

Caithness District Salmon Fishery Board
Electric-Fishing Survey Report, 2023

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Confluence of River Thurso and Little River.

Contents

1. Introduction	3
2. Survey Results	3
2.1. River Forss.	3
Cnoc-glas	4
Torran	5
Shurrery.....	7
Lythmore	8
Summary	9
2.2. Thurso River	10
Rumsdale.....	10
Tacher	11
Summary	12
2.3. Wick River	12
Acharole1	13
The Clow.....	14
Scorriclet	15
Sheriffs	16
Summary	16
2.4. Dunbeath River	17
Achnaclyth.....	17
Culvid.....	18
Summary	19
2.5. Berriedale/ Langwell Rivers.....	19
Gobernuisgach	20
Braemore.....	21
Wag	22
Aultibea	23
Summary	23
3. Conclusions	24
Appendix 1. Survey data	25
Appendix 2. Wick smolt ages.	28

1. Introduction

The background to the 2023 survey has been a long period of flux in many of the populations of juvenile salmon at particular sites in Caithness. This period of disturbance has lasted from around 2019 until present and was probably due to the sequence of drought summers from 2018 onwards. The droughts have varied in duration and severity and all the separate rivers have been affected in different ways and to different extents. As for last year's report, the 2023 report therefore considers the five Caithness catchments in separate sections, as below.

The survey methods in 2023 were precisely those that have been used since the outset of the present survey series in 2013. In brief, survey sites were electric-fished using bankside equipment with 3-pass fishing permitting Zippin-correction for variation in capture efficiency. In this way, estimates of the true densities of fry and parr at each site were derived from the raw data. Both data sets (observed numbers and Zippin-corrected densities) are presented in Appendix 1. Body length was measured for both fry and parr. Scale samples were obtained from parr to establish individual age and to assign them to the 1+ or 2+ parr groups. These data are also presented in Appendix 1.

Only 16 sites were surveyed in 2023 because poor weather and high water conditions curtailed activity towards the end of the survey period.

All the sites visited in 2023 had all been previously surveyed and, in particular, the six survey sites that have been examined every year since 2013 were surveyed again. As a result, continuous runs of data are available for these sites (standardised around the first week of September) that now extend to 11 years.

Finally, smolt ages were determined from scales obtained in the course of the 2023 Wick smolt tracking project run by Adam Piper of the Zoological Society of London in order to find out if one-year-smolts were present. The rationale and the results of this exercise are documented in Appendix 2. The aim was to cast additional light on the Wick electric-fishing survey results.

2. Survey Results

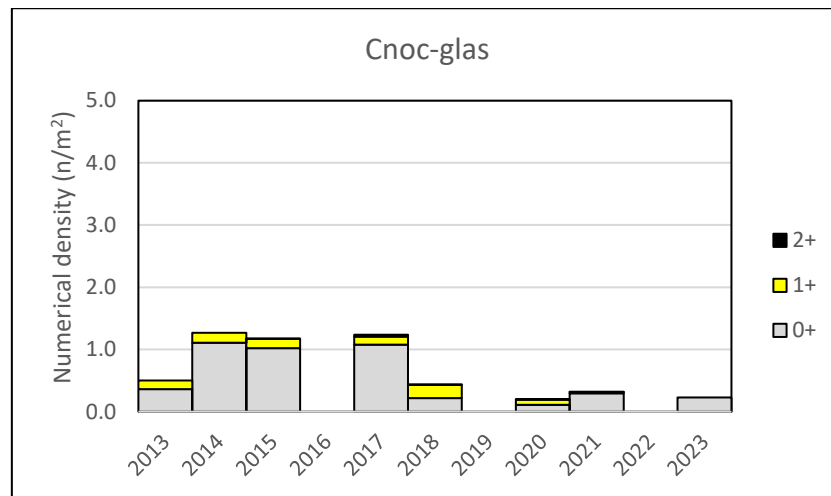
For presentational purposes, the graphical axes for the numerical and biomass density figures have been held constant throughout the Results section in order to facilitate comparisons between survey sites.

2.1. River Forss.

Since 2018, the Forss catchment has been marked by presence of extremely low juvenile densities throughout, as described in previous annual reports. All four of the previously surveyed sites in the Forss catchment were examined again in 2023 in order to follow up on the recent sequence of years of poor performance

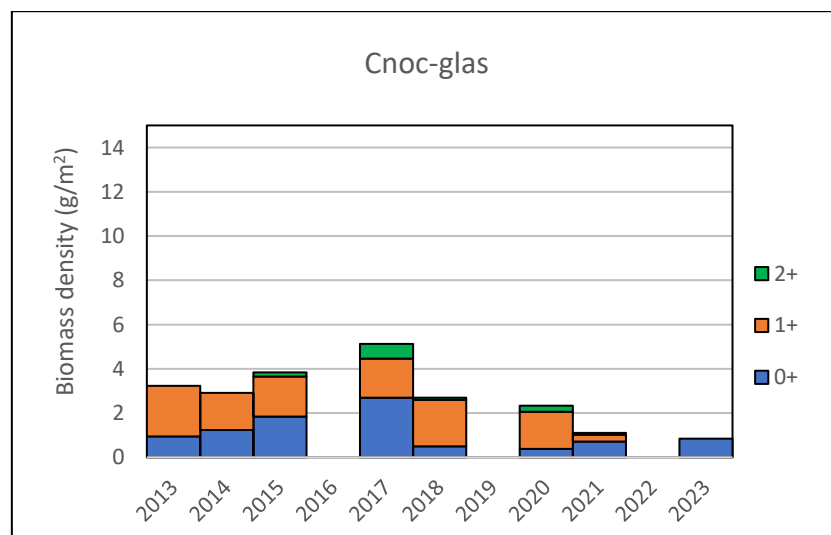
The Lythmore and Shurrery sites are located downstream of Shurrery dam. The Cnoc-glas and Torran sites are located in the upper catchment above Shurrery Dam. The Cnoc-glas site is located about 1km below Loch Caluim and Torran about 800m further downstream. Densities of young salmon at these latter sites have shared in the overall decline of young salmon in the Forss. However they may also be permanently affected by the presence of the dam given its poor provision for the free passage of ascending spawners.

Cnoc-glas



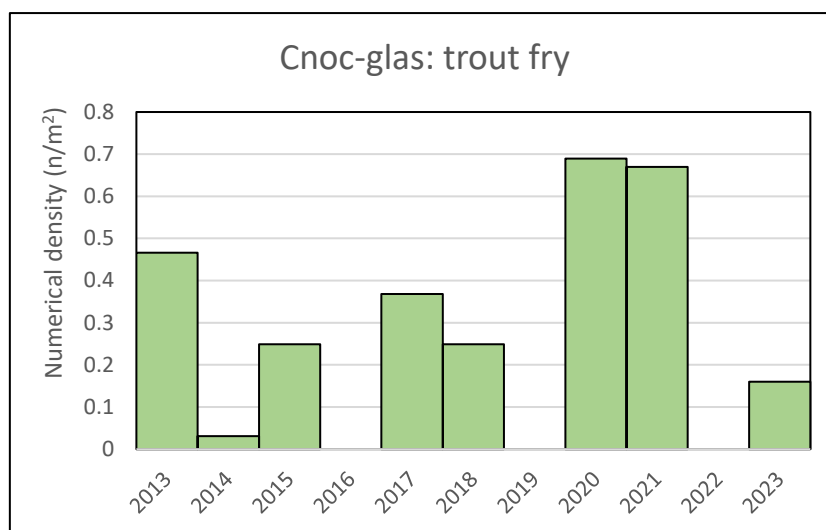
In 2023, the numerical density of salmon fry at Cnoc-glas was $0.23/\text{m}^2$, again low compared with the years before 2018 when fry densities of around $1.0/\text{m}^2$ were regularly recorded. The Board did not survey Cnoc-glas in 2022 because SEPA was scheduled to do so as part of its own programme. The SEPA survey showed that the density of fry was very low in 2022 at $0.02/\text{m}^2$ (based on single-pass rather than the 3-pass fishing used by the Board). The SEPA 1-pass value is probably about 60% of the true value¹. Allowing for this difference between survey methods the fry density value obtained by the Board's in 2023 was rather higher than the value as reported by SEPA for the previous year.

