# Caithness District Salmon Fishery Board

# Electric-Fishing Survey Report, 2024

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April 2025

*The largest flood since 2006 had an impact on the 2024 survey results.*

*Loch More at 1000hr on 22nd October 2023 when Halkirk gauge was at 1.90m.*

*Photo Jamie McCarthy*

# Contents

# 1. Introduction

This is the twelfth consecutive annual report in the current Caithness series. From the start, the main aim of the surveys has been to track trends in the abundance of juvenile salmon in the Caithness rivers. As explained in previous reports, the methods and equipment used, the core electric-fishing team, the key survey sites and the survey dates have all remained constant throughout. These measures were adopted to eliminate or minimise sources of extraneous variation that might otherwise affect the accuracy of the fish survey data.

To some extent, the Board and local river interests can manage the progress of events in fresh water by their own efforts while, with the demise of the commercial fisheries, they cannot directly influence events in the marine phase. From a management perspective juvenile production and smolt output is one of the main drivers of the fisheries. Attempting to keep smolt production maximal is now the most effective means of ensuring that fisheries remain sound. Monitoring the abundance of juveniles in fresh water is therefore key from a practical point of view.

The particular challenge facing the Caithness Board is that it represents the interests of multiple rivers. All the catchments are related by their geographical proximity and all have their roots in the Caithness peatlands. But otherwise they differ intrinsically from one another in important ways including catchment size, topography, geology and land-use and all of these affect their salmon populations in different ways.

All the catchments have been beset in previous years by shared pressures such as the sequence of summer drought years between 2018 to 2022. Most of the catchments also appear to have been affected by intermittent or one-off pressures with consequences that have not been equally shared. These pressures include recurring mortality among potential spawners in the River Forss due to disease, and high levels of juvenile mortality in Wick River seemingly driven by episodes of poor water quality driven in turn by summer drought and high water temperature.

If the conjoined Berriedale and Langwell Rivers are considered to be a single unit, the Caithness Board area includes five rivers. With multiple rivers and multiple pressures in play, detecting trends and attempting also to explain inter-annual differences or longer-term divergence in salmon populations is problematic. Given the limits on the resources available for survey work, a strategic approach is therefore required to match the Board's aims with the capacity of the survey team to provide the required data.

Therefore, six key survey sites were set up at the outset – one on each of the rivers including sites at Gobernuisgach on Berriedale and Wag on Langwell. These key sites have been surveyed every year since 2013. Additional sites are visited or revisited on a strategic basis to address particular issues or to increase spatial coverage. The physical boundaries of each site are set the first time they are visited and remain unchanged thereafter. A large set of sites for which data has previously been obtained has now built up and all these sites are potentially available for re-survey at any time. The particular advantage of surveying the same site in consecutive years or over runs of years is to enable comparisons of the same cohort of fish at both the fry and parr stages. It should be noted that two potential

comparisons of this type are missed for each single year's gap in the monitoring sequence. Potentially, therefore, there is more value in extending existing runs of data for particular sites rather than visiting new ones.

As regards interpretation of data, most one-off pressures cannot be foreseen and variation in the survey data must necessarily be examined after the event to try to establish the identity of the pressure, its likely effect on young salmon and the likely severity of its consequences. This approach has weaknesses. Inferences like these are usually impossible to confirm directly because most of the pressures cannot be anticipated - and some occur only infrequently or for short periods. However, inference can be used to accumulate knowledge by building experience and increasing confidence as the time-series gets longer. Existing knowledge can be adapted to accommodate new findings. Previous inferences can be discarded or modified when the original version can no longer be sustained. Indeed, those working on rivers on the practical aspects of salmon fisheries build their own understanding in exactly this way.

Even so, like all the decisions made in life, fisheries management decisions usually have to be based on inadequate or incomplete information. Therefore, while the primary aim of the Caithness survey programme is to track changes in juvenile abundance, the second equally important aim is to enrich knowledge and understanding of the Caithness fisheries in order to enhance practical decision making in the north. In this respect, after twelve survey-years the Caithness rivers are better understood and managed than most.

The 2024 electric-fishing survey of the Caithness rivers was carried out in the usual way. The starting plan was curtained by poor weather and high water levels and it was possible only to survey fifteen sites when conditions were favourable. Despite this, all of the six key sites which are targeted for survey every year were visited again.

*Table 1. Site data for locations visited in 2025.*

| River | Site | Date | Area ($m^2$) |
|---|---|---|---|
| | | | |
| Forss | Shurrery | 24 August | 90 |
| | Lythmore | 24 August | 184 |
| Thurso | Rumsdale | 17 August | 182 |
| | Dalganachan | 23 August | 149 |
| | Smerrary | 25 August | 144 |
| | Tacher | 17 August | 131 |
| | Braehour | 25 August | 140 |
| Wick | Acharole1 | 22 September | 134 |
| | Clow | 22 September | 160 |
| | Sheriffs | 28 August | 170 |
| Dunbeath | Culvid | 20 September | 215 |
| Berriedale | Gobernuisgach | 21 September | 166 |
| | Braemore | 7 September | 156 |
| LangwellL | Wag | 19 September | 212 |
| | Aultibea | 21 September | 241 |

The appendices at end of this document show the fish data and a map shows the locations of the features of the river network that are mentioned in the text.

It has proved informative to use the concept of the yield of 1+ parr from fry (see Appendix 7.7 of the 2021 Report) to screen for possible one-off pressures over the period between annual surveys. Yield is considered to be the number of 1+ parr present in any year as a percentage of the number of fry present the previous year.

In the context of this report, the concept of yield is helpful only when fry density is lower than the smallest value (usually around 1.0/$m^2$) that is sufficient to produce a full crop of 1+ parr in the following year. Where fry density is greater than the saturation value, the density of 1+ parr levels off at its maximum value and larger crops of fry do not result in larger crops of 1+ parr. In other words, although the density of parr remains the same the yield of parr from fry is by definition reduced, and the concept of yield ceases to be directly informative.

The report is again organised as five sections dealing separately with the Rivers Forss, Thurso, Wick, Dunbeath and the conjoined Berrydale/ Langwell system. Only salmon are considered because, as is usually the case in Caithness, few trout were captured. The raw data for trout is nevertheless contained in Appendix 5 for reference.

As regards presentation, time-series for numerical density and for biomass density are shown in twinned panels for each survey site. The scale on the vertical axis of both sets of panels is kept the same throughout in order to facilitate visual comparison of numerical and biomass density at different survey sites.

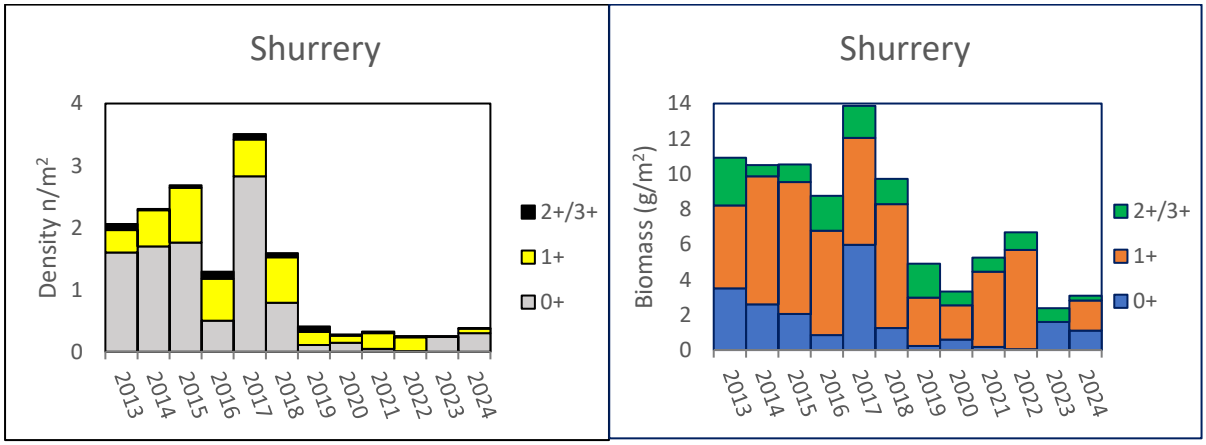
# 2. Catchment reports

## 2.1. River Forss

Populations of juvenile fish in Forss have been in a depressed state since 2019 due to a combination of negative factors detailed in previous annual reports - see https://caithness.dsfb.org.uk/publications/. The main constraint on the populations has been heavy mortality on adult fish due to episodes of *Saprolegnia*/ Red Skin Disease (RSD) and ensuing losses of spawners and, therefore, eggs and fry.

Forss was surveyed again in 2024 but not as extensively as intended owing to restrictions on survey time caused by poor weather and high water in late summer. The potentially productive sites at Lythmore and Shurrery were surveyed to check for any signs of recovery in fry numbers over the low levels of recent years. The density of 1+ parr was used to gauge prospects for smolt production in 2025 and therefore returns of adult fish in 2026 (grilse) and 2027 (2SW salmon).

### 2.1.1. Shurrery

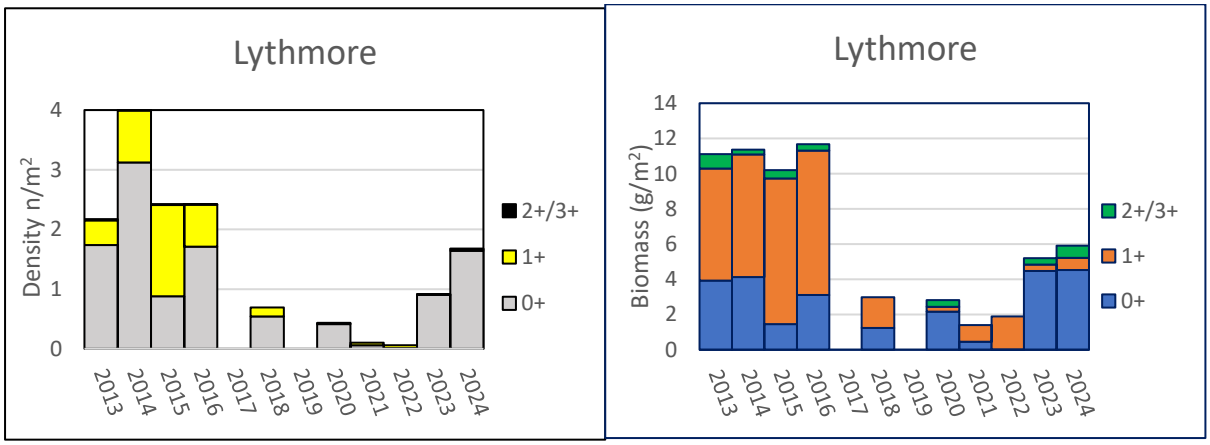



Fry density (0+; in grey) was 0.30/m$^2$ which is the greatest value observed since 2018 but still much lower than the high values observed before then. The high fry densities present before 2019 are assumed to represent the site's present potential to support young fish since no changes to the site's conformation or environment have been apparent over the period of the Board's surveys. The shortage of fry in 2024 is therefore likely to reflect the continuing adverse effects of *Saprolegnia*/ RSD on spawning.

