of construction. Trout fry numbers at DR1 dipped during 2023, but otherwise have remained above baseline (Figure 17). Trout parr numbers were lowest during 2023 and 2024 but increased to baseline levels during the current survey. Overall, the data suggest no ongoing impacts on trout densities.

5.4.7 Burrafirth catchment

5.4.7.1 South Burn of Burrafirth

Increased nitrate and calcium concentrations were recorded at BF1 and BF2. High concentrations of aluminium, sodium and zinc have been present at BF1, due to contamination entering via Burn of Lunklet. Trout fry have been scarce in all surveys at BF1 (Figure 17). Trout parr densities at BF1 declined fairly steadily since 2019 but recovered to baseline during the current survey. It is possible that this reflects recent improvements in water quality in Burn of Lunklet. No negative trends in trout densities have been apparent at BF2 or BF3 and densities of fry and parr during the current survey were above baseline at both sites.

5.4.7.2 Burn of Marrofield Water

The most potentially significant impacts on water chemistry have been increased concentrations of dissolved aluminium and/or zinc during the construction period, beginning in 2021 and peaking in 2023. Trout fry density at MA1 has been low in most years of survey, with a notable increase in 2022. Density during the current survey was low, but similar to baseline. Parr numbers fell between baseline and 2023 but have increased slightly in past two surveys. As the dip in trout parr numbers coincided with elevated levels of aluminium and zinc, a causal link is possible. However, invertebrate data from that period indicated a healthy stream fauna (Emes and Watt 2022 and 2023). Data from spring 2025 (Emes and Watt 2025) continued to indicate good water quality, with classifications of H (high) for the Water Framework Directive (WFD) WHPT and NTAXA indices at this site. Invertebrates were re-sampled in October 2025. The WFD and other indices continue to indicate good water quality with an invertebrate fauna typical of healthy, well oxygenated streams without significant pollution.

5.4.7.3 Burn of Lambawater

Changes in water chemistry of Burn of Lambawater resulting from construction are increased TON and calcium. As in other watercourses, these arise from the washing off of nitrate residues and rock dust from the rock used in the construction of the wind farm tracks and other infrastructure. Fry densities have fluctuated dramatically over the six years of monitoring (Figure 17) with high densities during 2022 and 2024. Fry were absent in 2023. Density during the current survey did not differ from baseline. Trout parr numbers have remained relatively stable and in 2025 were at baseline levels. There is no evidence of negative impacts on trout numbers due to construction. Invertebrate populations also remained unimpacted during the most recent round of monitoring.

5.4.7.4 Burn of Lunklet

This stream has been substantially impacted by very low pH and high concentrations of a number of metals. Metals contamination includes exceedances of bioavailable manganese, zinc, nickel and copper. Substantial ochreous deposits have been present in Burn of Lunklet since summer 2022 and these have been shown to contain high concentrations of metals (Headley 2022). Invertebrate populations were severely impacted by spring 2023 (Watt & Emes 2023) and, although some signs of improvement were evident in 2025, they remain depleted and dominated by pollution-tolerant species (Emes & Watt 2025).

Although present prior to the stream's contamination, trout were found to be absent from Burn of Lunklet between the Red Burn confluence and Burn of Marrofield Water confluence by summer 2022 (Figure 17). Data from the current survey suggest that trout remain absent from this reach. Spot checks downstream of the Burn of Marrofield Water found small numbers of trout parr. The data indicate that changes to water and habitat quality continue to make substantial reaches of Burn of Lunklet unsuitable for trout.

5.4.8 Voe catchment

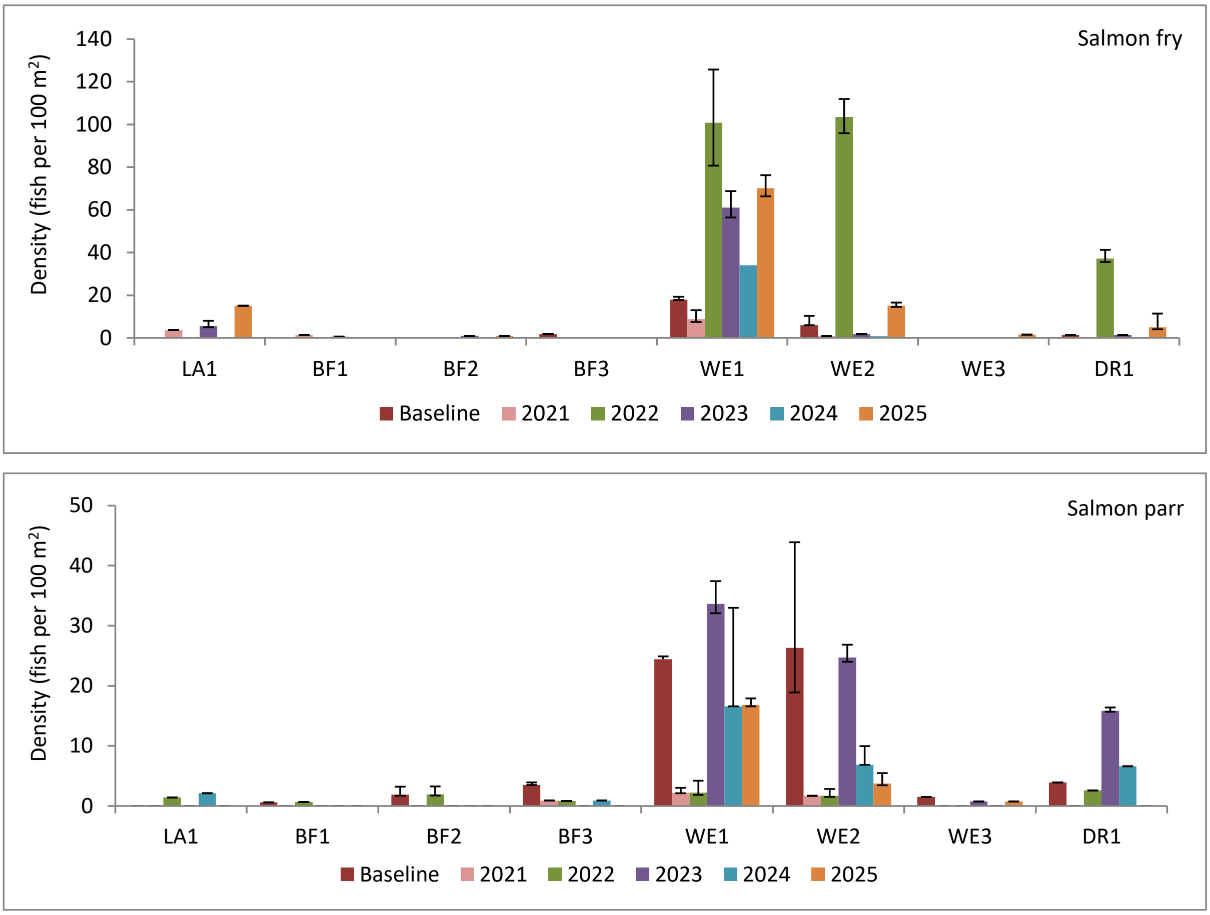
As in many streams, increased concentrations of TON and calcium were recorded in Burn of Wester Filla during construction. Levels were not so high as to be likely to directly impact trout populations which have remained high during most years of monitoring (Figure 16). The dip in trout parr densities during 2022 and 2023 did not coincide with any potentially damaging change to hydrochemistry.

5.5 Salmon

Salmon presence and abundance have been highly variable in the years since monitoring began. Salmon fry and/or parr have been intermittently present in Laxo Burn, Burn of Pettawater, Burn of Burrafirth and Burn of Droswall. However, the only watercourse where salmon have been recorded in each year of survey since 2019 is Burn of Weisdale. During the current survey, salmon fry were present only in Laxo Burn and Burn of Weisdale (Figure 18).

Salmon fry have been present every second year at LA1 in Laxo Burn and the density during the current survey was the highest recorded to date. Parr were absent, as they have been in during all years when fry were present. As parr at this site are mainly aged 1+ and fry have been present biennially this pattern is to be expected.

Figure 18. Salmon fry and parr Zippin densities, baseline to 2025



Salmon have been present only sporadically at monitoring sites in South Burn of Burrafirth and, when present, densities have been extremely low. Salmon parr were absent during the current survey but a single fry was captured at BF2 suggesting that spawning tool place somewhere in the stream in the winter of 2024-25.