Densities of 1+ parr at Cnoc-glas averaged $0.16/\text{m}^2$ before 2018, but in 2023 no parr at all were captured following on directly from the very low density of fry reported by SEPA in 2022.



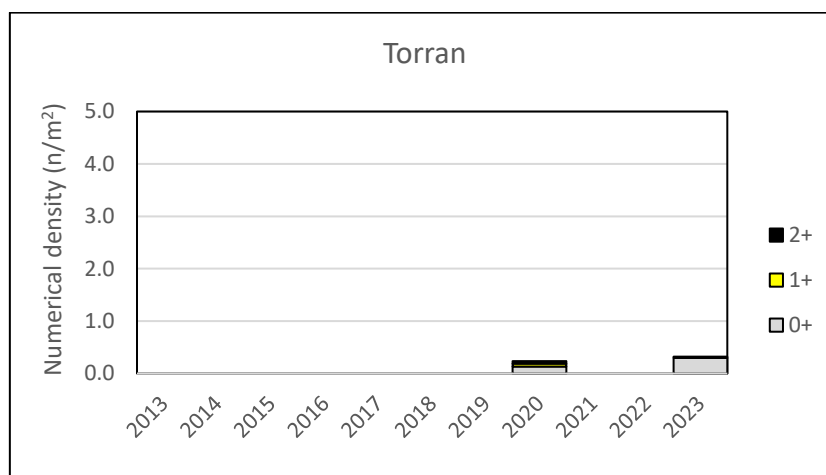
In 2023 the total biomass density of salmon ($0.84\text{g}/\text{m}^2$) was the lowest value recorded to date due mainly to the lack of any contribution from parr.

¹ For the record, SEPA's survey in 2022 recorded the presence of 1+ parr at Cnoc-glas at $0.13/\text{m}^2$ based on 1-pass fishing only. No older parr were captured.



High densities of trout fry relative to most other survey sites in Caithness have been a fairly consistent feature of the Cnoc-glas site throughout the survey series. In 2023, the density of trout fry was $0.16/\text{m}^2$, once again high relative to sites elsewhere in Caithness but low relative to the earlier part of the Cnoc-glas times series².

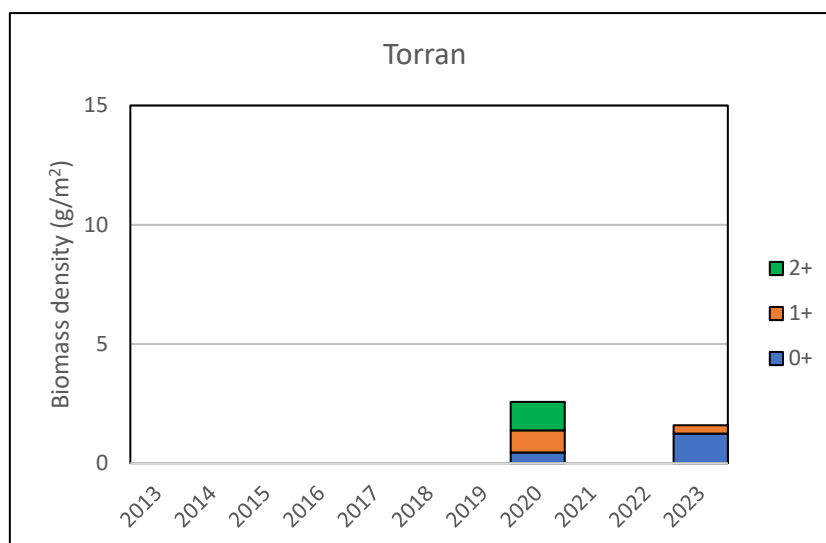
Torran



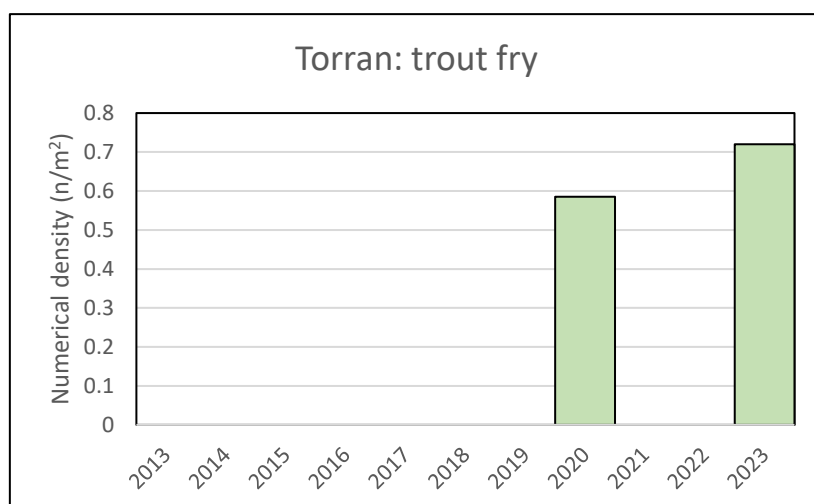
In 2023, fry density at Torran was $0.30/\text{m}^2$. The Board did not survey Torran in 2022 but SEPA did so, finding fry density to be very low at $0.02/\text{m}^2$ (based on 1-pass fishing only). The Board's value for 2023 therefore shows a marked improvement on SEPA's reported value for 2022. Unsurprisingly, given the low fry density reported by SEPA in 2022, very few 1+ parr were present in 2023 ($0.02/\text{m}^2$) and no older parr were captured³.

² For the record, SEPA recorded the presence of trout fry at Cnoc-glas in 2022 at $0.21/\text{m}^2$ based on 1-pass fishing, only, suggesting a true value of about $0.35/\text{m}^2$.

³ For the record, SEPA's survey of Torran in 2022 recorded the presence of 1+ salmon parr at $0.13/\text{m}^2$ based on 1-pass fishing only. No older parr were captured.