The density of 1+ parr in 2024 was 0.07/m$^2$ (in yellow) which is very low relative to previous years. Before 2019 values often exceeded 0.50/m$^2$, ranging up to 0.88/m$^2$ in 2015. Again, these high values are taken to approximate the true potential of the site to produce 1+ parr assuming a sufficient supply of fry. However, fry density in 2023 had been only 0.24/m$^2$. In 2024, the yield of 1+ parr from these fry was about 30% which is in line with the yardstick value of 30% for Caithness generally. Again, this indicates that the lack of 1+ parr in 2024 was mostly or solely attributable to the shortage of fry in 2023 rather than to any gradual deterioration of the site itself or any one-off environmental effect.

As expected given their low densities, both the fry (average length = 71mm) and the 1+ parr (average length = 125mm) were relatively large for conditions in Caithness and for the Shurrery site specifically. Again, this suggests that the environmental quality of the site remains high. Although the few fish present grew unusually well, they could not grow quickly enough to fully utilise the site's resources. Their relatively large size buffered total biomass density upwards to 3g/m$^2$ but this value is still much lower than the maximum values of around 11g/m$^2$ attained in the years before 2019.

### 2.1.2. Lythmore




The density of fry at Lythmore showed signs of resurgence over recent years at 1.64/m$^2$. This value is high relative to values in many places elsewhere in Caithness and comparable with values at Lythmore itself in the earlier part of the time series. Evaluating the hoped-for effects of 2024's large crop of fry on the resulting crop of 1+ parr in 2025 should be a priority for next year's survey.

Given the marginally good crop of fry in 2023 (0.90/m$^2$), the density of 1+ parr in 2024 was much lower than expected at 0.03/m$^2$. The yield of 1+ parr from the fry was only 2% which is much lower than the rule-of-thumb value of 30% expected for Caithness and lower still than the values of 50%, 50% and 80% recorded at Lythmore itself in 2014-2016. The reason for the shortfall is unknown – but reminiscent of the similar shortfall at Rumsdale on Thurso River where fry on the verge of becoming 1+ parr appear to have succumbed to unusually large winter floods (see Section 2.2.2. below). The low yield of 1+ parr at Lythmore in 2024 from seemingly adequate densities of fry in 2023 may be linked to the events at Rumsdale. River level data for Forss is not available. Judging by the data for Rumsdale (see below) any effect of floodwater on the annual yield of parr will be uncommon and should not, therefore, feature in the 2025 survey. However, the one-off nature of the shortfall should be a priority for checking at survey in 2025 when the density of 1+ parr should return to the high values observed in former years.

The size of the fry (average = 65mm) was unremarkable for the site but the low density of parr was reflected in atypically large size of individual fish (average = 123mm for both 1+ and 2+). The biomass density of young salmon was therefore buoyed upwards by the

contribution of the parr. Total biomass density was 5.9g/m$^2$ which, as for 2023, is greater than the values observed immediately after 2016 but much less than those observed before then.

### 2.1.3. Forss summary

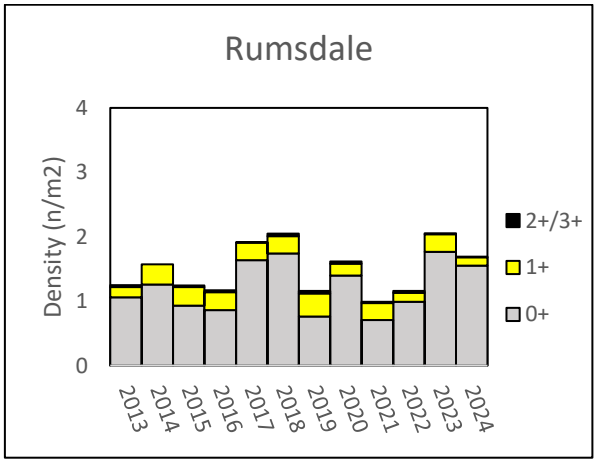
Overall, both the Forss survey sites showed signs of improvement in 2024 although the changes were not consistently expressed. In particular, parr levels were lower than expected at Shurrery and markedly lower than expected at Lythmore. This suggests that smolt output in 2025 will again be low and much lower than in earlier years when fry production and the resultant crop of parr were much greater. Low smolt production in 2025 will impact negatively on grilse numbers in 2026 and on 2SW salmon numbers in 2027 extending the period over which the river will continue to need support.

Surveillance of Shurrey and Lythmore should continue in 2025. Conditional on these results, coverage should be extended to eg. the existing Westfield survey site. The upper river south of Shurrery Dam should also be re-visited to cover previous sites at Torran and Cnoc-glas.

## 2.2. Thurso

### 2.2.1. Rumsdale

The Rumsdale site in the upper Thurso catchment was surveyed for the twelfth consecutive year in 2024 and the grey bars in the panel below show that the density of fry in 2024 was one of the highest values in the time series at 1.55/m$^2$. Judging from past outcomes, this is more than enough fry to ensure the site will be saturated with 1+ parr in 2025.




In 2023, however, the density of fry had been even higher at 1.76/m$^2$. Yet as can be seen in the panel the density of 1+ parr (as represented by the yellow bar) was rather lower than expected at 0.13/m$^2$. Figure 1 below shows this more clearly.

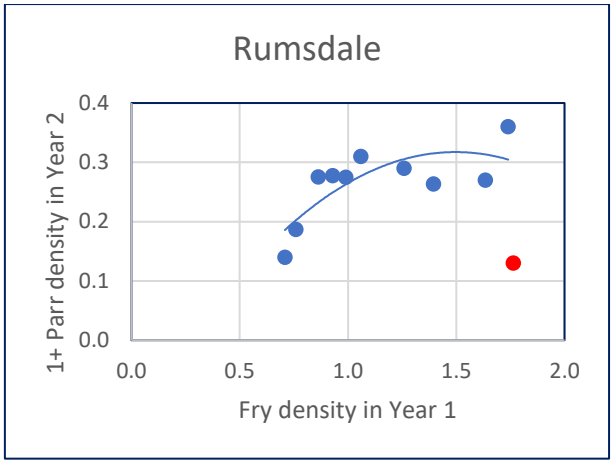
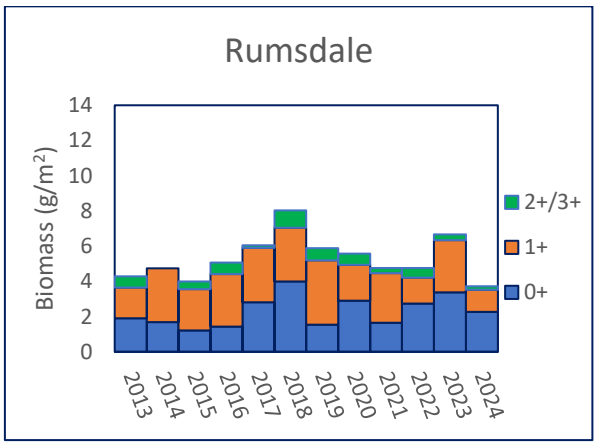



*Figure 1. The relationship between fry and 1+ parr density in successive pairs of survey years*

Figure 1 plots the density of salmon fry (horizontal axis) against the density of 1+ parr one year later (vertical axis) for all the years for which the Board has data. The ten blue points and the blue line represent the ten fry-years from 2013-2022 versus the ten 1+ parr-years from 2014-2023. The red point shows the equivalent value for the fry of 2023 versus the 1+ parr of 2024.

In 2024, the yield of 1+ parr from the previous year's crop of fry was less than half of the value expected based on the equivalent values for the ten pairs of years represented by the blue line shown in Figure 1. The shortfall is large enough to demand further scrutiny and Section 2.2.2 considers whether it might be attributed to the very large autumn and winter spates of late-2023 and early-2024.




Turning to consider biomass, the total biomass density (3.7g/m$^2$) was lower in 2024 than in any previous year due mostly to the small size of the many fry present (av. body length = 54mm) and the low density of parr.

### 2.2.2. Floodwater effects?

Figure 2 shows the river level data for the SEPA gauging station on the River Thurso at Halkirk covering the period between 1$^{st}$ September 2023 and 31$^{st}$ August 2024. The observed river level in meters is shown against the date. As a reference point, it can be seen that the typical low summer value is around 0.25m.

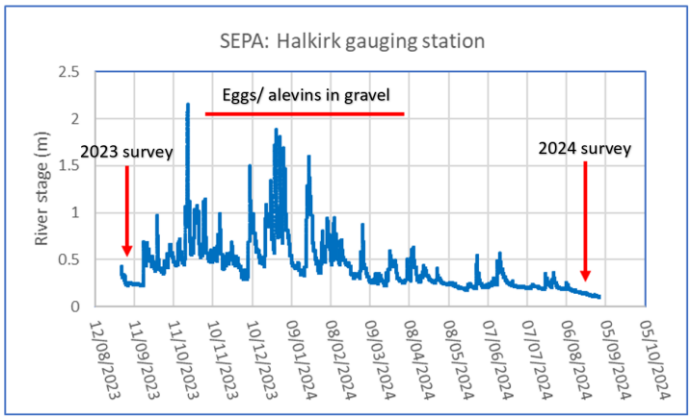



*Figure 2. River stage at the SEPA gauging site at Halkirk for the year spanning the 2023 and 2024 survey dates.*

On 21nd October, 2023 the river reached its greatest height for the period shown, running above 2.0m for 8 hours from 2300hr until 0700hr on the 22nd and peaking at 2.15m. The cover photograph gives some idea of the size of the flood near its peak for those who are familiar with Loch More dam, the fish-pass and the cottage. Further very large floods followed on 8th December (max. 1.50m), 28th December (max. 1.88m) and 22nd January (max. 1.60m).

Figure 2 also shows the dates of the 2023 and 2024 electric-fishing surveys and the period over which eggs and alevins were present in the redds (ie from spawning time until swim-up). Thus, the first electric-fishing survey of the fish produced by the eggs spawned in 2022 took place at the fry stage in September, 2023. A year later in August, 2024, the same year-class of fish was surveyed again, by now at the 1+ parr stage.

In summary -

- Fish that had been spawned in 2022 - surveyed as fry in September 2023 - were exposed to all the floods including the largest one on 21st October 2023. These fish were surveyed again in August 2024 now as 1+ parr.
- Eggs spawned in 2023 were not exposed to the largest spate of all on 21st October because spawning does not take place until November.
- After spawning time, eggs incubating in the streambed were exposed to the large floods of December 2023 and January 2024 which ran up to 1.88m as measured at Halkirk.