In the Weisdale catchment, salmon fry densities at WE1, WE2 and DR1 were the second highest to date. Parr densities were below baseline but these largely reflect fry densities in the preceding years. There is no indication that fluctuations in salmon densities are driven by any of the observed changes to water quality. Nevertheless, the continuing presence of salmon demonstrates that water quality in Burn of Weisdale remains sufficiently good to support this species.

5.6 Conclusions

The fish monitoring data from 2025 are consistent with those from previous years and indicate there have been no site-wide impacts on fish populations due to construction works.

Trout fry densities during 2025 showed no consistent change compared with baseline and although mean fry density increased slightly at impact monitoring sites the change was non-significant. Mean fry density also increased slightly at the control sites, but again this trend was non-significant. While no site-wide changes were apparent, there were some substantial changes in trout fry density at individual sites. Notable decreases compared with baseline were apparent at QU1 (Burn of Quoys), KI1 (Burn of Kirkhouse) and control site LB2 (Burn of Laxobigging). Fry density at the latter declined to zero. Trout fry were once again absent from LU1 and adjacent reaches of Burn of Lunklet.

At most sites, trout parr densities in 2025 were broadly similar to baseline and no site-wide trend was apparent. Mean density decreased slightly at control sites as well as at impact monitoring sites, but the changes were not statistically significant. Trout parr were present at all monitoring sites other than LU1 in Burn of Lunklet.

Time series data on trout densities in each catchment were assessed against hydrochemical data. The data suggest that few of the fluctuations in trout numbers are likely to have been driven by changes to water quality. Trout densities are naturally variable year-to-year, as can be seen from control data, and this makes it difficult to determine causation when dips in numbers are observed. In general, the data continue to indicate that year-to-year variation in trout densities result largely from regional effects, possibly climatic, that are unrelated to construction. The loss of trout from long reaches of Burn of Lunklet are an exception and have clearly coincided with substantial contamination of water and streambed substrates.

Poor water quality in parts of Burn of Weisdale may have impacted on trout and invertebrates in the period 2022 to 2023 (Waterside Ecology 2024). This is uncertain but declines in trout numbers at WE3 and WE4 coincided with the presence of metal-rich run-off from Scallafield Scord and from cabling works. The improvement in trout fry numbers and invertebrate indices at these sites in 2024 has been sustained through 2025.

Juvenile salmon presence and abundance remain highly variable and there is no evidence that construction has had any impact on this species. Small numbers of salmon were recorded at sites in Burn of Burrafirth while fry density at LA1 in Laxo Burn was the highest recorded to date. Salmon fry and parr were once again present in Burn of Weisdale, suggesting that water chemistry in this watercourse remains suited to the maintenance of sensitive salmonid species.

6 Recommendations

- The suite of fish survey sites should be reviewed in late 2025 based on full assessment of time series data on hydrochemistry, freshwater invertebrates and fish. This process is underway (Headley et al. in prep).

- Due to substantial between-site variations in capture efficiency resulting from physical conditions any ongoing monitoring should use fully quantitative methods, where possible.
- Given the observed range of fluctuations in fish densities (in particular substantial variation in annual recruitment), changes in fish numbers are unlikely to provide reliable evidence of impact unless some causal mechanism can be identified. This mechanism would primarily be a change in water quality of sufficient magnitude to impact on one or more salmonid life stage. Therefore, interpretation of fish data must continue to be guided by the results of hydrochemical and/or invertebrate monitoring.
- Efforts to reduce the concentrations of metals reaching Burn of Weisdale and Burn of Lunklet should continue. The efficacy of mitigation measures should be assessed on an ongoing basis aided regular water quality monitoring, including biota.

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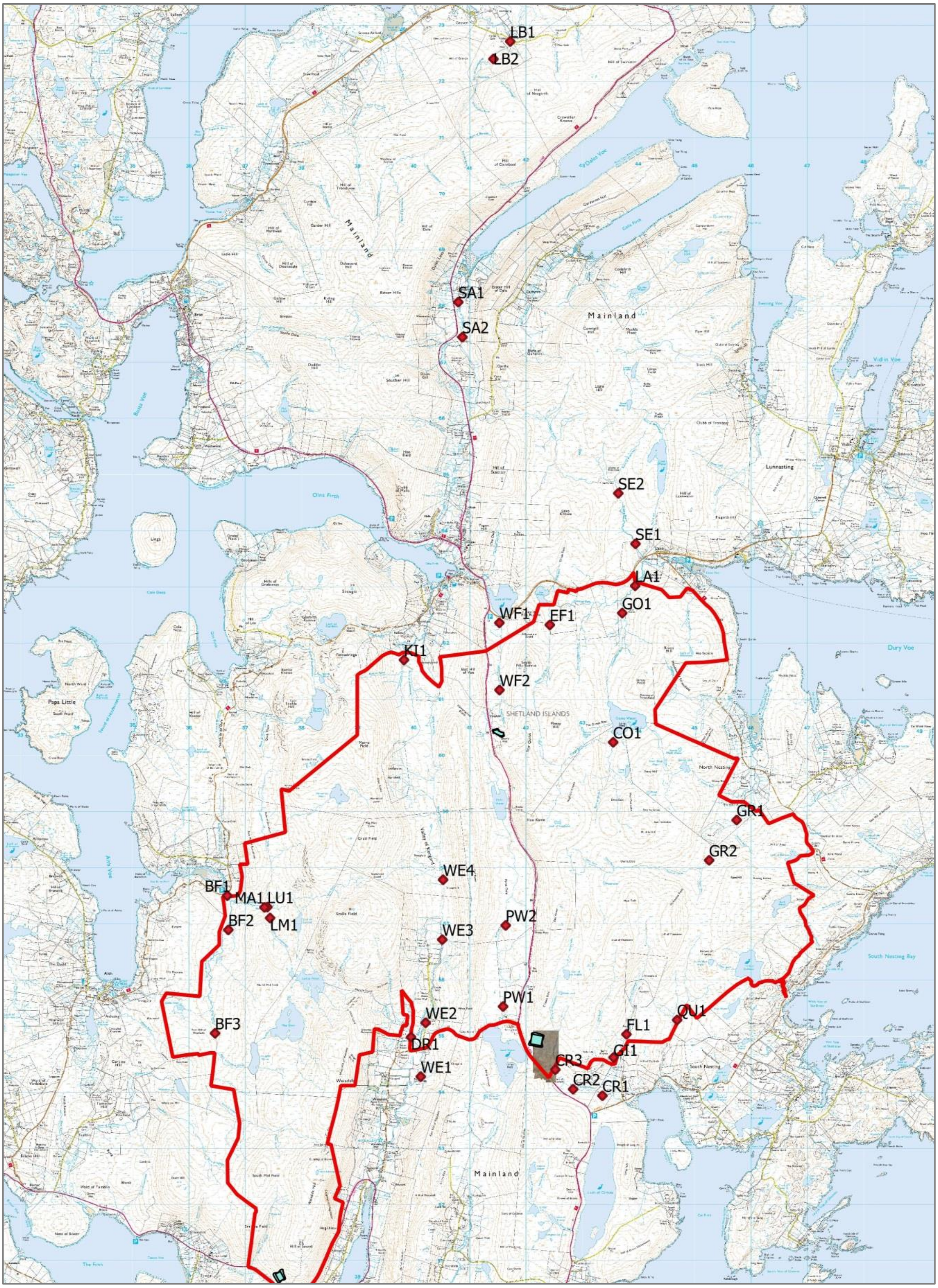
8 Appendices