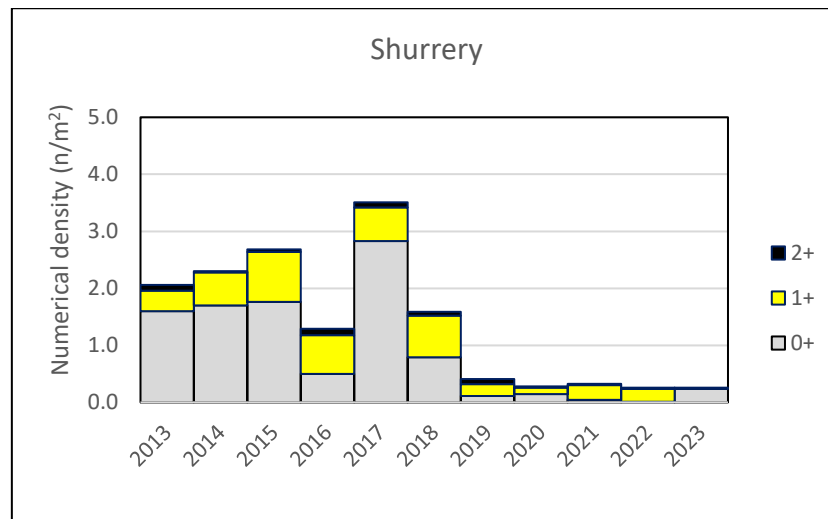


Total biomass density (1.6g/m^2) at Torran was relatively low relative to sites elsewhere in Caithness but consistent with the low value shown at Cnoc-glas just upstream.

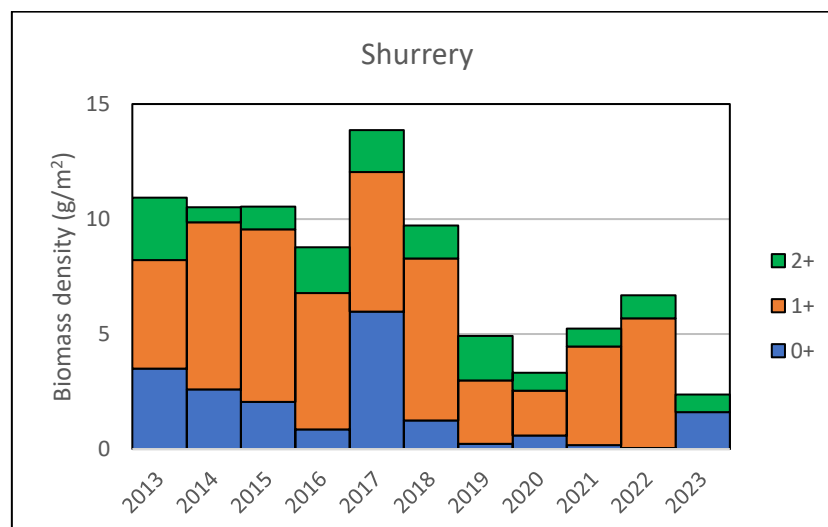


The density of trout fry was again relatively substantial for Caithness sites at $0.72/\text{m}^2$ and similar to the only previous survey value obtained by the Board team in 2020. For the record, SEPA reported trout fry at $0.21/\text{m}^2$ in 2022 based on 1-pass fishing only and probably at around 60% capture efficiency, suggesting a true value of about $0.35/\text{m}^2$.

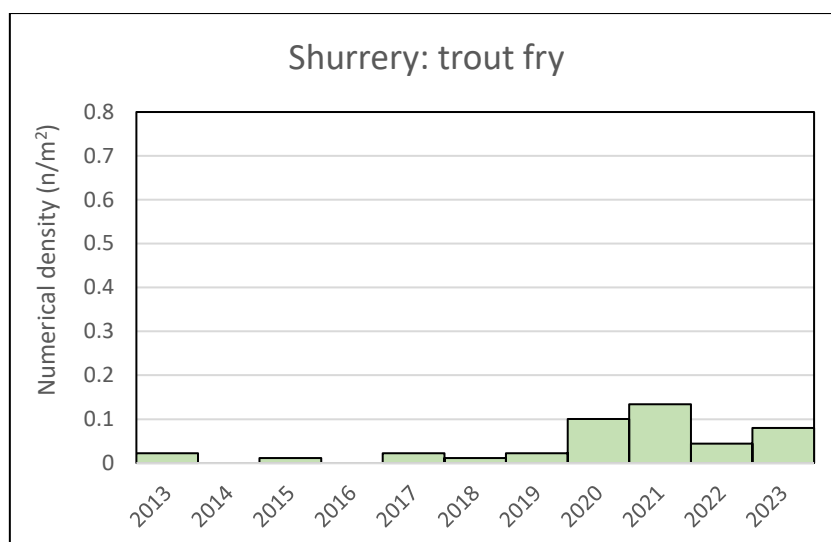
Shurrery



Shurrery has been surveyed every year since 2013. Before 2019, fry density regularly exceeded $1.5/m^2$ but since 2019 densities have been consistently trivial. In 2023, fry density was $0.24/m^2$, still relatively low for the site but the highest value noted since 2018. No 1+ parr were present in 2023 following on from the trivial fry-year in 2022.

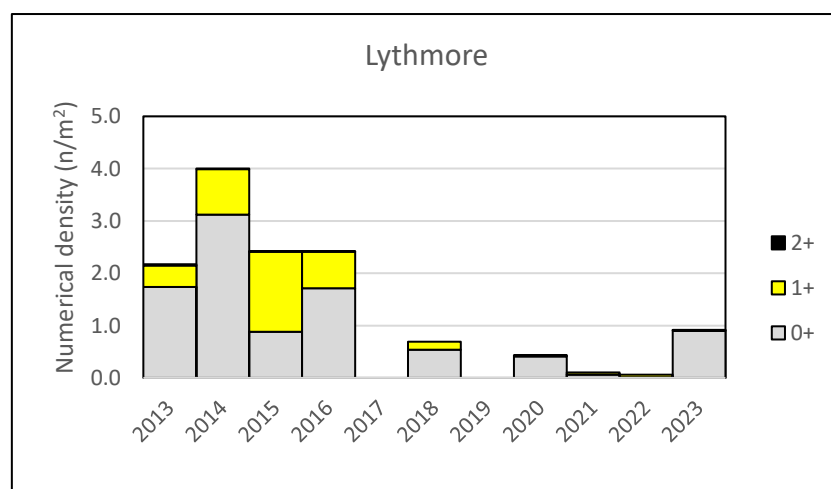


Biomass density at Shurrery was the lowest recorded value in the time-series, mostly driven by the contribution of the modest density of very large fry (average body length = 80mm) and depressed by the absence of 1+ parr. A single 2+ parr contributed.

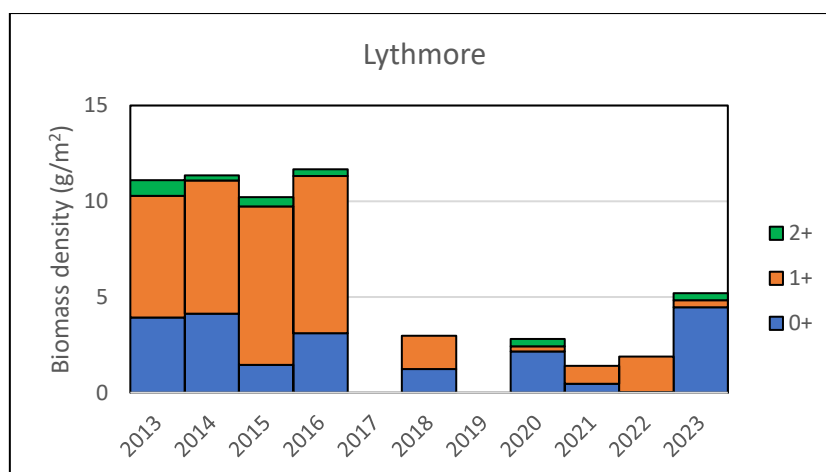


In past years, the density of trout fry at Shurrery has tended to be less than at the other Forss survey sites although, like the other Forss sites, the value has become greater in recent years. In 2023, the value was broadly in line with the recent part of the time series at 0.08/m².