The simplest explanation for the patterns shown in Figure 1 is that the flood of 21st October 2023 was large enough to destroy a substantial proportion of the group of fish spawned in November 2022 and hatched in March 2023. These fish were still relatively small in size at the survey date (average 58 mm at the time of the 2023 survey). Older, larger 1+ parr (hatched in 2022, average 98 mm) were also present at this time. Whether this older, larger group was affected in the same way cannot be known because most fish leave the Rumsdale site in April or May as 2-year-old smolts. Parr aged 2+ are therefore uncommon at survey time every year.

The eggs spawned in 2023 were not exposed to the largest flood of all but they were exposed to those in December and January. If these floods affected the survival of eggs at all, the effect was not critical since fry were still present in excess at survey in autumn 2024 and will likely saturate the site with parr in 2025.

It can be asked if flood water may have affected fish populations in previous years and what can be expected in future? The question therefore arises how large the October, 2023 spate really was relative to previous years. This can be explored using river level data for previous years for the SEPA gauging station at Halkirk.

SEPA makes adjustments to the river level data to increase precision and also to transform the measurement of river height in meters to estimates of discharge expressed as cubic meters per second. This is important because it is velocity and turbulence rather than river height that affects the local dynamics of the stream- or river-bed. The discharge data are not yet available for the period running up to the 2024 survey. When they do become available it will be possible to make more telling comparisons of river level over a longer period of time to find out how the river's flow regime in 2023/24 compared with previous years. In particular, it will be possible to consider how high discharge rates, high water velocities and high levels of turbulence may have affected parr and fry over the wider time-scale covered by the Board's electric-fishing surveys.

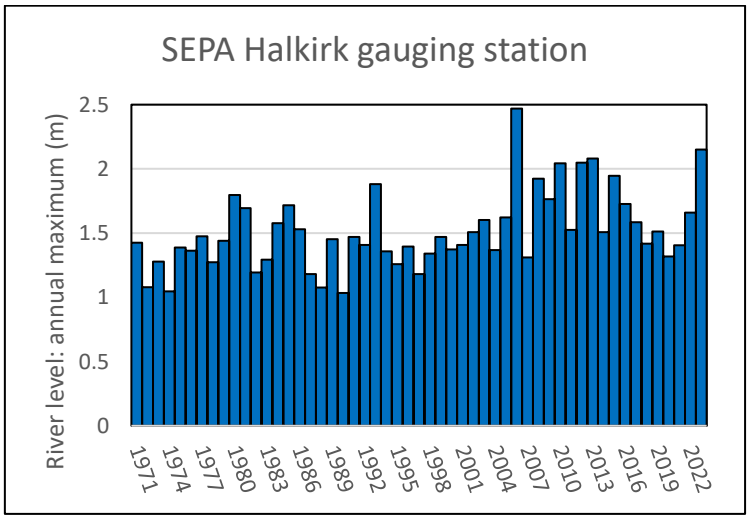



*Figure 3. The maximum annual value for river-stage since 1971 when the Halkirk gauging station was established*

In the meantime, Figure 3 shows the maximum river level in meters observed at the Halkirk gauging station for each of the years back to 1971. The largest river height of 2.47m was recorded on 26th October, 2006 (see http://www.thursoriver.co.uk/videos/spate.wvx). The value for 21st October, 2023 was the second largest recorded at 2.15m. Otherwise, maximum river levels in the 1.5 - 1.8m range feature in many years.

There are two provisos that must be registered before drawing any conclusions regarding the possible effects of floodwater on the survival of eggs or fry. Firstly, although the Halkirk

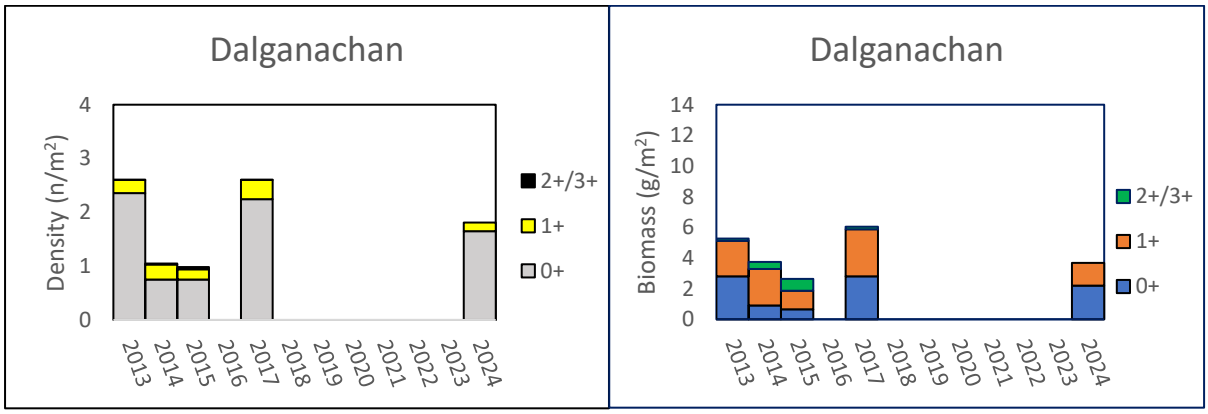
gauging station may be considered representative of the Thurso catchment as a whole it is a long way from Rumsdale itself. Secondly, Rumsdale and Halkirk differ greatly in the geometry of their channels (eg. gradient, width, bank height) and differences like these profoundly affect velocity and turbulence – the factors most likely to alter local hydrodynamics.

Tentatively, therefore, and considering only the Rumsdale survey site –

- In 2024, fry recruitment from eggs exposed to winter floodwater levels equivalent to 1.5 – 1.9m at Halkirk gauging station was not materially compromised.
- In 2024, 1+ parr recruitment from fry was reduced due to prior mortality caused by winter floodwater levels ranging to 2.15m as measured at Halkirk.

### 2.2.3. Dalganachan

The survey site at Dalganachan was last visited in 2017. Dalganachan is located in the upper reaches of Thurso River on the mainstem itself. Dalganachan's location towards the southern periphery of the Thurso catchment is similar to that of Rumsdale and the two sites are only 3km apart. Having discovered the unexpectedly low density of parr at Rumsdale, the status of the fish population at Dalganachan was surveyed to provide a further check on the status of young salmon in the same general vicinity.



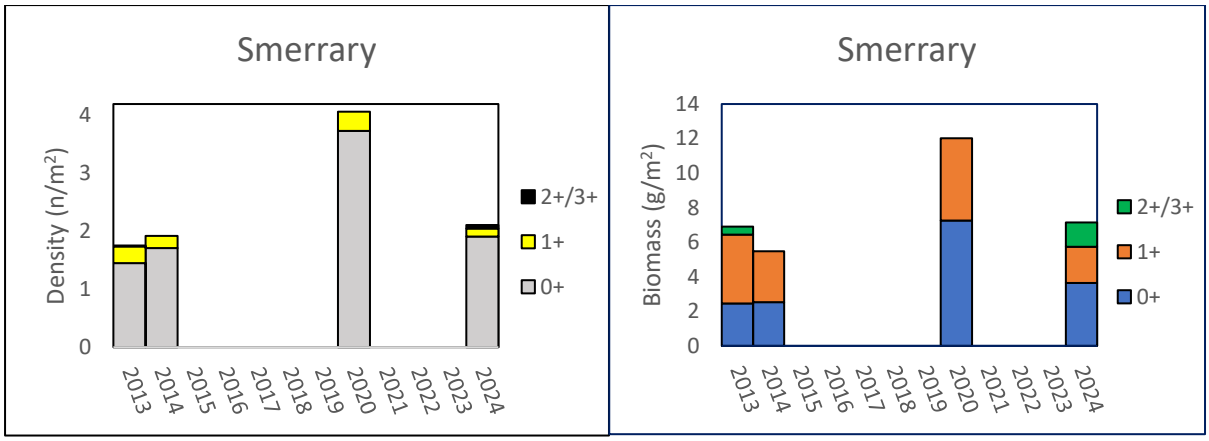

In 2024 fry density at Dalganachan was 1.65/m$^2$ which is comparable with the high values observed in previous years and comparable, too, with the equivalent value attained at Rumsdale. As for Rumsdale, however, the density of 1+ parr was unexpectedly low at 0.16/m$^2$; this is the lowest value in the short series that is available. The yield of parr from fry could not be calculated because no survey data for fry in 2023 are available.

Total biomass density was 3.7g/m$^2$ roughly in line with previous values.

Overall, therefore, the status of Dalganachan in 2024 was generally comparable with former years. In particular, fry levels were more than sufficient to support a likely capacity population of 1+ parr in 2025. The density of 1+ parr, however, was lower than expected providing weak evidence that the effect detected at Rumsdale, and tentatively attributed to winter floodwater, had also been a feature at Dalganachan.

### 2.2.4. Smerrary

The Smerrary site lies on the main river at the top of the Private Beat. Smerrary was revisited in 2024 to extend the observations made at Rumsdale and Dalganachan to the main river. The site was last visited in 2020.

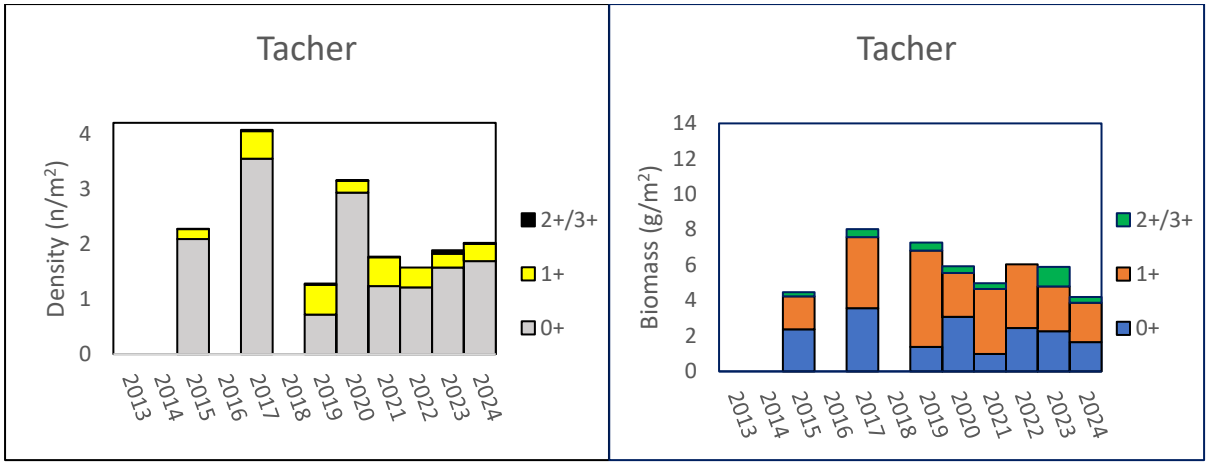



Fry density was very high at 1.91/m$^2$ and easily capable of supporting a full crop of 1+ parr in 2025. The density of 1+ parr was unexpected low at 0.14/m$^2$ and the lowest in the small set of values accumulated over the years. This provides more weak evidence that populations of 1+ parr at Rumsdale, Dalganachan and Smerrary were affected by some shared effect that did not affect fry in the same way.