8.1 Monitoring sites



8.2 Electric fishing survey site locations and survey event details: impact sites

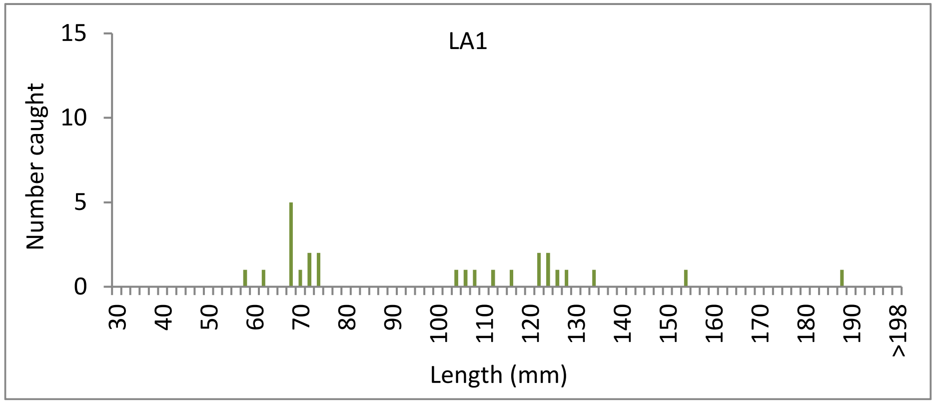
Site	Watercourse	NGR	Length (m)	Width (m)	Area (m^2)	Voltage	Conductivity ($\mu S.cm^{-1}$)	Temp. (°C)	Level	Colour
LA1	Laxo Burn	HU 43942 63020	27	5.2	140.0	190	203	16.5	low	clear
GO1	Gossawater Burn	HU 43712 62535	44	2.3	101.2	250	129	16	low	coloured
CO1	Corgill Burn	HU 43551 60235	61	1.2	70.6	150	125	13	low	coloured
EF1	Easter Filla Burn	HU 42424 62324	59	2.6	153.4	130	270	15	low	clear
WF1a	Wester Filla Burn	HU 41561 62202	73	1.1	81.2	120	329	14	low	clear
WF2	Wester Filla Burn	HU 41529 61165	75	1.2	90.8	120	343	13	low	clear
GR1	Burn of Grunnafirth	HU 45748 58851	49	3.1	151.9	200	205	16	low	clear
GR2	Burn of Grunnafirth	HU 45258 58134	52	3.0	153.4	190	205	15.5	low	clear
CR1	Burn of Crookadale	HU 43360 53944	66	1.7	114.1	150	280	15.5	low	clear
CR2	Burn of Crookadale	HU 42839 54059	78	1.1	86.5	150	258	15	low	coloured
CR3	Burn of Crookadale	HU 42522 54408	80	1.1	90.0	170	204	17	low	clear
GI1	Gill Burn	HU 43558 54625	81	0.9	71.9	150	225	16	low	coloured
FL1	Burn of Flammister	HU 43787 55037	71.5	1.2	85.8	150	160	12.5	low	coloured
QU1	Burn of Quoys	HU 44688 55292	64	2.1	131.2	150	203	15	low	coloured
KI1	Burn of Kirkhouse	HU 39830 61701	51	2.3	115.6	150	240	15	low	coloured
PW1	Burn of Pettawater	HU 41593 55531	63.5	2.6	167.2	150	312	11	low	coloured
PW2	Burn of Pettawater	HU 41693 56975	50	2.7	132.5	180	286	14.5	low	clear
BF1	Burn of Burrafirth	HU 36687 57505	23	6.9	157.8	200	176	15	low	clear
BF2	Burn of Burrafirth	HU 36705 56895	28	4	112.0	200	155	15	low	clear
BF3	South Burn of Burrafirth	HU 36469 55055	48	2.4	116.0	190	138	18	low	clear
LM1	Burn of Lamba Water	HU 37448 57107	77	1.3	100.1	180	157	14.5	low	clear
LU1	Burn of Lunklet	HU 37400 57302	55	2.2	119.2	170	266	15	low	coloured
MA1	Marrofield Water	HU 37348 57296	33	2.7	89.1	170	173	15	low	coloured
WE1	Burn of Weisdale	HU 40128 54283	24	4	90.4	180	224	14.5	medium	coloured
WE2	Burn of Weisdale	HU 40215 55242	34	3.4	116.7	140	294	12.5	low	coloured
WE3	Burn of Weisdale	HU 40511 56722	43.5	3.1	134.9	150	303	18.0	low	coloured
WE4	Burn of Weisdale	HU 40526 57788	86	1.2	103.2	170	217	13.0	low	coloured
DR1	Burn of Droswall	HU 39956 54987	48	1.6	76.1	150	234	12	low	coloured
SE1	Seggie Burn	HU 43948 63767	33	3.6	118.8	150	295	13.5	low	clear
SE2	Seggie Burn	HU 43642 64667	45	2.5	112.5	150	295	16.5	low	coloured
LB1	Burn of Laxobigging	HU 41710 07271	42	3.4	142.8	170	185	17	low	clear
LB2	Burn of Laxobigging	HU 41421 72398	38	2.85	108.3	180	180	17	low	clear
SA1	Burn of Sandgarth	HU 40796 68070	82	1.03	84.3	120	366	14.5	low	clear
SA2	Burn of Sandgarth	HU 40869 67447	65	1.2	79.9	120	402	15	low	clear

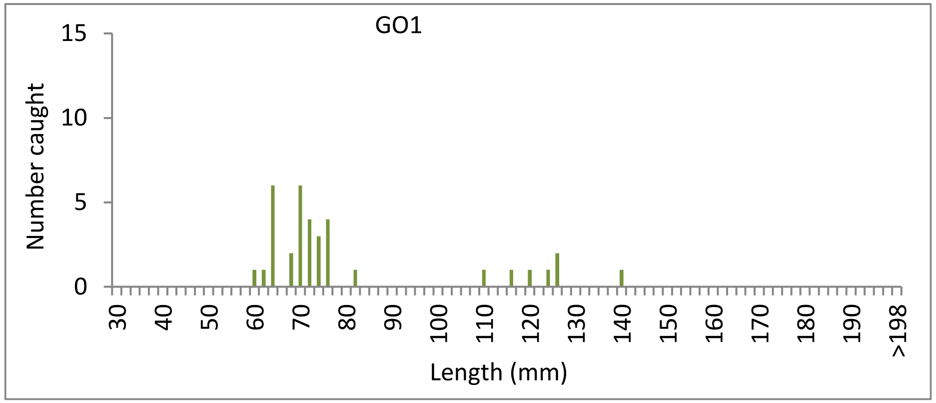
8.3 *Depletions attained at fully quantitative electric fishing sites*

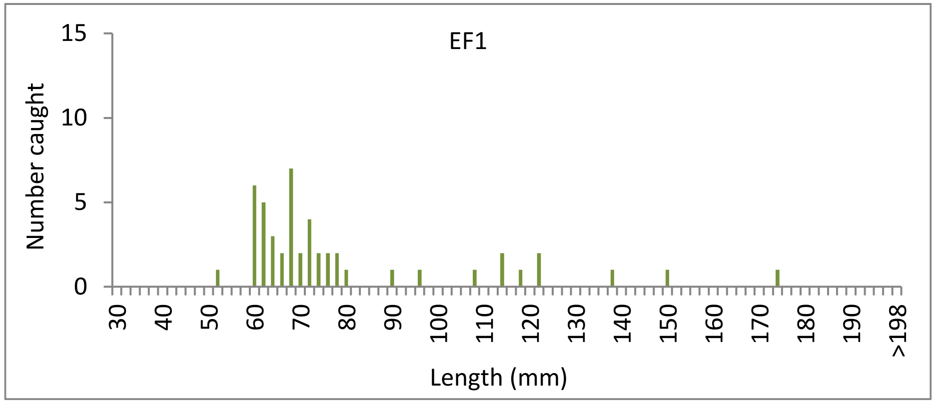
Site	Equipment type	Number trout fry caught			Number trout parr caught			Total trout		
		run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3
LA1	Backpack	8	4	1	14	0	0	22	4	1
GO1	Backpack	22	5	1	7	0	0	29	5	1
CO1	Backpack	30	11	8 (2)	2	1	1 (0)	32	12	9
EF1	Backpack	29	5	3	9	1	0	38	6	3
WF1a	Backpack	48	15	5	6	2	1	54	17	6
WF2	Backpack	55	23	10	9	3	1	64	26	11
GR1	Backpack	2	0	0	23	4	0	25	4	0
GR2	Backpack	5	2	1	28	5	1	33	7	2
CR1	Backpack	13	4	0	24	6	0	37	10	0
CR2	Backpack	15	2	0	7	0	0	22	2	0
CR3	Backpack	8	0	0	6	2	0	14	2	0
GI1	Backpack	4	4	0	1	0	0	5	4	0
FL1	Backpack	4	N/A	N/A	1	N/A	N/A	5	N/A	N/A
QU1	Backpack	4	1	0	7	2	0	11	3	0
KI1	Backpack	11	3	1	8	1	0	19	4	1
PW1	Backpack	72	21	6	22	3	0	94	24	6
PW2	Backpack	26	4	0	9	1	0	35	5	0
BF1	Backpack	1	0	0	6	1	1	7	1	1
BF2	Backpack	0	0	0	8	1	0	8	1	0
BF3	Backpack	0	0	0	10	2	0	10	2	0
LM1	Backpack	7	0	0	6	0	0	13	0	0
LU1	Backpack	0	0	0	0	0	0	0	0	0
MA1	Backpack	4	0	0	3	1	0	7	1	0
WE1	Backpack	9	2	3	5	3	1	14	5	4
WE2	Backpack	1	3	0	14	1	0	15	4	0
WE3	Backpack	24	10	1	6	1	1	30	11	2
WE4	Backpack	21	16	3	11	7	0	32	23	3
DR1	Backpack	12	3	0	10	1	0	22	4	0
SE1	Backpack	8	3	1	19	4	1	27	7	2
SE2	Backpack	15	3	1	20	4	0.0	35	7	1
LB1	Backpack	1	0	0	24	4	3	25	4	3
LB2	Backpack	0	0	0	15	3	0	15	3	0
SA1	Backpack	1	0	0	6	3	0	7	3	0
SA2	Backpack	2	1	0	7	0	0	9	1	0