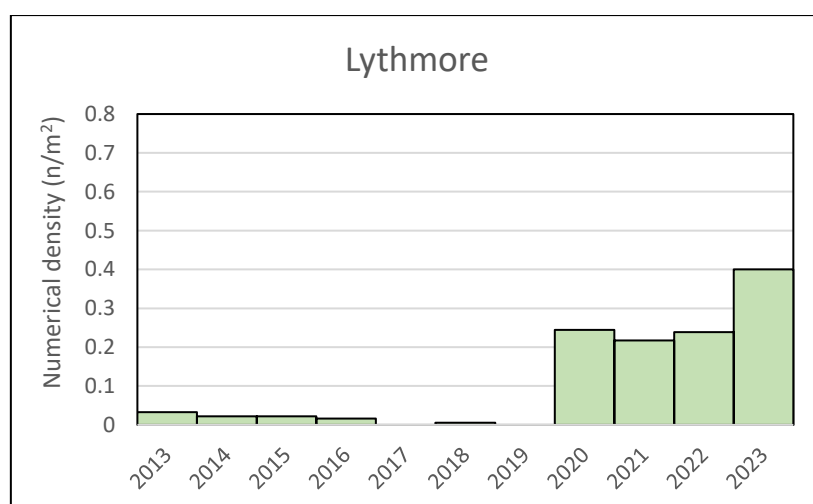
Lythmore



Fry density in 2023 was the highest recorded since 2016 and at 0.90/m² is large enough to found a substantial population of 1+ parr for 2024. However, parr numbers were trivial in 2023, following on from the very poor fry-years of 2021 and 2022.



The value for biomass density was greater than in recent years driven almost solely by the presence of the fry and their relatively large size (average body length = 77mm).



In 2023, trout fry were present at the highest density (0.40/m²) recorded to date.

Summary

In 2023, only trivial numbers of 1+ parr were detected at all four Forss survey sites because only trivial numbers of fry had been present in 2022. The low densities of parr in 2023 indicate that the smolt run of 2024 will again be very poor and the latest in a more or less continuous run of poor smolt-years extending back to around 2020.

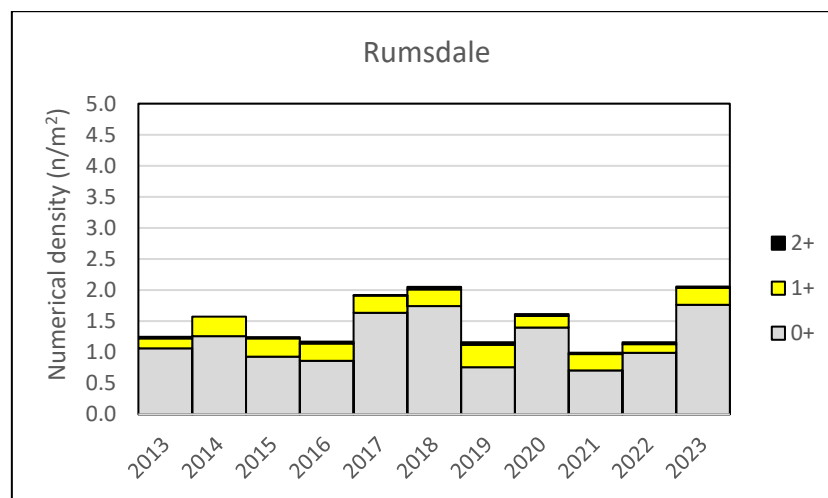
Fry numbers showed a partial resurgence in 2023 at all four sites but especially at Lythmore, the lowest site in the catchment. This latter finding may be a local anomaly due, for example, to a small number of adults (or even a single pair) spawning near to the survey site. On the other hand, if the fry values at Lythmore are more generally reflective of an increase in the abundance of spawners in the lower river then a reasonable class of 1+ parr ought to follow in 2024. This point should be specifically addressed in the course of the 2024 electric-fishing survey by extending coverage from Lythmore to the Westfield area where prior information exists for several sites that the Board has previously surveyed.

2.2. Thurso River

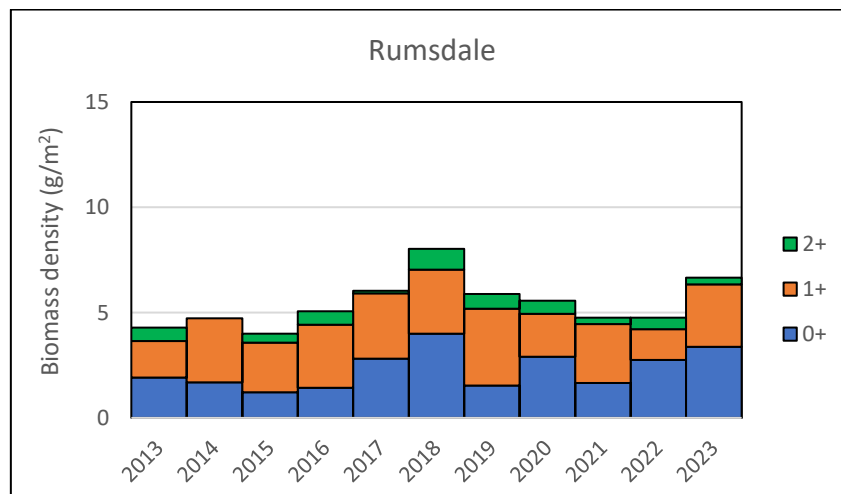
In 2023, emphasis was placed on surveying sites on catchments other than Thurso because the juvenile salmon populations on Thurso had been shown to be in consistently excellent condition while populations on some of the other Caithness catchments had been showing signs of stress. The Thurso survey was further constrained by poor weather which prohibited intended survey of main river sites due to high water levels.

The key site at Rumsdale was surveyed for the eleventh year in succession. An extended time series is also available for the site at Tacher and it was surveyed again in 2023.

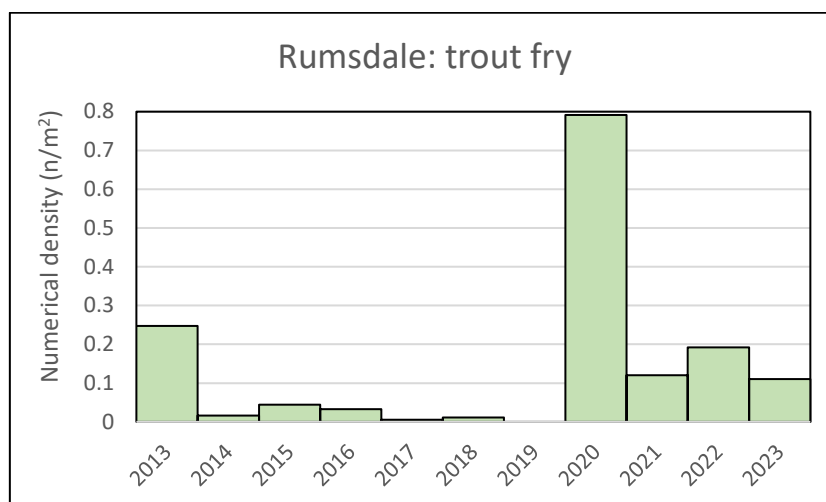
Rumsdale



In 2023, fry density at Rumsdale was at the highest level yet recorded for the site at 1.76/m² and easily sufficient to saturate the vicinity with 1+ parr for 2024. In 2023 the density of 1+ parr was 0.27/m² which matches the proven maximum capacity of the site to support young salmon (see 2022 Electric-fishing Survey Report).