The size of the Smerrary fry was as expected (average = 58mm); the 1+ parr were slightly larger than expected (average = 108mm). Total biomass density including a substantial contribution from 2+ parr (average = 122mm) was 7.14g/m$^2$, confirming the continuing high productivity of the Smerrary site.

### 2.2.5. Tacher

The Tacher site has been surveyed eight times since 2013 and a continuous run of data is available from 2019 onwards. The site lies on the Little River. This is the main tributary stream in the mid part of Thurso catchment with origins around Loch Rangag on the western side of the A9 roadway.

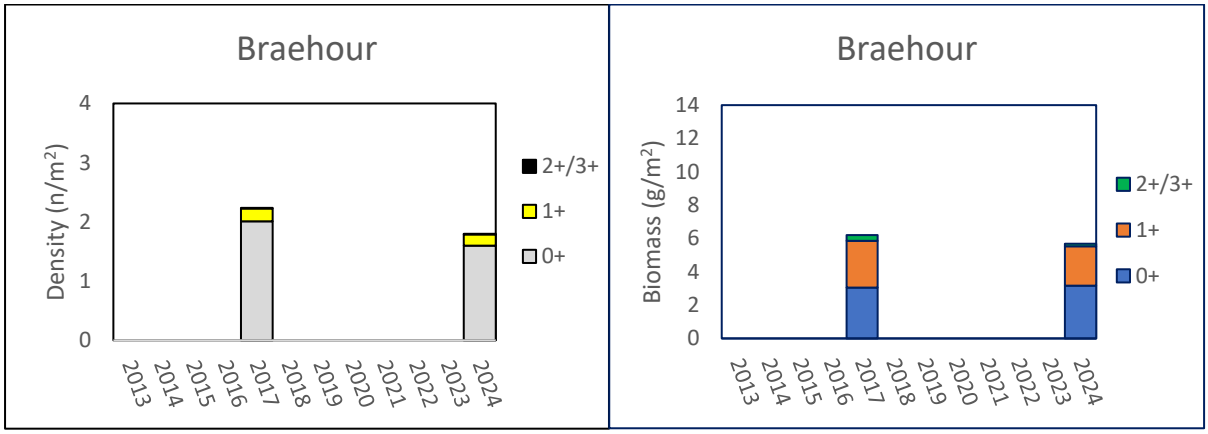



Fry density was 1.69/m$^2$ which, once again, is fully in line with expectation, exceeding the density needed to flood the site with 1+ parr in 2025 and maximise smolt output in 2026. The density of 1+ parr was 0.31/m$^2$, about average for the site. There was no evidence to suggest that either fry or parr had been compromised over the winter in the manner indicated for the survey sites located in the higher catchment.

The average length of fry and 1+ parr was 47mm and 86mm, respectively, which is relatively small for the site and the total biomass density (4.36g/m$^2$) was one of the lower values observed in previous years.

### 2.2.6. Braehour

The Braehour Burn north of Westerdale is the largest tributary of the lower section of the Thurso catchment. It was surveyed once before in 2017 and was visited again in 2024 to provide further information on the overwinter performance of juveniles in 2023/ 2024.




Salmon fry density was 1.60/m$^2$ and the density of 1+ parr was 0.19/m$^2$ which is roughly the same as for 2017. Biomass density was 5.68g/m$^2$ which, again, is very similar to the equivalent value for 2017. There was no evidence of over-winter constraints on the survival of young salmon.

Unusually among survey sites in all the Caithness rivers, Braehour supports substantial numbers of trout. Trout fry density was 0.20/$m^2$ in 2024; parr density was 0.13/$m^2$. The equivalent values for 2017 were rather similar at 0.25 and 0.09/$m^2$, respectively.

### 2.2.7. Thurso summary

As for previous years, the 2024 crop of salmon fry was uniformly good. Fry densities over the five sites sampled across the catchment ranged from 1.55$m^2$ to 1.91/$m^2$. It should be emphasised that none of these sites is chosen for proximity to features such as spawning fords, for example, that might result in over-optimistic assessments. Rather the survey sites are chosen to be accessible because of the cumbersome equipment that must be used and shallow enough to be a realistic target for census. They must also comprise stream habitat that is likely to support sufficient numbers of fry and parr to track interannual changes in abundance – the main purpose of the Board's surveys.

Densities of 1+ parr varied from 0.13 to 0.31/$m^2$ over all five Thurso sites. The highest values were roughly as expected based on previous years. However, values at the three sites in the upper part of the catchment were lower than expected ranging between 0.13 and 0.16/$m^2$. It was only possible to scrutinise the Rumsdale series of surveys with confidence because the series is continuous back to 2013 and stable before 2024. The 2024 anomaly therefore stands out clearly. Trying to define the effect is open to a simple graphical comparison of 2024 data with values for previous years. This implicates extreme winter floodwater as a likely cause of the low parr density observed in 2024.

The other sites – Dalganachan and Smerrary - are surveyed only occasionally to extend coverage across the catchment and the insights these data series can offer are therefore weaker. In line with this, the table below extends within-site comparison to all three sites but in a more qualitative way. The 2024 values for 1+ density were compared with equivalent values for the same site in all previous years for which data is available. As can be seen from the Table 1 below the 2024 values for the three sites in question were lower than in former years for all 18 of the possible comparisons.

*Table 2. Qualitative assessment of potential flood effects on 1+ parr density at Thurso survey sites.*

| | 1+ parr density in 2024 versus previous years | |
|---|---|---|
| | Higher in 2024 | Lower in 2024 |
| Rumsdale | 0 | 11 |
| Dalganachan | 0 | 4 |
| Smerrary | 0 | 3 |

Overall, therefore, it seems likely that the unusually large winter floods in 2023/4 eliminated some of the juvenile salmon at Rumsdale at the post-fry/ pre-parr stage and that the same effect probably extended to Dalganachan and Smerrary. There was no evidence that the populations of the Little River or the Braehour Burn were similarly affected.

Looking forwards, smolts are likely to be fewer than usual in 2025 due to the low densities of 1+ parr detected in the upper catchment in 2024. However, the high densities of fry observed in 2024, coupled with reductions in competition from the reduced parr class above them, is expected to result in a capacity crop of relatively large 1+ parr in 2025 and a full crop of smolts in 2026.

The Rumsdale, Dalganachan and Smerrary sites should be prioritised for survey in 2025 to check on their expected recovery.

### 2.3. Wick River

In the earlier part of the survey series, juvenile salmon populations at the survey sites on Wick River were among the most productive in Caithness. In 2021 and 2022, however, low survey values became a cause for concern. The cause of the decline could not be identified but was probably linked in some complex way with the succession of severe drought years from 2018 onwards. These brought extremely low water and atypically high temperatures to all parts of the catchment each year for much of the spring and summer. The corresponding values in 2024 were more moderate.

Section 2.2.2 describes the likely negative impact of the severe spates experienced in late autumn and winter on young fish in the Thurso catchment. River level is also monitored in the Wick River catchment at the Tarroul gauging station run by SEPA. The data for the Tarroul gauge for 2023-2024 are shown in Figure 4.

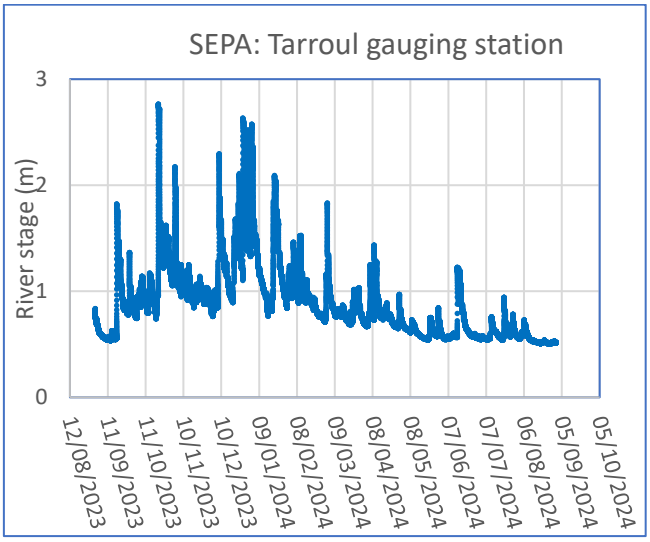
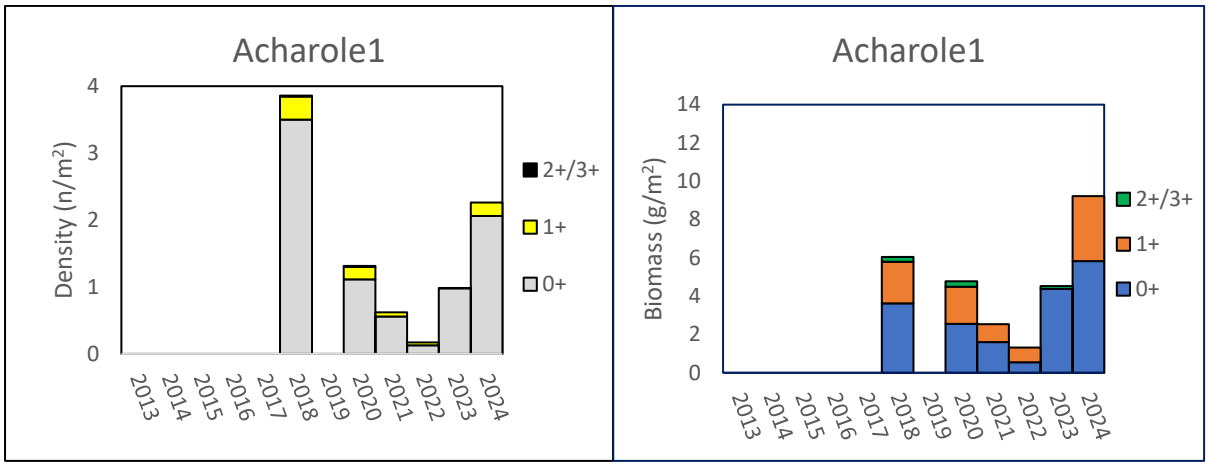



*Figure 4. River stage at the SEPA gauging site at Tarroul for the year spanning the 2023 and 2024 survey dates.*

Comparison of the hydrographs for the Wick and Thurso gauging stations shows that they contain most of the same features and all the major ones although the relative values of individual events vary to a minor extent. In particular, the flood of 21st October was the largest event of the year in both catchments. Wick River peaked at 2.77m running above 2.5m from 1800hr on the 21st to 0600hr on the 22nd October. For reference, summer level on the Tarroul gauge is typically around 0.7m.