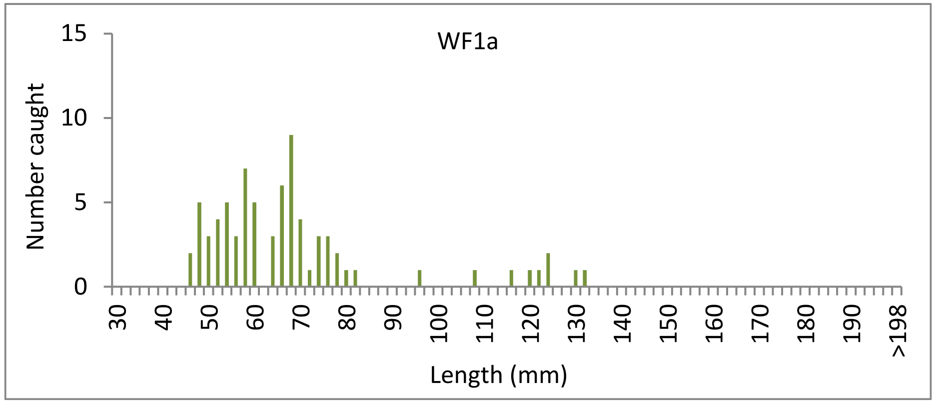
Numbers in parentheses at site CO1 refer to the number of fish captured in fourth electric fishing run

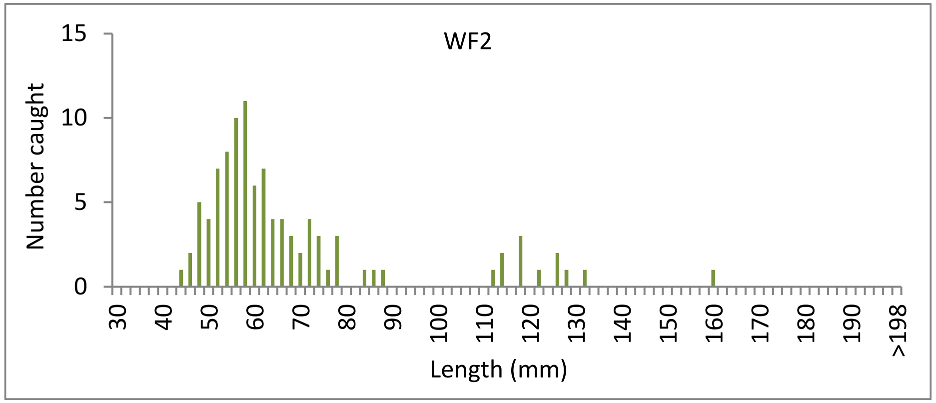
8.4 Trout length frequencies at individual survey sites