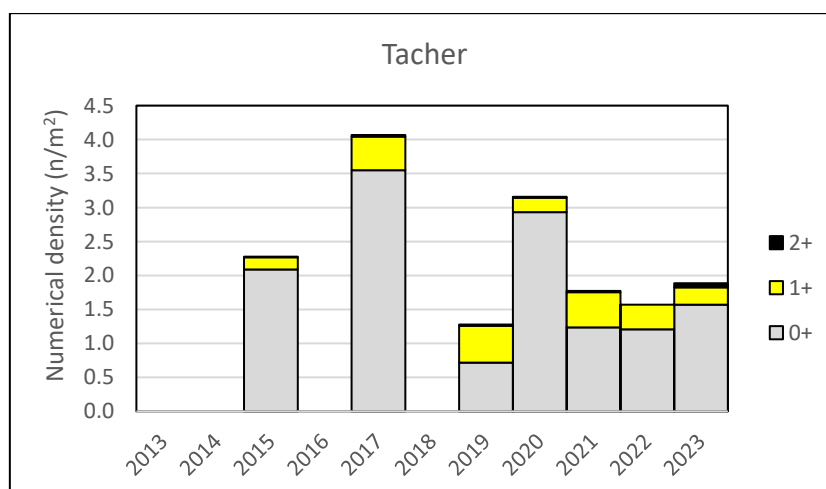
The total biomass density of juvenile salmon was above the annual average value at about 6.5g/m². Based on previous years, balanced contributions were made by all three of the age-classes present.



The Rumsdale site is the only one of the Caithness sites outside the Forss catchment that regularly supports substantial numbers of young trout as well as young salmon. In 2023, trout fry were present at 0.11/m² which is higher than the long-term average and consistent with the up-tick that is evident from 2020 onwards. The timing of this change matches the timing of similar changes at the Lythmore and Shurrery sites in the Forss catchment.

It was suggested in a previous annual reports that the increase in trout fry densities at the Forss sites might reflect decreased competition from young salmon because the density of the latter declined precipitously at around the same time as the number of trout fry increased. At Rumsdale, however, the up-tick in trout numbers after 2020 was not associated with a decrease in salmon numbers suggesting that another factor may be play. Further, close monitoring of trout at Rumsdale and on the Forss sites may help resolve this issue.

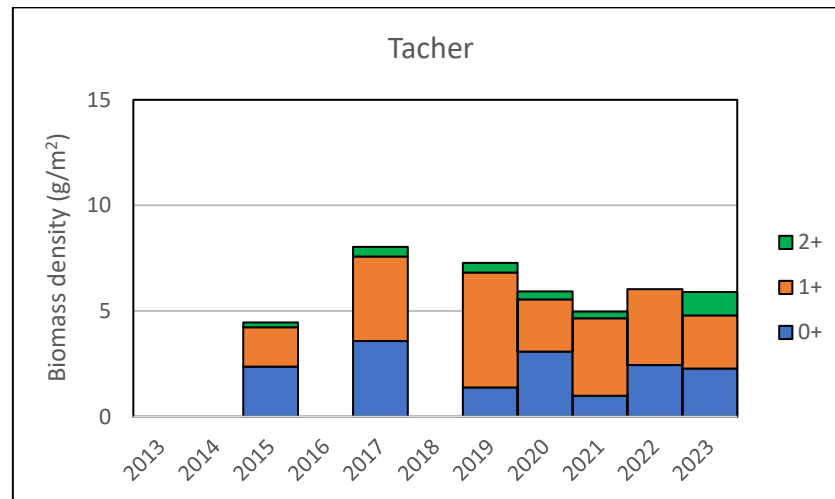
Tacher



The Tacher site has been visited regularly since 2015 and it has been surveyed each year since 2019. In 2023, fry density was 1.6/m² which is very high in a Scottish context but in the mid-range of values

detected at Tacher in previous years. The strength of the fry year-class of 2023 is more than sufficient to found a full year-class of 1+ parr for 2024.

As previously, most of the parr were aged 1+; their density ($0.25/\text{m}^2$) was in the lower part of the range of values previously encountered.



In 2023, the total biomass density of young salmon at Tacher was as expected for the site at $5.9\text{g}/\text{m}^2$.

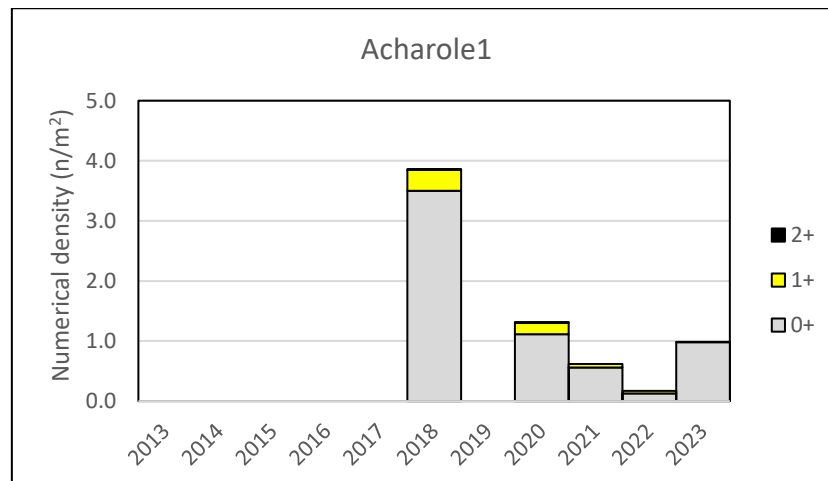
Summary

As anticipated, the condition of the salmon populations at both of the sites surveyed on the Thurso in 2023 was again consistent with the high status consistently evident throughout the Thurso catchment since the survey series began in 2013.

2.3. Wick River

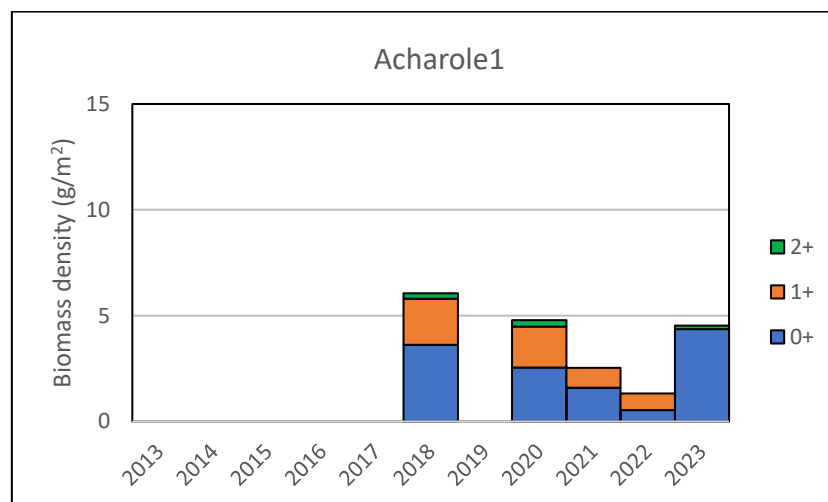
Four sites were surveyed on Wick River in 2023 in the Scouthal (Acharaole1 and Clow) and Strath (Scorriclet and Sheriffs) Burns. Juvenile salmon populations in all these locations have shown signs of stress in recent years probably due to the cumulative effects of the succession of drought years and it was considered important to follow this up in 2023.