The Wick survey data were therefore checked for any indication that the high water levels over winter had affected juvenile salmon populations in the river.

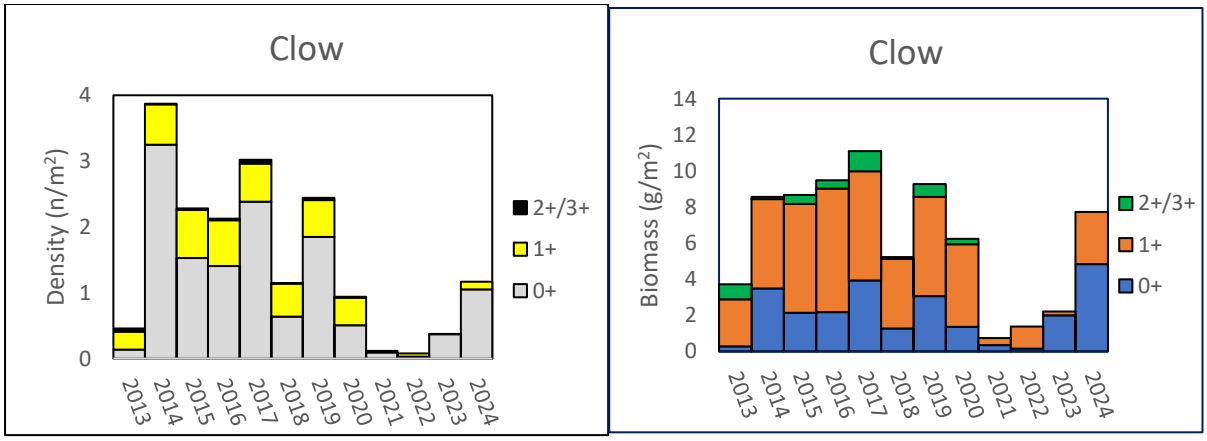
### 2.3.1. Acharole1




The densities of both fry and 1+ parr at Acharole1 staged recoveries in 2024. Fry density showed a full recovery to 2.06/m$^2$ - very high by any standard. The density of 1+ parr had been unexpectedly low in 2021, 2022 and 2023 (no 1+ parr were detected in 2023) but recovered to near-normal in 2024 at 0.20/m$^2$, founded on a good crop of fry (0.98/m$^2$) in 2023.

Both fry and parr were relatively large for the site. The average lengths of fry and 1+ parr were 64mm and 113mm, respectively. Equivalent values in 2018, for example, when fish numbers were also high, were 49mm and 82mm. Accordingly, total biomass density in 2024 (9.2g/m$^2$) was the largest value yet detected, greatly extending the range of values that have been observed. This emphasises the high potential of the Acharole1 site and ranks it close to the Clow and Sheriffs sites in terms of its intrinsic productive quality.

### 2.3.2. Clow

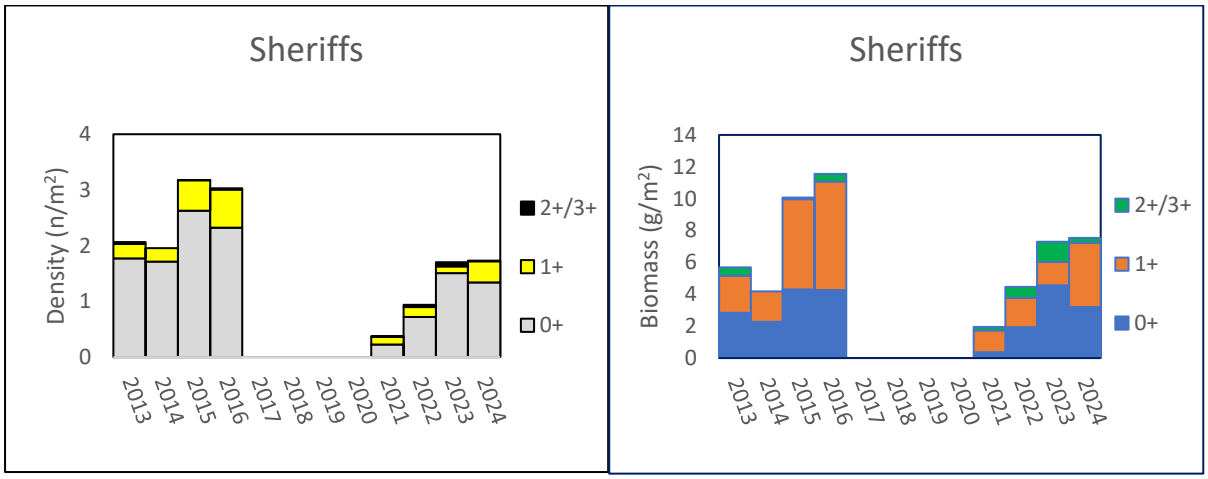



Very high densities of fry and, especially, 1+ parr were often observed at Clow before 2021. However, from 2021 to 2023 Clow showed depressed levels of both fry and 1+ parr for reasons that, as for Acharole1 nearby, were not clear. However, also like Acharole1, Clow staged a recovery in 2024. Fry density rose to 1.05/m$^2$ and the 1+ parr staged a more modest recovery to 0.12/m$^2$. Fry density in 2023 had been only 0.37/m$^2$ and in 2024 the

yield of 1+ parr from the fry was therefore 32%. This value is in line with expectation for Caithness generally. The low parr density does not, therefore, constitute evidence of any flood effect.

The fish were relatively large; average fry length was 75mm and average 1+ parr length was 126mm. In line with this, total biomass density was 7.7g/m$^2$ which is within the range of high values observed before 2021.

### 2.3.3. Sheriffs




Sheriffs was surveyed several times in the earlier part of the time series and picked up again in 2021 in response to finding that fish densities at Acharole1 and Clow were much lower than expected. Sheriffs proved to be similarly affected and annual surveys were reinstated.

The site staged a steady recovery from 2022 onwards. In 2024 fry density was 1.34/m$^2$. This value is very high by any standard. The density of 1+ parr was 0.38/m$^2$ which was less than some of the very high values observed in earlier years but still entirely satisfactory. There was no evidence of mortality caused by the prior winter floods.

The fry averaged 62mm and the 1+ parr averaged 98mm. Both were therefore relatively modest in size and the total biomass density was 7.53g/m$^2$ which is about average for the site.

Overall, the recovery at Sheriffs has returned the salmon population to good condition although it has not yet attained values fully comparable with the high values of former years.

### 2.3.4. Wick Summary

There was no evidence for over-winter flood effects in 2023/24 on parr populations in Wick River. Moreover, fry densities were >1/m$^2$ in all three survey sites, sufficient to ensure a full crop of 1+ parr in 2025 and therefore a full crop of smolts in 2026.

The setbacks evident in previous years and centred on 2021 and 2022 appear to have resolved themselves; their underlying cause was not discovered. The current high values for biomass density indicate that the productive capacity of the survey sites themselves is not in

doubt and each of the sites is capable of supporting around 10g of young salmon per square metre.

Finally, there can be no doubt that the fisheries management measures taken by Wick Angling Association in response to the poor survey data for 2021 contributed to the recovery evident by 2024. In particular, changes to the angling regulations will have speeded recovery by ensuring that greater numbers of spawners were on the redds from 2022 onwards than would otherwise have been the case.

The recovery of juvenile fish populations cannot be regarded as fully complete because only one year of good fry and parr densities has been documented so far (ie. 2024). The cause of the original decline in juvenile numbers over the period from 2021 to 2023 is still unknown and may therefore occur again without warning - perhaps, for example, if the river is beset by another summer drought associated with low river levels and high water temperatures.

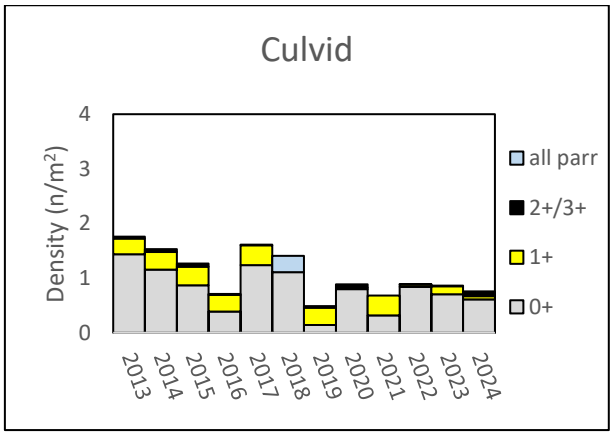
Furthermore, the low numbers of parr surveyed from 2021 to 2023 and consequent reductions in smolt output from 2022 to 2024 will probably result in legacy effects on spawner numbers. Thus, the number of spawners returning each year is likely to be relatively low from 2023 onwards as a result of reductions in juvenile density in earlier years. The grilse of 2023 to 2025 will be affected in this way; similar reductions in the 2SW fish are expected from 2024 to 2026 (ie. offset from the grilse by one year). An improvement can be expected thereafter based on the 2024 survey data.

All these changes are already in train. It will be necessary for WAA to remain especially watchful over the next year or two because of the many factors in play. The annual electric fishing survey can support this, especially if the programme is reviewed each year to ensure that the best information required for management is obtained within the limits of the resources available.

## 2.4. Dunbeath River

Survey work on Dunbeath River was restricted to the key site at Culvid. A more extensive survey had been planned but work was curtailed by the adverse weather and high water levels.

### 2.4.1. Culvid




Fry density at Culvid was generally in line with previous values at 0.61/m$^2$ but the density of 1+ parr was unexpectedly low at 0.06/m$^2$. The yield of 1+ parr in 2024 from the fry crop of 2023 (0.71/m$^2$) was 8% - the lowest value yet recorded for Culvid and much lower than the 30% value which is considered the yardstick for Caithness generally.

In Figure 5 the blue points represent comparisons of fry density for each year from 2013-2023 against 1+ parr density in the following year; the equivalent value for 2024 is shown by the red point. The blue points are widely scattered compared with the other key sites in Caithness. This is due to as-yet unexplained variation between years in either fish mortality, or differences in the net movement of young fish into and out of the site – or, of course, the quality of the survey data.