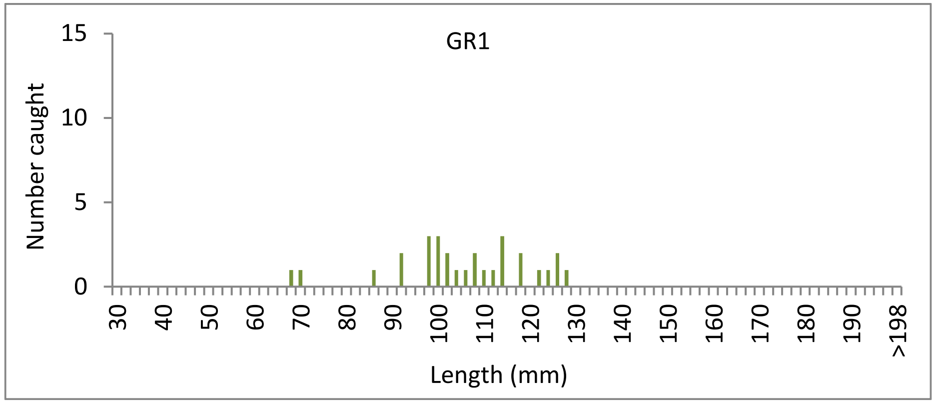


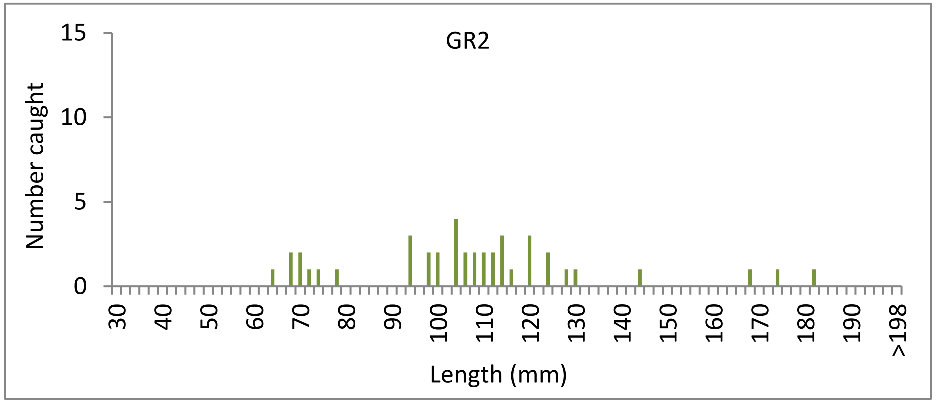








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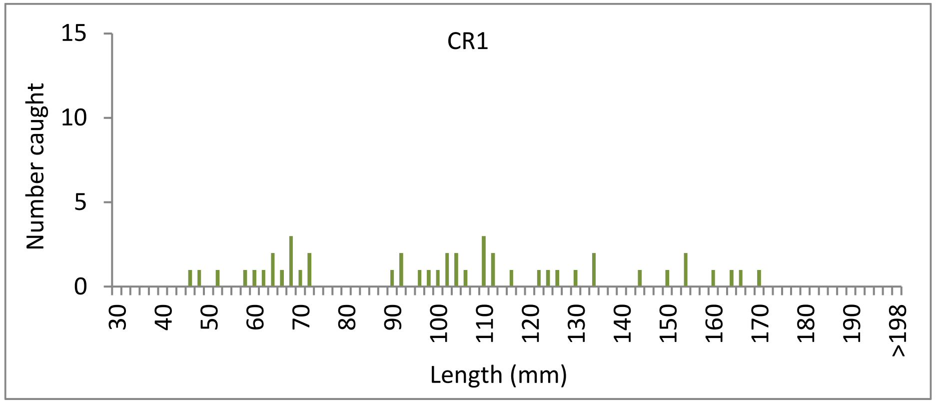
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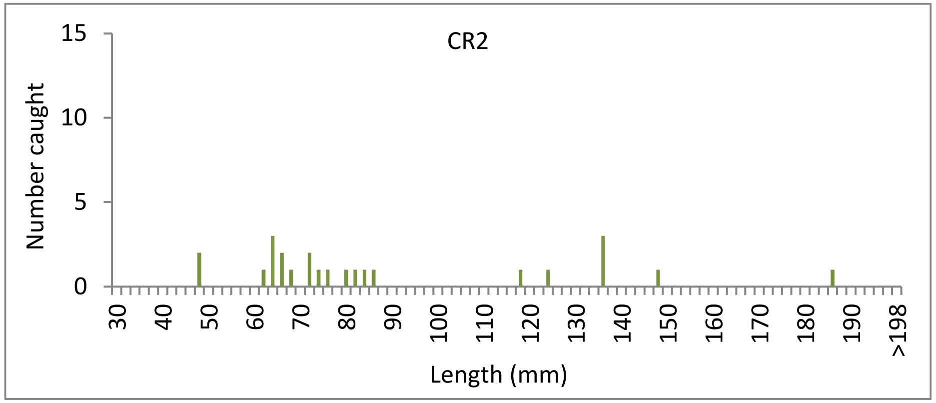
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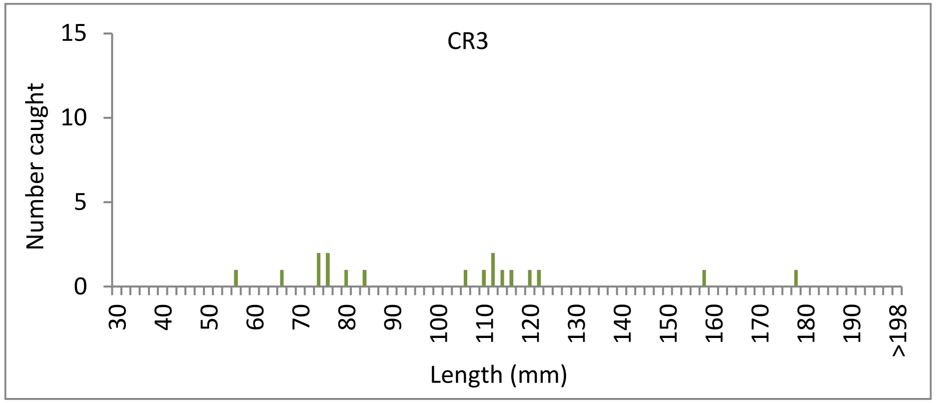
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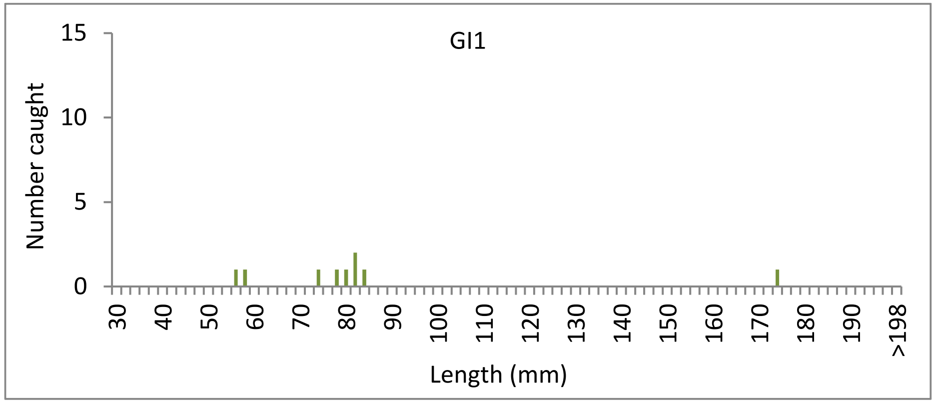
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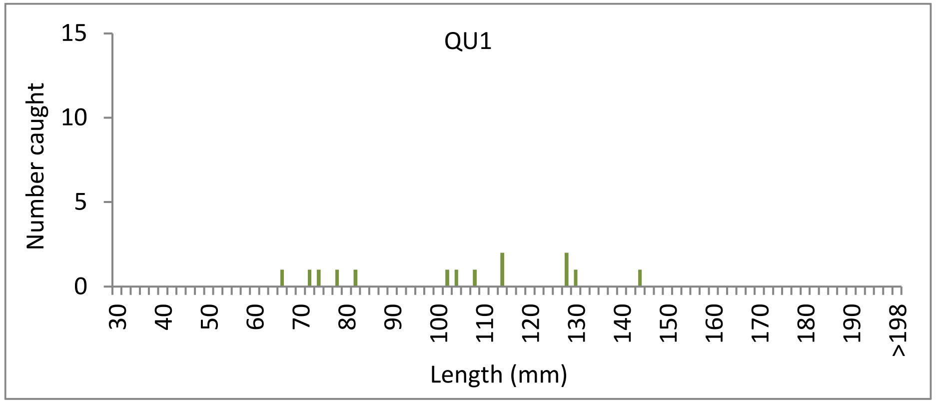
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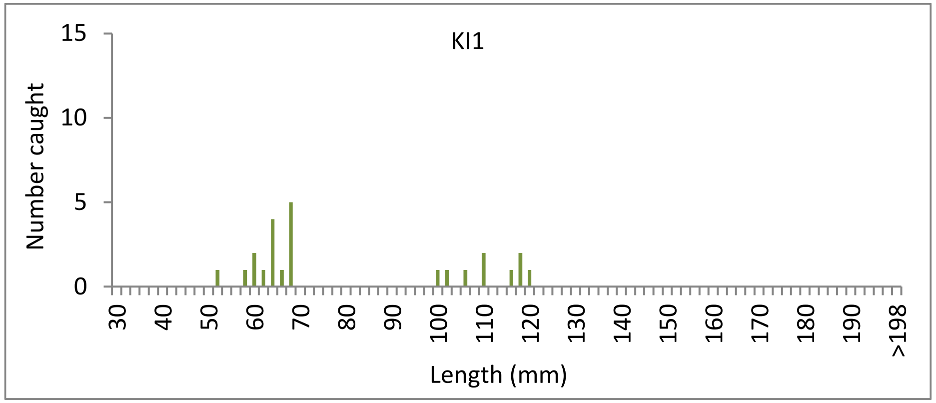