Acharole1



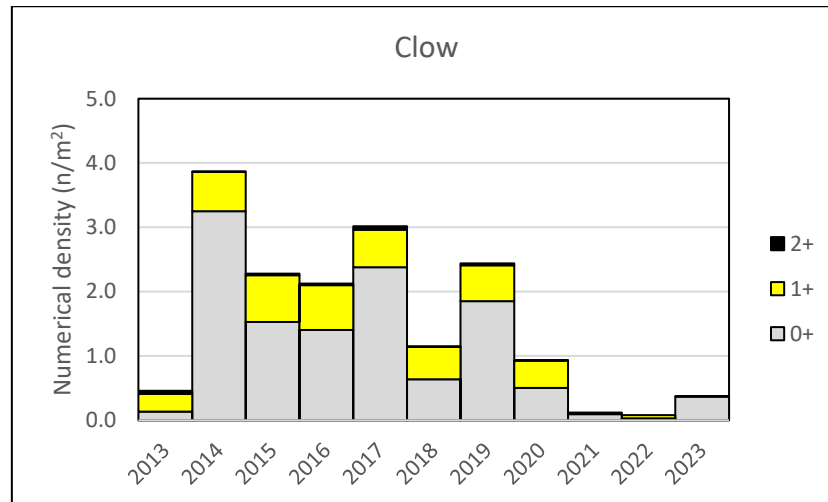
Fry density at Acharole1 was $0.98/\text{m}^2$, higher than in recent years and potentially sufficient to found a full year-class of 1+ parr for 2024.

However, no 1+ parr were captured in 2023 following on from the relatively poor fry-year in 2022. Even so, the small crop of fry present in 2022 ($0.13/\text{m}^2$) should have produced a small crop of 1+ parr rather than the zero year-class detected. This suggests that, as for 2021 and 2022, poor water quality associated with summer drought had once again intervened at some point between the 2022 and 2023 surveys to reduce the expected yield of parr from the survey site (as discussed in the 2021 Electric-fishing Report).



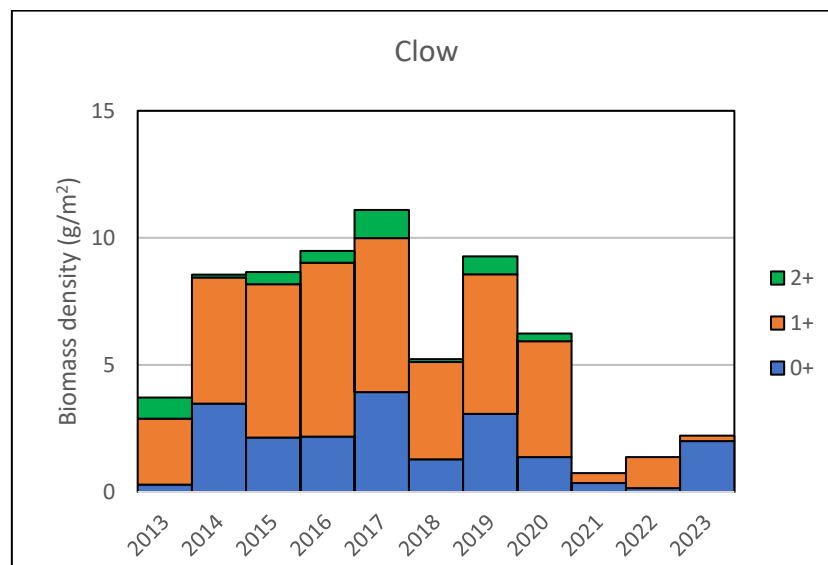
Total biomass density was driven almost solely by the contribution of fry. The fry were very large (average body length = 74mm) due to the absence of competition from parr and the total biomass density was about average for the site at $4.5\text{g}/\text{m}^2$.

The Clow



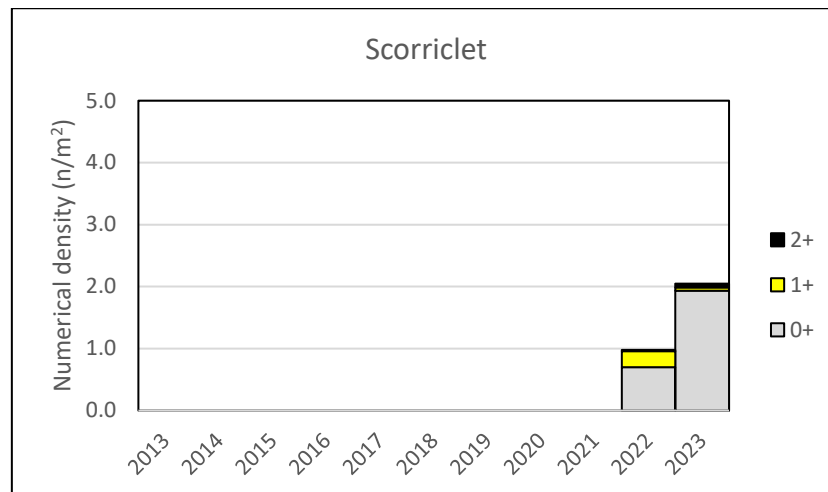
In 2023, fry density at Clow was again much lower than average but greater than in 2022. The density value was $0.37/m^2$ which, if conditions prove suitable, is sufficient to found a modest population of 1+ parr in 2024.

Parr were more-or-less absent in 2023 due to the near-absence of fry in 2022, extending a poor run of parr-years from 2021 onwards.



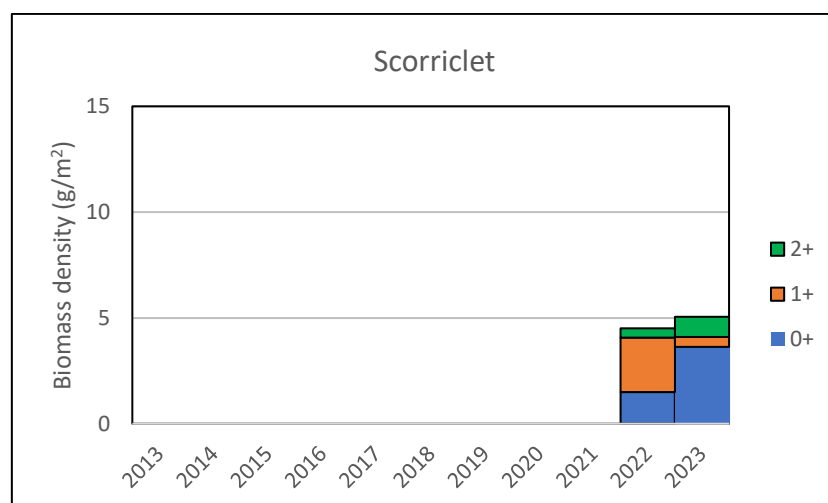
The only substantial contribution to the total biomass density value of $2.2g/m^2$ was made by the fry which due to the absence of competition from parr were relatively large (average body length = 79mm).