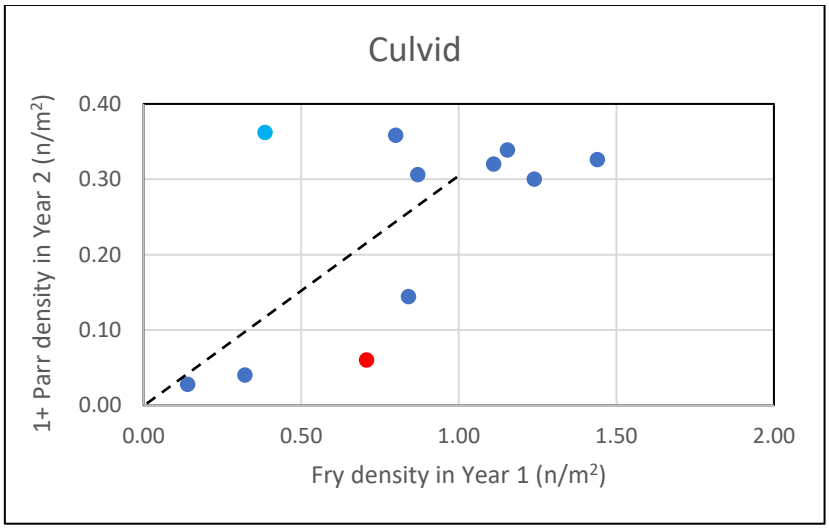



*Figure 5. The relationship between fry and 1+ parr density in successive pairs of survey years*

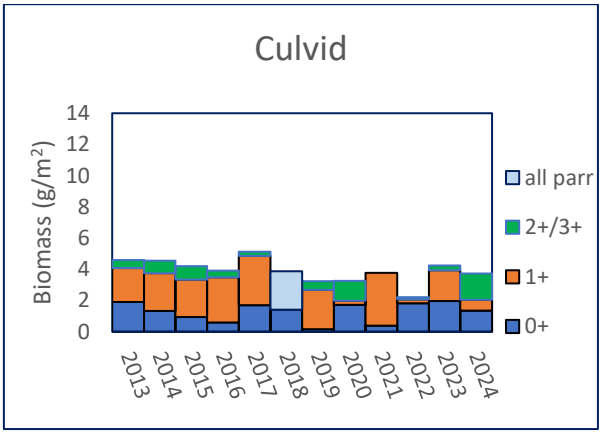
It can be seen from the figure that the maximum crop of 1+ parr that the Culvid site can support is around 0.34/m$^2$. This is the average of the cluster formed by the seven highest values which range from 0.30 to 0.36/m$^2$. It can be seen that it requires a fry density of around 0.80/m$^2$ to ensure a full crop of 1+ parr – all else being equal. The single point shown in light blue is an obvious anomaly because the fry and parr densities are little different. This

probably indicates an unusual and substantial - but unexplained - net in-migration of fish in the period between annual surveys (namely those of 2016 and 2017). The alternative explanation is for near-zero mortality between annual surveys - but this is not a reasonable proposition.

The broken line represents the yardstick measure (ie. 30%) for the yield of 1+ parr from fry which can be applied when fry density is below the saturation value (ca. 1/m$^2$). It can be seen that the red point representing the yield of 1+ parr in 2024 from the fry of 2023 undershoots the broken line to the greatest extent of all the annual values. Based on this, the density of 1+ parr (0.06/m$^2$) in 2024 was only about one third of the expected value (ca. 0.20/m$^2$).

This is reminiscent of the situation already described above for the key Thurso site at Rumsdale. This suggests that, as for Rumsdale, the yield of 1+ parr from the Culvid fry was impacted by a one-off effect – plausibly, by the severe floods of late autumn and winter. There is no gauging data for Dunbeath River. However, the main features of the hydrographs for the Halkirk and Tarroul gauging stations are the same and they probably also apply to the Dunbeath River because of the proximity of all three catchments.

As was concluded for Rumsdale, the main effect of the extreme water levels appears to have been on 1+ parr rather than eggs incubating in the streambed. Thus, although fry density at Culvid was slightly below average in 2024, Figure 5 shows that it ought to prove sufficient to support a modest crop of 1+ parr in 2025. However, this prediction is necessarily tentative because of the wide scatter of points shown in Figure 5. The Culvid site should therefore be prioritised for checking at survey in 2025.




Total biomass density was 3.74g/m$^2$, about average for the site. All the age-classes of fish were of modest size; the average lengths of fry, 1+ parr and 2+ parr were 61, 101 and 118mm, respectively. Total biomass density was buoyed by the contribution of the atypically large crop of 2+ parr (0.09/m$^2$).

In 2025, the electric-fishing survey of Dunbeath River should be extended to cover those sites targeted, but missed, in 2024.

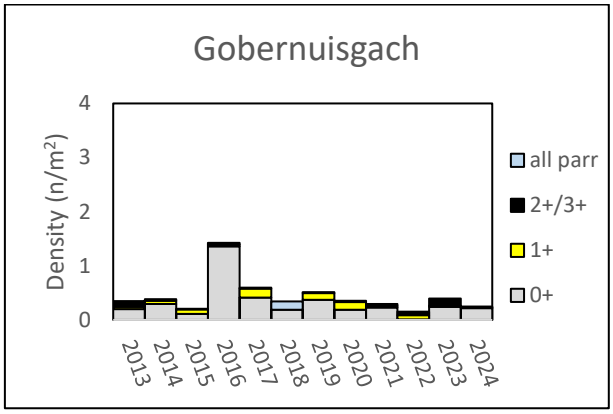
## 2.5. Berriedale/ Langwell

Over recent years, Berriedale/ Langwell has shared a problem with the River Forss in the form of notably high adult mortality rates in some runs of adult fish caused by *Saprolegnia*/ RSD. However, juvenile density in Berriedale/ Langwell has proved more resilient to the consequences of the mortalities than in Forss.

The key survey sites at Gobernuisgach (Berriedale River) and Wag (River Langwell) were surveyed again in 2024 for the twelfth successive year. The sites at Braemore and Aultibea were respectively surveyed for the fourth and fifth years in succession.

### 2.5.1 Gobernuisgach

Gobernuisgach is surveyed every year. It is an extreme site for Caithness in being located at an elevation of 250m and over the years fish have proven to be relatively sparse.




In 2024, fry density was 0.22/m$^2$ which is rather typical of the site. However, the density of 1+ parr was only 0.01/m$^2$ and the lowest value observed in the survey time series. The yield of 1+ parr from the fry crop of 2023 was only 4%, also the lowest value in the annual series and very much lower than the expected yardstick measure of 30%.

The relationship between annual values for fry density and the density of 1+ parr in the succeeding year is shown in Figure 6. It can be seen that most annual values for fry density have been less than 0.50/m$^2$ with a single anomalous value in 2016 at 1.36/m$^2$. Due to the lack of values in the middle range the maximum capacity of the site to support 1+ parr cannot yet be accurately gauged although it is probably somewhere around 0.15/m$^2$.

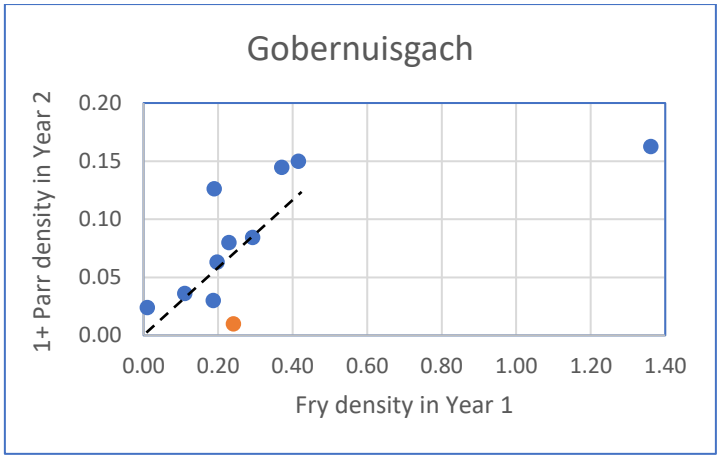
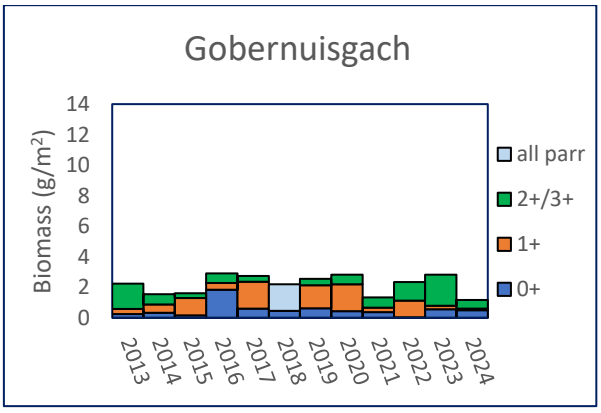



Figure 6. *The relationship between fry and 1+ parr density in successive pairs of survey years*

The blue points in the figure represent the paired comparisons of density in the ten fry years from 2013 to 2022 with the ten 1+ parr years from 2014 to 2023. These comparisons probably lack numerical robustness due to the low densities - and therefore low numbers - of fish often observed. However, the 30% yardstick value for the yield of 1+ parr from fry (as explained above) is imposed on the figure - represented by the broken line. Despite the low numbers involved the nine blue points representing fry densities of less than 0.50/$m^2$ conform well to the imposed line; the outlying fry value (1.36/$m^2$ in 2016) in not considered in what follows.

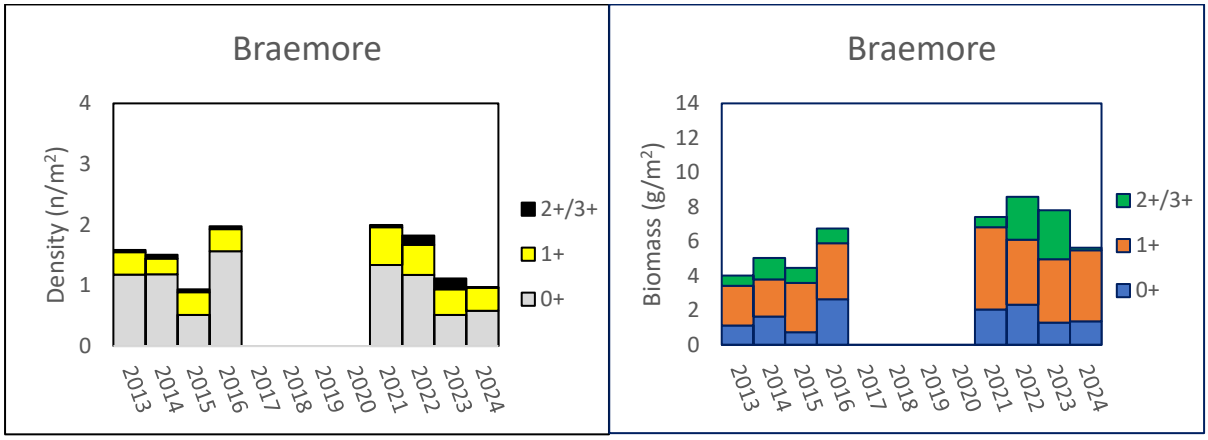
The red point represents the comparison of fry density in 2023 with 1+ parr density in 2024. It can be seen that that the red point deviates from the broken line to the greatest extent of all; the observed density of 1+ parr in 2024 was only around one eighth of the expected value as predicted from the broken line. This suggests that - as for Rumsdale - 1+ parr density may have been negatively affected by the extreme floods of the preceding winter. In contrast, fry density in 2024 was about average for the site suggesting – as for Rumsdale - no effect or a lesser effect than for the parr.