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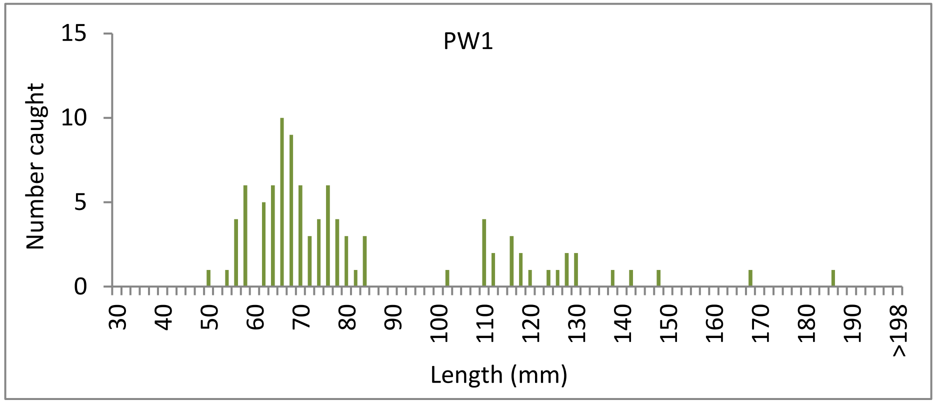
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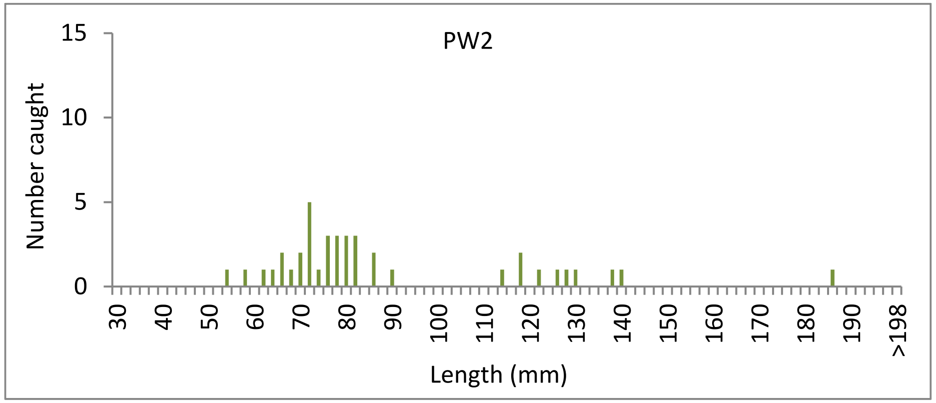
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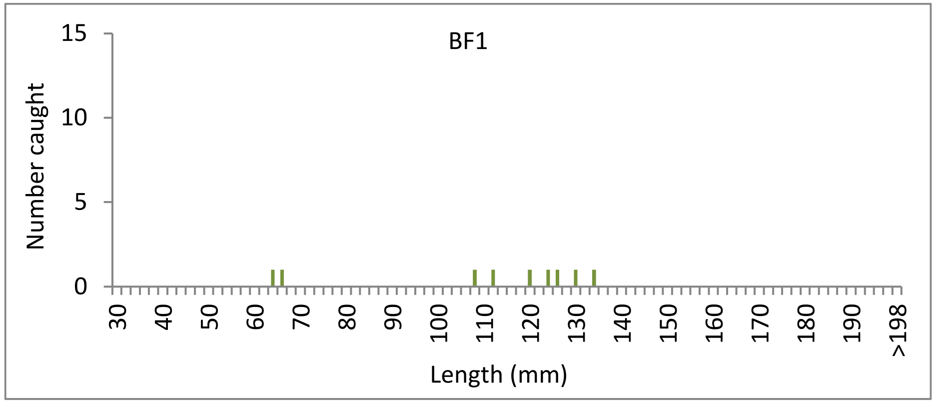
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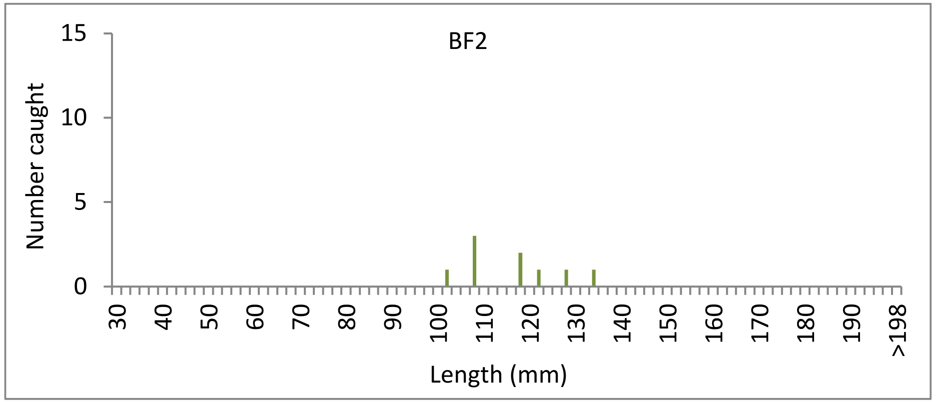
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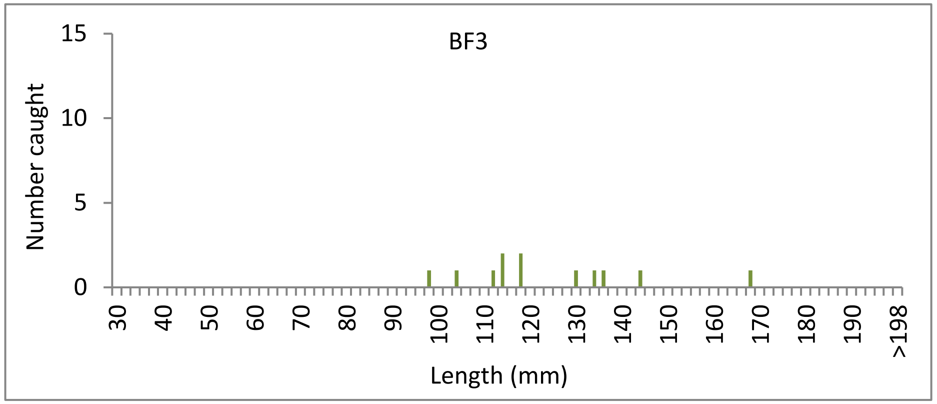
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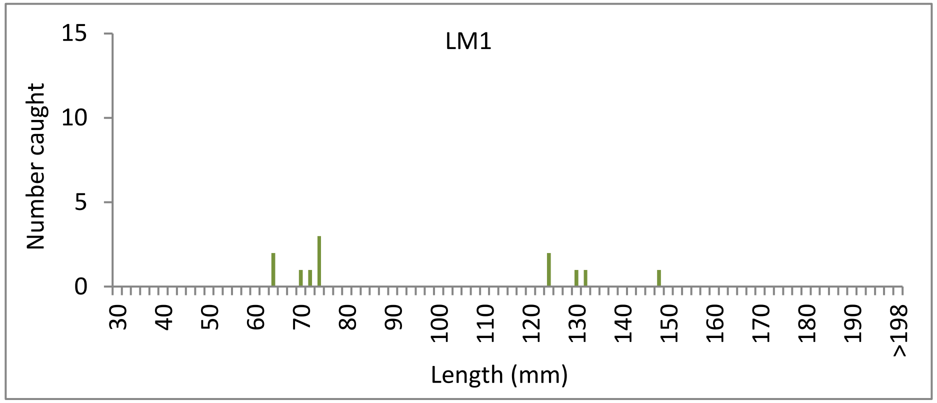
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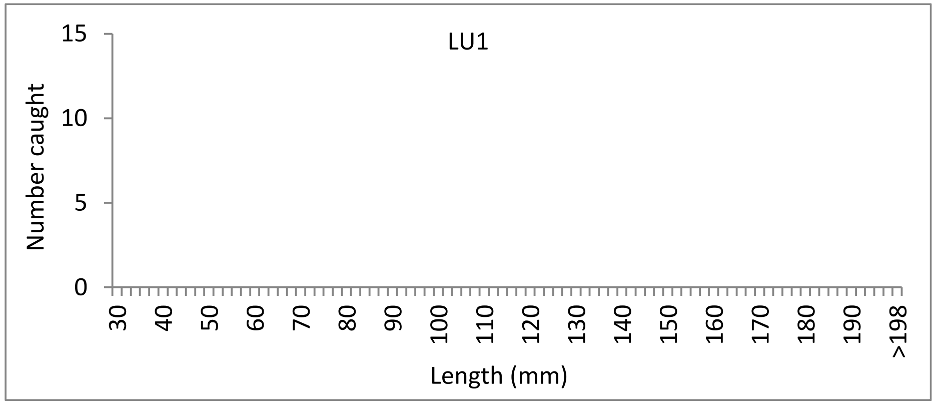
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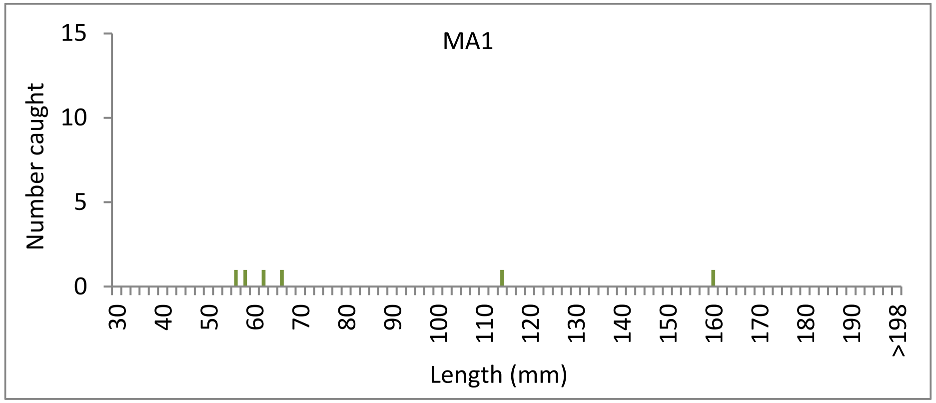