Scorriclet



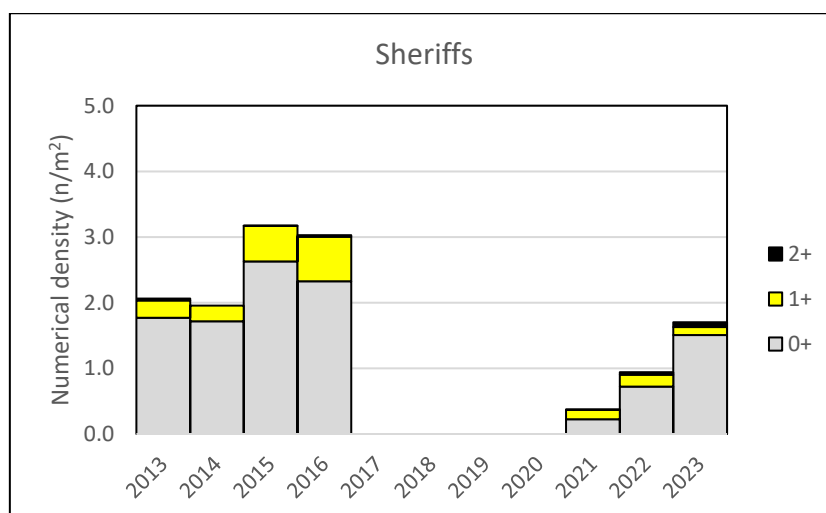
Scorriclet was adopted as a Board site in 2022 in order to obtain further information on the declines in the abundance of juvenile salmon noted elsewhere in the Wick catchment from 2021 onwards.

An excellent class of fry ($1.9/\text{m}^2$) was present in 2023. A good class of fry ($0.70/\text{m}^2$) had also been present in 2022. But despite this (and as for the Acharole1 site), the resulting class of 1+ parr in 2023 was much smaller than expected at $0.05/\text{m}^2$. Once again this suggests that as for previous years unusually high levels of mortality or movement away from the survey site had occurred in the interval between the 2022 and 2023 survey dates.

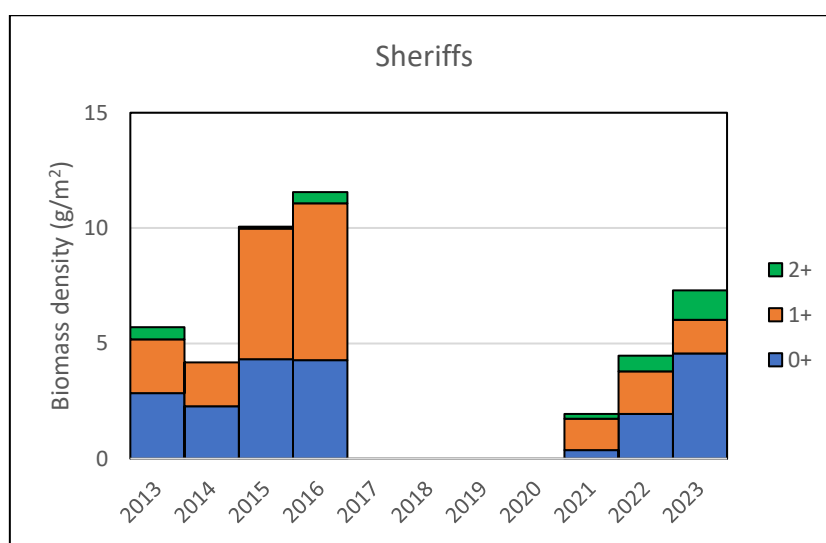


Total biomass density was about $5\text{g}/\text{m}^2$ and similar to the value achieved in 2022 the only other year for which data is available.

Sheriffs



Fry density at Sheriffs was very high and greater than in recent years at $1.51/\text{m}^2$ which is potentially sufficient to found a full year-class of 1+ parr for 2024. However, a substantial year-class of fry in 2022 ($0.72/\text{m}^2$) produced a yield of 1+ parr in 2023 of only $0.12/\text{m}^2$ which, as for the other Wick sites, was lower than anticipated. This again suggests that adverse stream conditions in the period between surveys had impaired survival or that that fish had moved away from the survey site.



Total biomass density was greater than in recent years at $7.3 \text{ g}/\text{m}^2$ due mainly to the greater contribution made by the fry.

Summary

Fry densities in the four Wick sites surveyed in 2023 staged a partial recovery from the very low fry levels evident in 2021 and 2022. Presumably, these low values were the result of poor spawning in 2020 and 2021, respectively. The improvement in fry density in 2023 may therefore reflect better spawning in 2022 and, based on the evidence of surveys for the years before 2021, the 2023 fry values ought to be large enough to found a full year-class of 1+ parr for 2024.

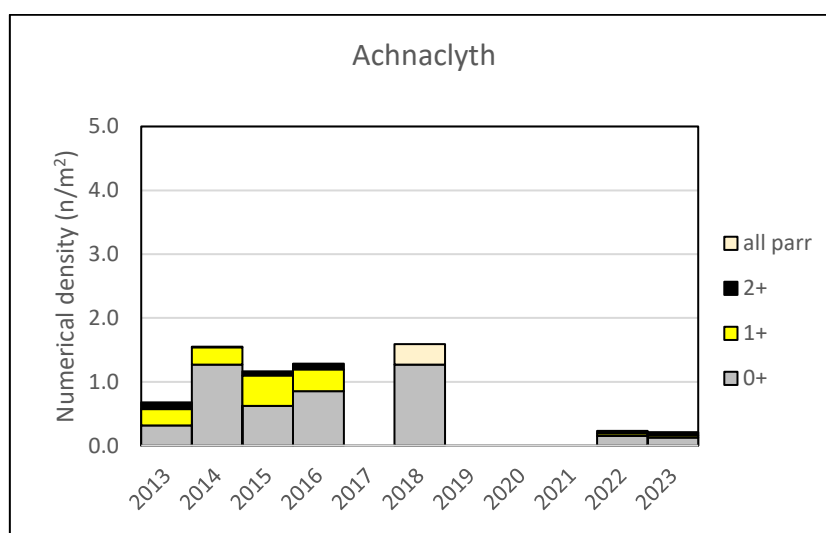
However, the low densities of fry observed in 2021 and 2022 failed to generate the modest densities of 1+ parr that were expected for the following year. It is possible that this seeming deficit is related to water quality problems associated with summer droughts, as previously suggested. More specifically, more fry than usual may be going missing over the summer between the dates of the Board's surveys although it is worth bearing in mind that the same effect was not evident in the earlier part of the series of drought series which started in 2018. (See Appendix 2 for information on Wick smolt ages).

The sequence of years with low summer flows and high stream temperatures was interrupted after June, 2023 and, subsequently, river conditions were more stable with lower temperatures at higher levels of flow – conditions more suited to young fish – and this situation has continued to the date of this report. If the survey results for 2024 pick up the results of this change as a higher yield of parr from fry the present in 2023 some of the unexplained complexity detected in recent years will be resolved. Monitoring of the situation will need to be continued into 2024 and all four Wick sites should be surveyed again.

2.4. Dunbeath River

The Board has detailed knowledge of salmon populations at two sites on Dunbeath River. Culvid has been surveyed every year since 2013. The Achnaclyth site is 3km upstream of Culvid. Achnaclyth was fished regularly in the early years of the survey series and survey was resumed in 2022 after a break of three years. Achnaclyth was surveyed again in 2023.