In 2024 total biomass density (1.2g/$m^2$) was the lowest value in the time series, reflecting the near-absence of 1+ parr.

### 2.5.2. Braemore

The site at Braemore is in mid-catchment, about 12km downstream of Gobernuisgach and at an elevation of around 150m. Braemore was surveyed in the early part of the time-series and visited again from 2021 onwards. The objective was to augment surveillance of Berriedale River given the low densities of fish that have been a consistent characteristic of the Gobernuisgach site.

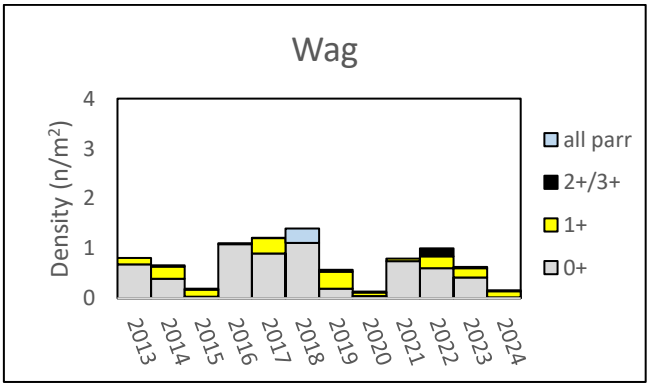



In 2024, fry density was 0.58/m$^2$. This is among the lower values recorded. The density of 1+ parr was 0.38/m$^2$ which is about average for the site. The yield of 1+ parr from the fry of 2023 was 75%, greater than most previous values and much higher than the Caithness yardstick value of 30%. This indicates that a net influx of parr occurred between the surveys of 2023 and 2024. Older parr were essentially absent.

The size of the fish was unremarkable; the average body length of fry and 1+ parr was 62mm and 98mm, respectively. In line with this, and lacking a substantial contribution from 2+ parr, the total biomass density in 2024 was 5.6g/m$^2$ which is about average for the site.

### 2.5.3. Wag

Wag on the River Langwell is somewhat analogous to Gobernuisgach on Berriedale River in being a relatively high altitude site (ca 190m). The site has been surveyed every year since 2013.




In 2024, fry density at Wag was 0.02/m$^2$, one of three very low values in the time series. The density of 1+ parr was 0.12/m$^2$, also among the lower values in the site's range. The yield of 1+ parr from the fry of 2023 was very similar to the 30% yardstick value at 29%.

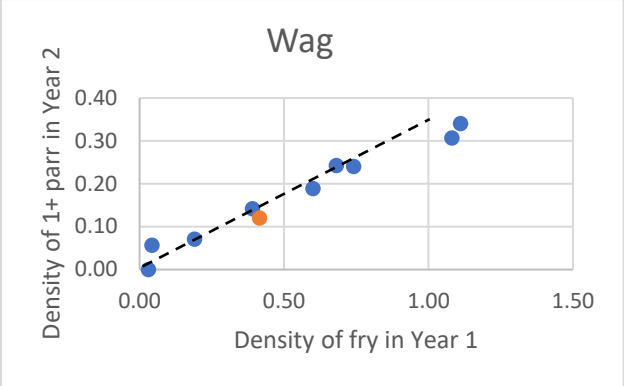
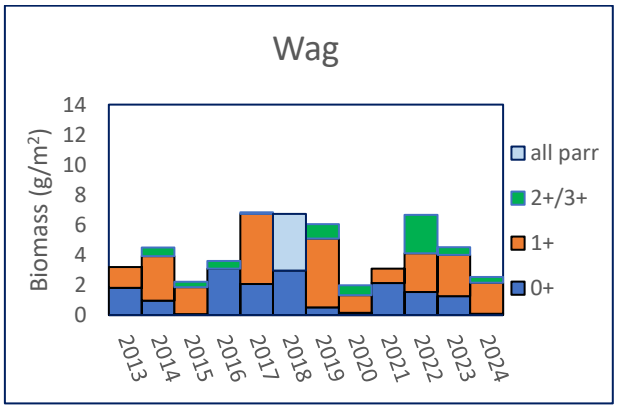



Figure 7. *The relationship between fry and 1+parr density in successive pairs of survey years*

The paired values for the density of 1+ parr and the density of fry in the preceding year is plotted in Figure 7. The relationship is very well-defined. The site's maximum capacity to support 1+ parr is probably around 0.30/$m^2$ derived from a fry density in the preceding year of around 1/$m^2$. However, the site's capacity to support 1+ fry has not yet been explicitly identified because the time-series lacks any years of excess fry recruitment. The broken line represents the Caithness yardstick value for an expected yield of 30% and all ten points conform very closely to this prediction.

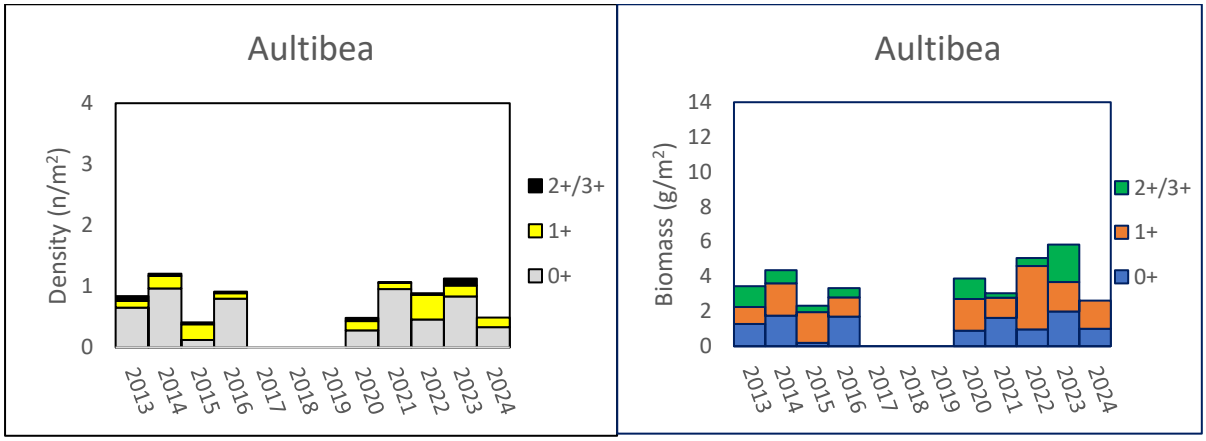
The red point represents the comparison between the density of fry in 2023 and the resultant density of 1+ parr in 2024 and it also conforms closely with the distribution of the points for all the other paired comparisons. The yield of 1+ parr from fry (29%) was essentially the same as the yardstick value predicted for Caithness generally. Therefore, there was no evidence for any unusual one-off effect on the number of 1+ parr.




As is usually the case, the body size of fry (average = 71mm) and of 1+ parr (average = 113mm) were among the largest of the values observed at any of the Caithness sites. The maximum proven capacity of the Wag site to support biomass of juveniles is around 7g/$m^2$ but the total biomass density in 2024 was only 2.54g/$m^2$ principally due to the low density of fry.

### 2.5.4. Aultibea

The site at Aultibea in the mid-catchment was surveyed in the earlier part of the survey series until 2016. It was re-started in 2020 to add more scope to the Langwell part of the programme as all the Caithness rivers came under pressure from a series of drought summers.




Fry density at Aultibea was 0.33/m$^2$ in 2024, among the lower of the values observed in previous years which have ranged up to 1.0/m$^2$. The density of 1+ parr was 0.16/m$^2$ which is about average for the site. However, fry density in 2023 was 0.83/m$^2$ and the yield of 1+ parr was therefore only 19%, the lowest of the seven values that can be calculated from the available time-series. Aultibea is therefore a candidate for a negative effect of winter flooding on the yield of 1+ parr although the case for this is considered weakest among the other candidate survey sites, as detailed in previous sections of this report.

Both the fry (average = 67mm) and 1+ parr (average = 96mm) were relatively large for Caithness. Lacking a contribution from 2+ parr, total biomass density was low at 2.62g/m$^2$ - the lowest value yet observed barring only 2015.

### 2.5.5. Berriedale/ Langwell summary

. All four survey sites on Berriedale/ Langwell were understocked with fry in 2024. Predictions for 1+ parr in 2025 based on the yardstick measure of 30% for yield of 1+ parr from fry suggest that these values will all be less-than-average for their respective sites in 2025. This in turn suggests that smolt output in 2026 will be correspondingly lower than average.

Interestingly, most Berriedale/ Langwell survey sites showed evidence of similar low-fry episodes in 2015 and 2020. Coincidently, five years is the period of the life-cycle of 2SW spawners derived from 2+ smolts. It will therefore be important to take the opportunity to try to find out if cyclicity is a determinant of inter-annual variation in egg deposition and fry density in Berriedale/ Langwell. Such a finding would also have important implications elsewhere in Caithness - notably following the recent set-backs in Forss and Wick. Therefore, all four sites on Berrydale/ Langwell that were surveyed in 2024 should continue to be monitored and surveillance should be expanded if possible in 2025 to track how the present situation develops and how it resolves.

# 3. Conclusions

Overall, the 2024 survey has shown that juvenile salmon populations are in a state of flux in all the Caithness catchments as a result of different types of pressures (eg drought, poor water quality, disease and flooding) acting at different times over the survey series including the most recent part as covered by this report. Indeed, the likely adverse effects of extreme winter floods on 1+ parr density were encountered (or identified) for the first time in 2024 although – unsurprisingly - some survey sites appear to have been more affected than others.

Table 3 summarises the evidence for local flood effects at each of the fifteen sites that were surveyed. The strength of the evidence, for or against, varied among the sites according to the extent of the survey data that was available for previous years. However, the density of 1+ parr at six or seven of the fifteen sites was plausibly affected. Judged by the 30% yardstick measure for the expected yield of 1+ parr from fry, the magnitude of the flood effect was large at many of these sites. As reported above, fry density appears not to have been affected at any of the sites – or, at least, not to any perceptible extent.