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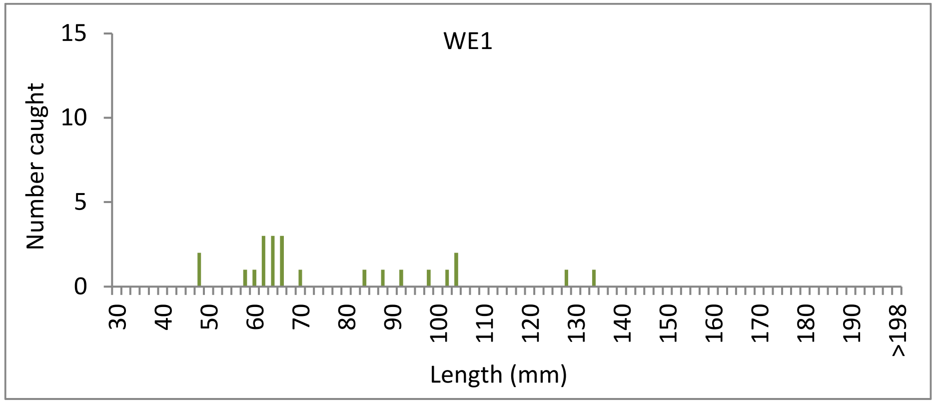
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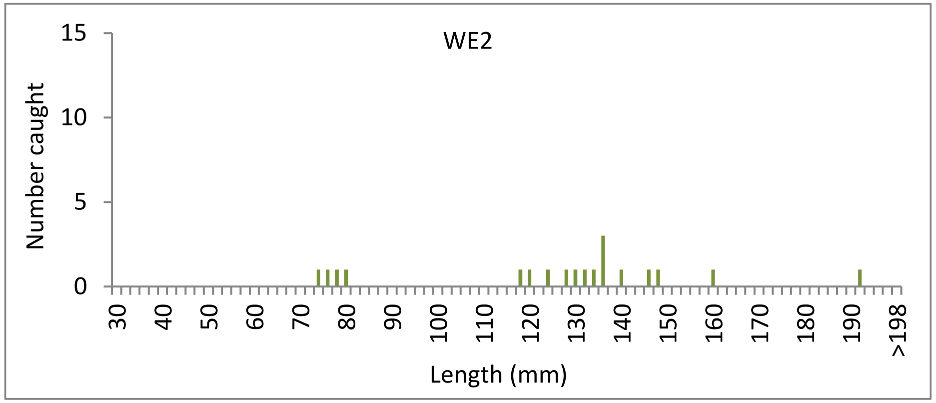
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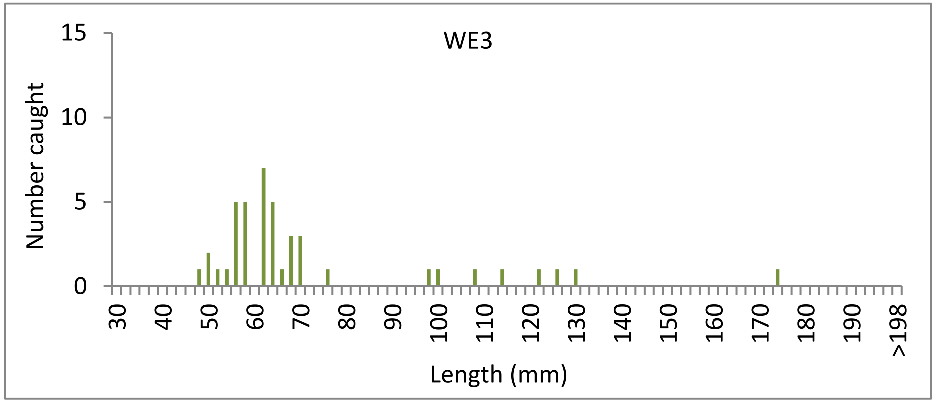
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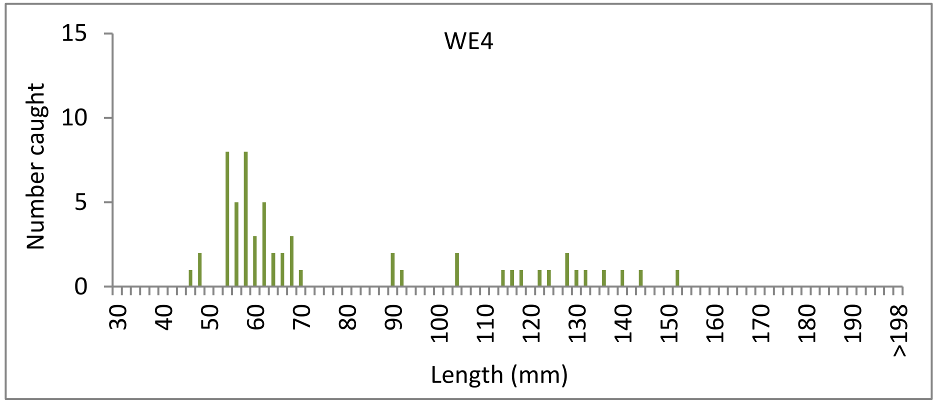
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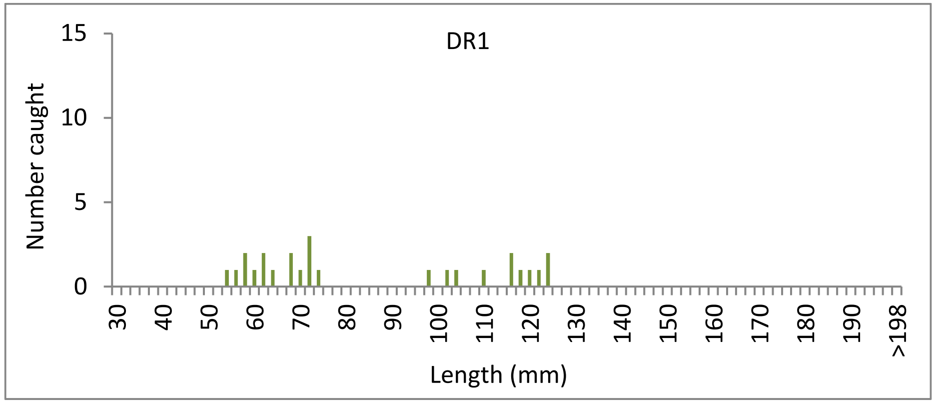
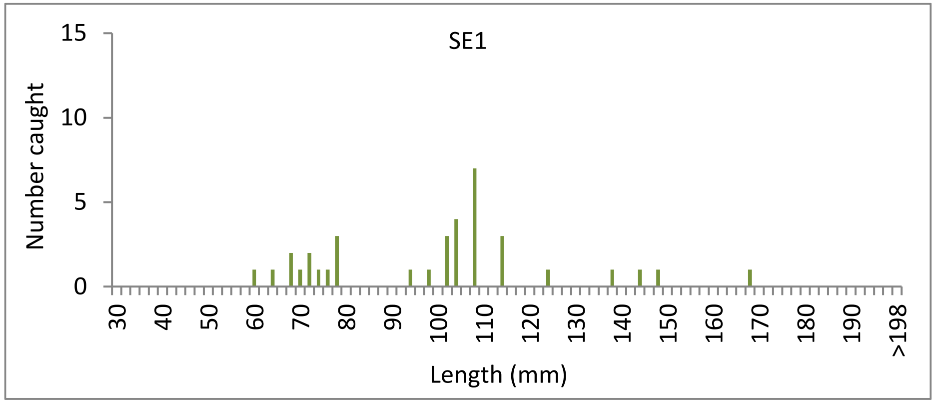
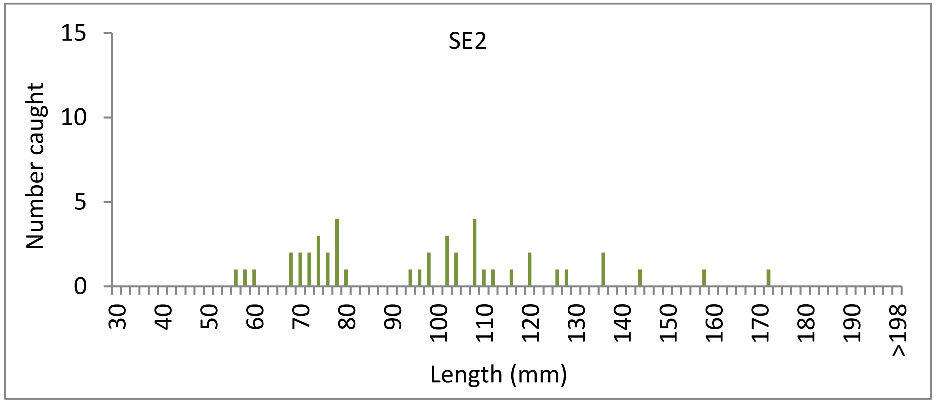
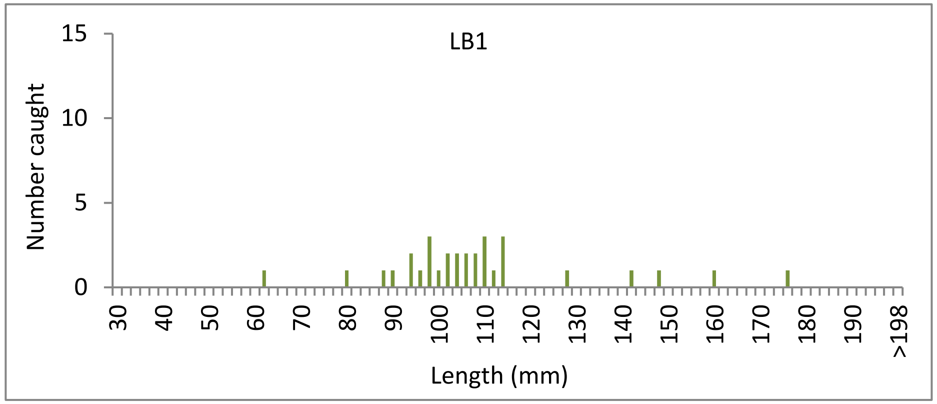
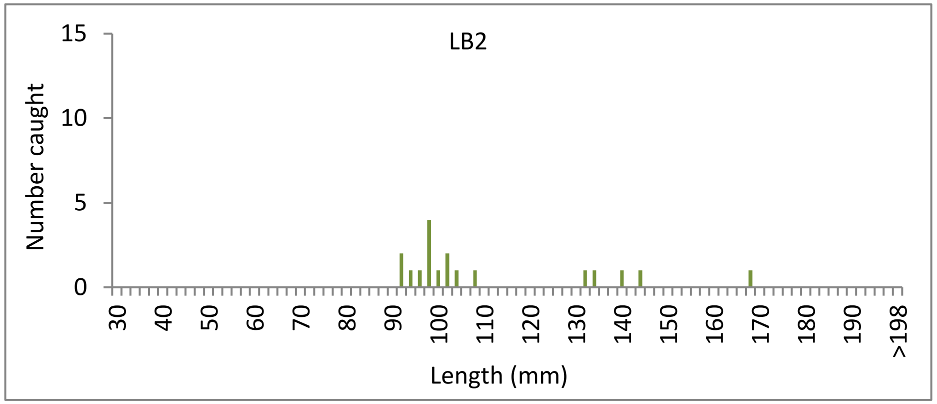
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)

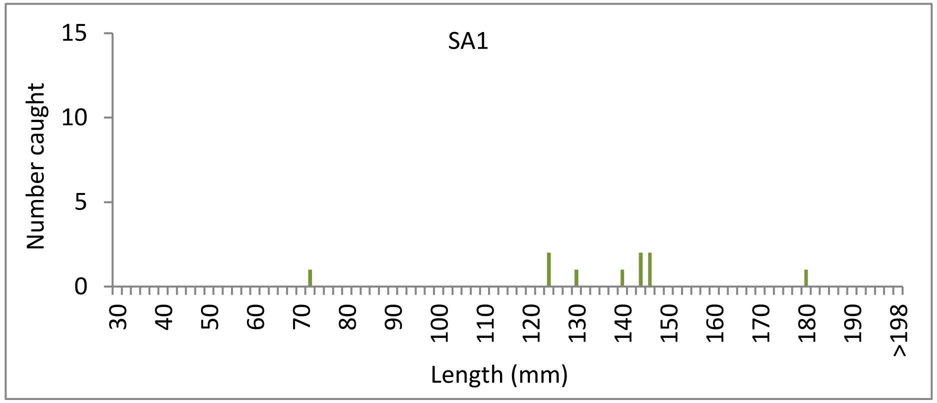

DR1
Number caught
0
5
10
15
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)

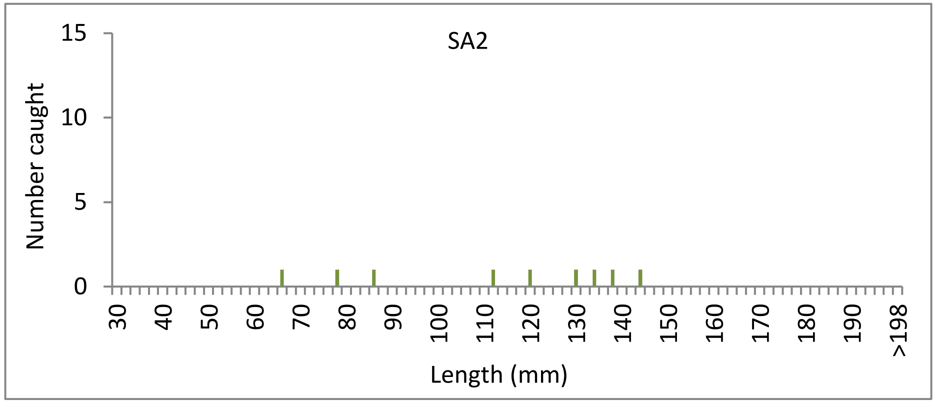

SE1
Number caught
0
5
10
15
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)


SE2
Number caught
0
5
10
15
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)

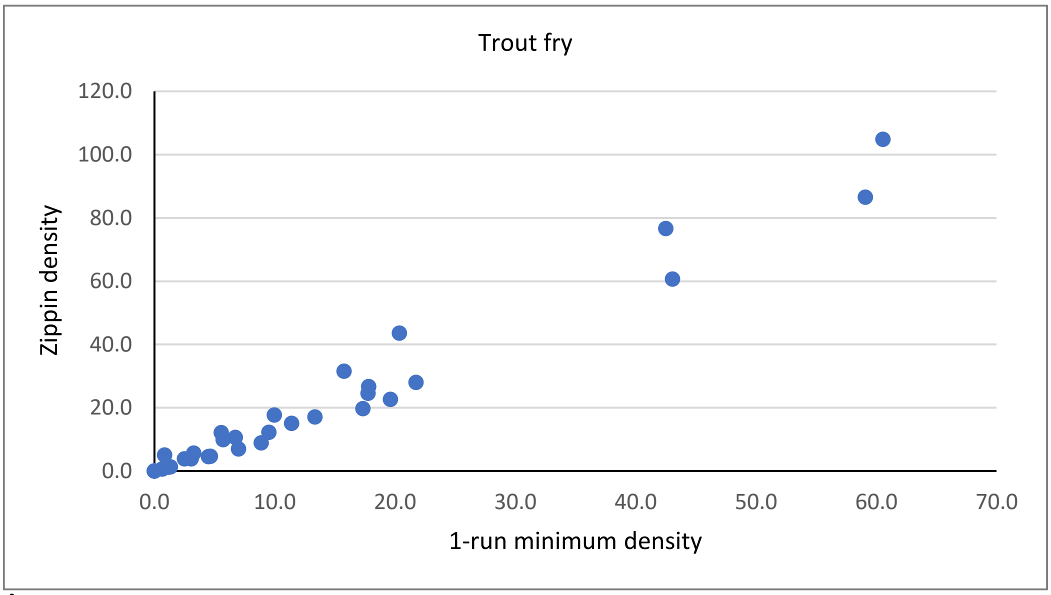

LB1
Number caught
0
5
10
15
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)


LB2
Number caught
0
5
10
15
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)

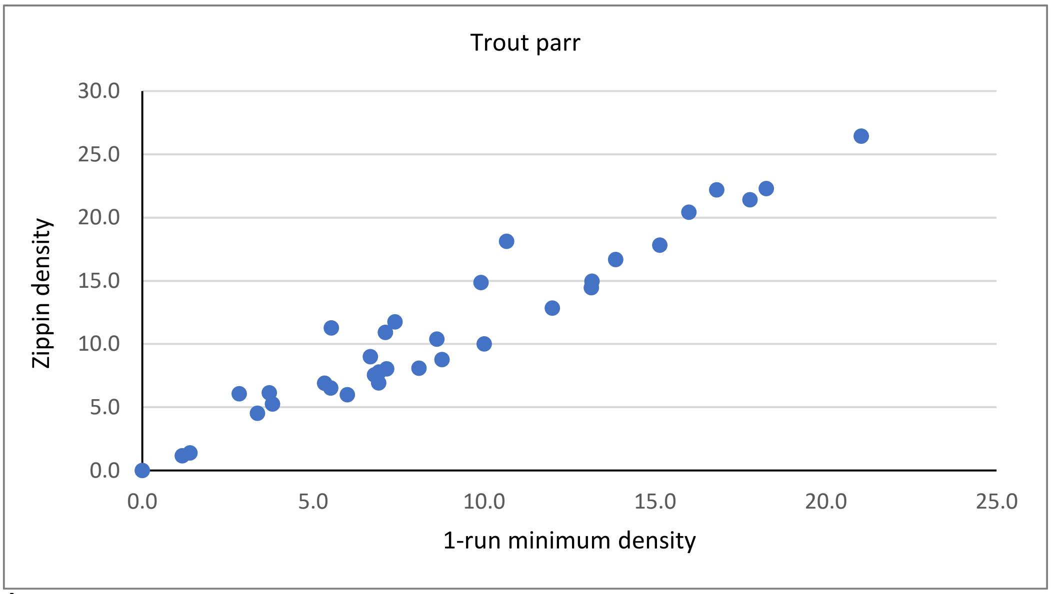

SA1
15
10
5
0
Number caught
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)


SA2
15
10
5
0
Number caught
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
>198
Length (mm)

8.5 Regression equations between single-run and Zippin trout densities



$\hat{Y} = -0.8963 + 1.5995X$
$R^2 = .97$, $F(1,32) = 946.29$, $p < .001$.



$\hat{Y} = 0.5276 + 1.1934X$
$R^2 = .93$, $F(1,32) = 410.13$, $p < .001$.