*Table 3. Summary of likely effects of extreme winter floods in 2023/2024 on the representation of 1+ parr in 2024 as derived from the fry of 2023.*

| River | Site | Yield of 1+ parr in 2024 from fry of 2023 (%) | No detectable effect of floods on 1+ parr density | Probable negative effect of floods on 1+ parr density |
|---|---|---|---|---|
| | | | | |
| Forss | Shurrery | 30 | √ | |
| | Lythmore | 2 | | √ √ √ |
| Thurso | Rumsdale | unknown | | √ √ √ |
| | Dalganachan | unknown | | √ √ |
| | Smerrary | unknown | | √ √ |
| | Tacher | unknown | √ | |
| | Braehour | unknown | √ | |
| Wick | Acharole1 | unknown | √ | |
| | Clow | unknown | √ | |
| | Sheriffs | unknown | √ | |
| Dunbeath | Culvid | 8 | | √ √ √ |
| Berriedale | Gobernuisgach | 4 | | √ √ √ |
| | Braemore | 74 | √ | |
| Langwell | Wag | 29 | √ | |
| | Aultibea | 19 | | √ |

At present, multiple issues are in play in Caithness, affecting every life stage, acting at different times of year or different ages or in different locations and having effects with consequences that propagate over variable periods of time. As mentioned above, the primary aim of the electric-fishing programme is to track changes in abundance. The planned coverage of the 2024 electric-fishing programme was not fully achieved due to poor

weather. A more extensive programme should therefore be attempted in 2025 in order to continue tracking progress to the fullest extent. Dunbeath River and Berriedale/ Langwell should be particularly targeted for increased coverage.

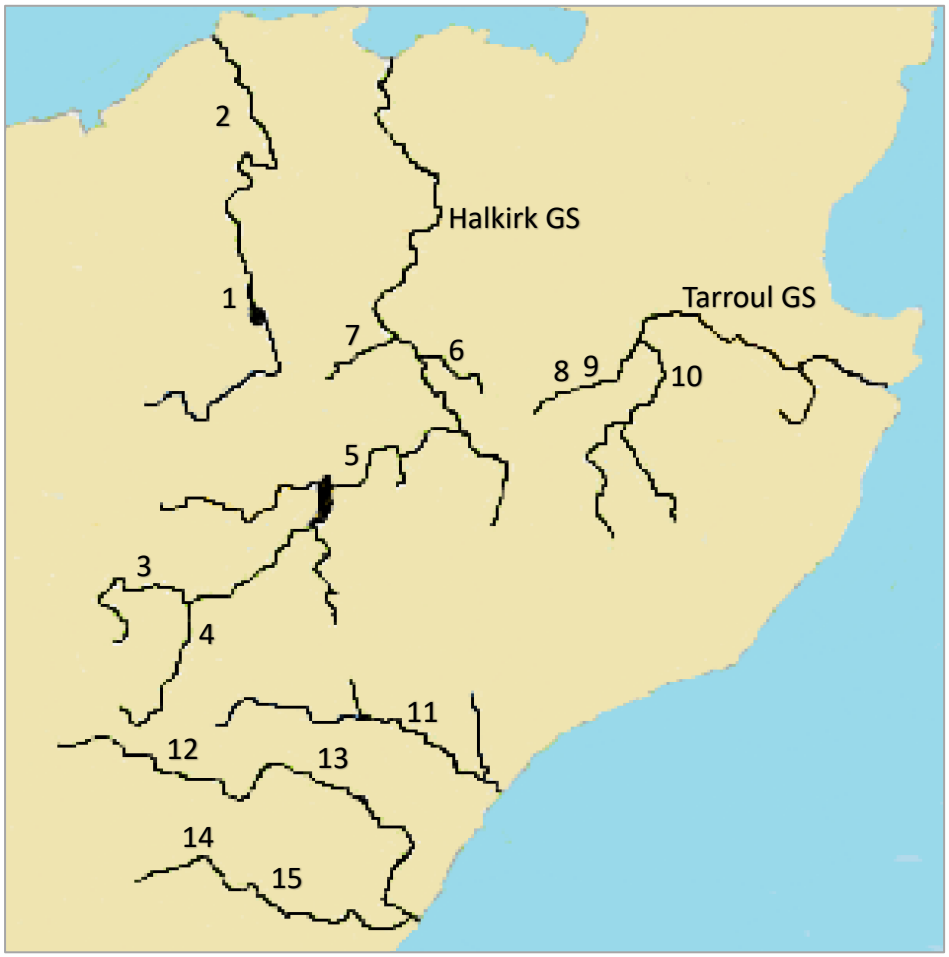
## Acknowledgements

Thanks are due to Kirsteen MacDonald of the SEPA team in Dingwall for making stage data available for the Halkirk and Tarroul Gauging Stations. Special thanks are due to Jamie McCarthy and Simon Harrison and also to David Miller, Jason McIlvenny, William Coughlin, Gordon Warren and Mac Young who all contributed to the electric-fishing team at various times.

## Appendices

Appendix 1.

*Caithness river network showing survey sites and gauging stations referred to in the text.*




1. Shurrery
2. Lythmore
3. Rumsdale
4. Dalganachan
5. Smerrary
6. Tacher
7. Braehour
8. Acharole1
9. Clow
10. Sheriffs
11. Culvid
12. Gobernuisgach
13. Braemore
14. Wag
15. Aultibea

*Appendix 2. Raw e/f data for salmon by survey site.*

| | | Salmon fry | | | Salmon parr | | |
|---|---|---|---|---|---|---|---|
| | | E/F Pass | | | E/F Pass | | |
| **River** | **Site** | **1** | **2** | **3** | **1** | **2** | **3** |
| Forss | Shurrery | 21 | 4 | 2 | 5 | 2 | 0 |
| | Lythmore | 195 | 68 | 23 | 5 | 5 | 1 |
| Thurso | Rumsdale | 177 | 79 | 34 | 18 | 7 | 0 |
| | Dalganachan | 159 | 62 | 15 | 16 | 6 | 1 |
| | Smerrary | 163 | 69 | 25 | 21 | 5 | 3 |
| | Tacher | 114 | 55 | 27 | 26 | 10 | 4 |
| | Braehour | 146 | 40 | 26 | 24 | 4 | 0 |
| Wick | Acharole1 | 189 | 63 | 16 | 19 | 5 | 2 |
| | Clow | 126 | 31 | 8 | 16 | 2 | 1 |
| | Sheriffs | 114 | 48 | 34 | 45 | 11 | 7 |
| Dunbeath | Culvid | 85 | 31 | 10 | 25 | 5 | 1 |
| Berriedale | Gobernuisgach | 21 | 10 | 3 | 3 | 1 | 0 |
| | Braemore | 57 | 18 | 10 | 39 | 11 | 7 |
| LangwellL | Wag | 1 | 2 | 2 | 18 | 5 | 4 |
| | Aultibea | 56 | 15 | 6 | 30 | 8 | 0 |

*Appendix 3. Zippin-corrected estimates of salmon density by survey site.*

| | | True density (n/m$^2$) | | |
|---|---|---|---|---|
| **River** | **Site** | **Fry** | **1+ Parr** | **2+/3+ Parr** |
| Forss | Shurrery | 0.30 | 0.07 | 0.01 |
| | Lythmore | 1.20 | 0.05 | 0.03 |
| Thurso | Rumsdale | 1.55 | 0.13 | 0.01 |
| | Dalganachan | 1.65 | 0.16 | 0.00 |
| | Smerrary | 1.91 | 0.14 | 0.06 |
| | Tacher | 1.69 | 0.31 | 0.02 |
| | Braehour | 1.60 | 0.19 | 0.01 |
| Wick | Acharole1 | 2.06 | 0.20 | 0.00 |
| | Clow | 1.05 | 0.12 | 0.00 |
| | Sheriffs | 1.34 | 0.38 | 0.01 |
| Dunbeath | Culvid | 0.61 | 0.06 | 0.09 |
| Berriedale | Gobernuisgach | 0.22 | 0.01 | 0.02 |
| | Braemore | 0.58 | 0.38 | 0.01 |
| LangwellL | Wag | 0.02 | 0.12 | 0.02 |
| | Aultibea | 0.33 | 0.16 | 0.00 |

*Appendix 4. Average body length by age-class and survey site.*

| River | Site | Fry | 1+ Parr | 2+ Parr |
|---|---|---|---|---|
| | | | | |
| Forss | Shurrery | 70.7 | 125 | n/a |
| | Lythmore | 64.6 | 123 | |
| Thurso | Rumsdale | 53.6 | 95.9 | n/a |
| | Dalganachan | 51.8 | 93.5 | n/a |
| | Smerrary | 58.0 | 108 | 122 |
| | Tacher | 47.3 | 85.7 | n/a |
| | Braehour | 58.5 | 101 | n/a |
| Wick | Acharole1 | 64.3 | 113 | n/a |
| | Clow | 74.6 | 126 | n/a |
| | Sheriffs | 62.3 | 97.5 | n/a |
| Dunbeath | Culvid | 60.5 | 101 | 118 |
| Berriedale | Gobernuisgach | 61.6 | 113 | n/a |
| | Braemore | 62.1 | 98.0 | n/a |
| LangwellL | Wag | 71.4 | 113 | n/a |
| | Aultibea | 67.3 | 95.8 | n/a |

Appendix 5. Raw e/f data for trout by survey site.

| | | Trout fry | | | Trout parr | | |
|---|---|---|---|---|---|---|---|
| **River** | **Site** | **E/F Pass** | | | **E/F Pass** | | |
| | | 1 | 2 | 3 | 1 | *2* | 3 |
| Forss | Shurrery | 4 | 1 | 0 | 1 | 0 | 0 |
| | Lythmore | 8 | 6 | 2 | 5 | 0 | 0 |
| Thurso | Rumsdale | 26 | 9 | 11 | 6 | 1 | 0 |
| | Dalganachan | 2 | 0 | 0 | 1 | 0 | 0 |
| | Smerrary | 1 | 0 | 0 | 0 | 0 | 0 |
| | Tacher | 0 | 0 | 0 | 6 | 1 | 2 |
| | Braehour | 30 | 8 | 3 | 16 | 2 | 0 |
| Wick | Acharole1 | 9 | 1 | 0 | 2 | 1 | 1 |
| | Clow | 0 | 0 | 0 | 2 | 0 | 0 |
| | Sheriffs | 0 | 0 | 0 | 3 | 1 | 0 |
| Dunbeath | Culvid | 2 | 0 | 0 | 5 | 0 | 0 |
| Berriedale | Gobernuisgach | 4 | 2 | 1 | 4 | 3 | 1 |
| | Braemore | 0 | 0 | 0 | 3 | 0 | 2 |
| Langwell | Wag | 1 | 0 | 0 | 1 | 1 | 2 |
| | Aultibea | 0 | 0 | 0 | 1 | 0 | 1 |