Achnaclyth

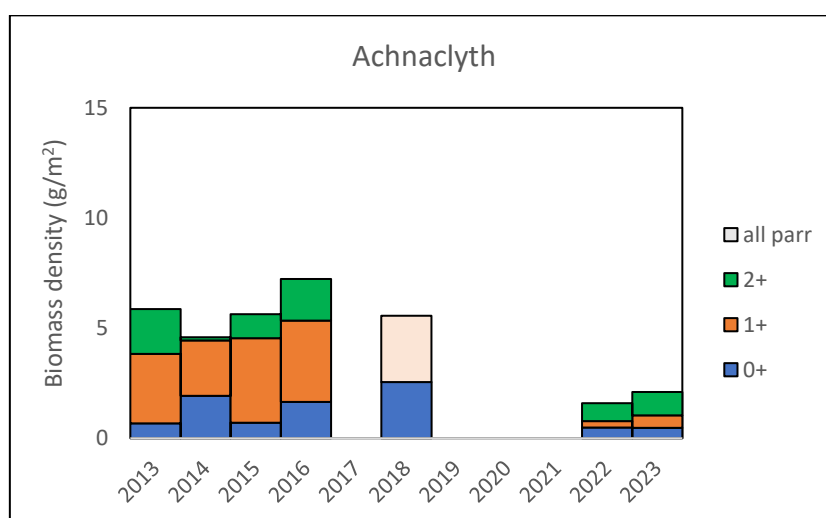


From 2013 until 2018, Achnaclyth supported robust populations of both fry and parr. As recently as 2018, parr density was $0.32/\text{m}^2$ and generally, therefore, in line with preceding years. (The parr were not classified by age in 2018 because scale samples were not taken due to the exceptionally high temperatures prevailing at survey time). Fry levels in 2018 ($1.27/\text{m}^2$) were more than sufficient to saturate the site with 1+ parr in 2019. After the break in sampling, however, the situation was found to have changed. In 2022, fry were relatively scarce ($0.15/\text{m}^2$) suggesting a poor spawning in 2021.

Furthermore, the density of 1+ parr was also low ($0.04/\text{m}^2$), suggesting a scarcity of fry in 2021 and, therefore, that spawning in 2020 had also been poor.

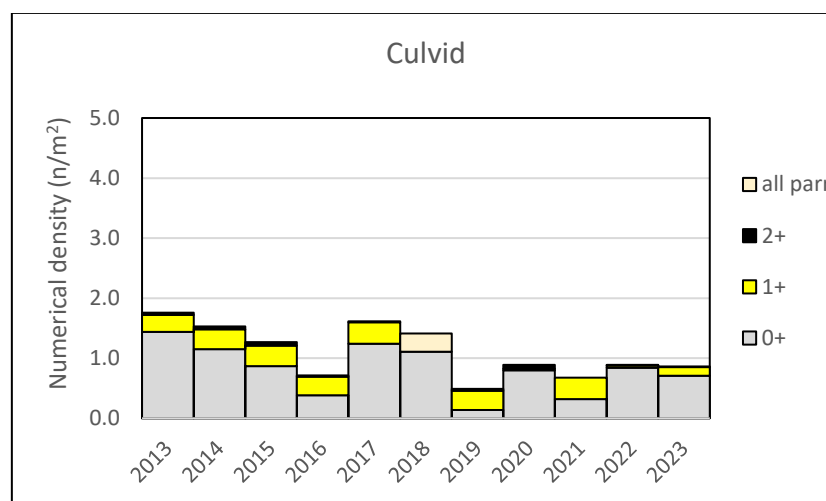
No recovery was evident in 2023; fry density was only $0.12/\text{m}^2$ (suggesting another poor spawning in 2022); the density of 1+ parr was only $0.04/\text{m}^2$.

In summary, spawning in the vicinity of Achnaclyth appears to have declined over the period 2020 to 2022 with consequent effects on fry recruitment and on 1+ parr densities a year later. There is no obvious reason why this should be the case. The prospects for 1+ parr in 2024 are similarly affected and this should be checked again at survey in 2024.

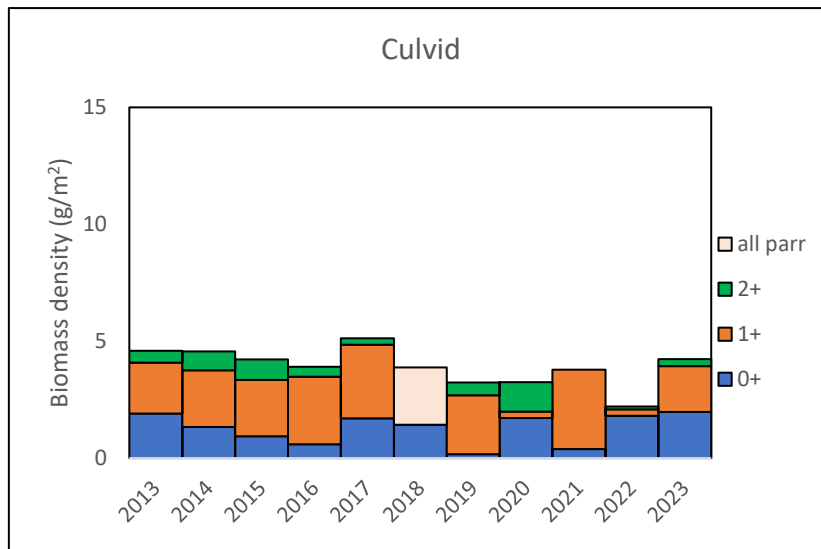


As expected from the density values, biomass values in 2023 were relatively low at $2.1\text{g}/\text{m}^2$.

Culvid



In contrast to Achnaclyth, fry and parr densities at Culvid have been well- maintained throughout - although fry densities have been lower on average over the most recent part of the time-series. In 2023, fry density was about average for the site at $0.71/\text{m}^2$. The density of 1+ parr was less than average at $0.14/\text{m}^2$ despite the substantial fry-year in 2022.



Total biomass density at Culvid was about average at 4.2g/m².

Summary

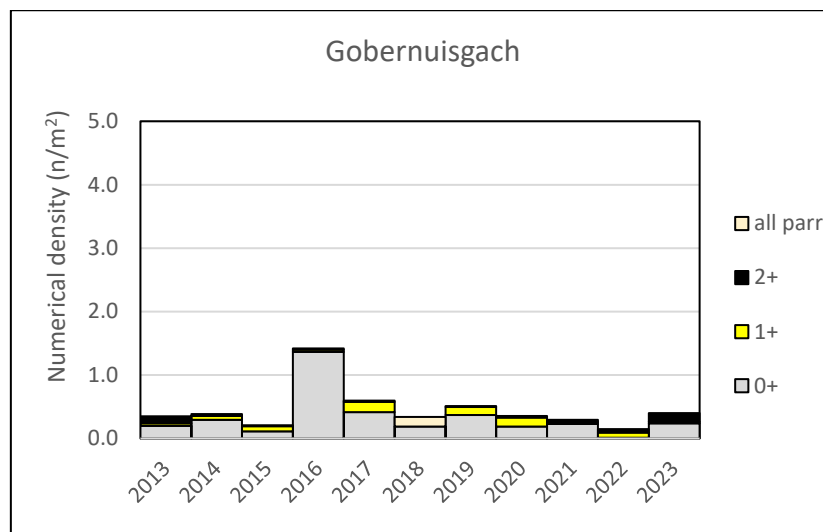
The Board has detailed knowledge of two sites in Dunbeath River, The status of the sites appears to have diverged at some time after 2018 with production at Culvid being maintained while production at Achnaclyth fell markedly. There is no obvious reason for the difference; the sites are only 3km apart, there are no barriers for adult access and the physical characteristics of both sites have remained unchanged.

Both sites should be surveyed again in 2024 and survey work should be extended upstream to examine additional main river locations above Achnaclyth for which the Board has previous information.

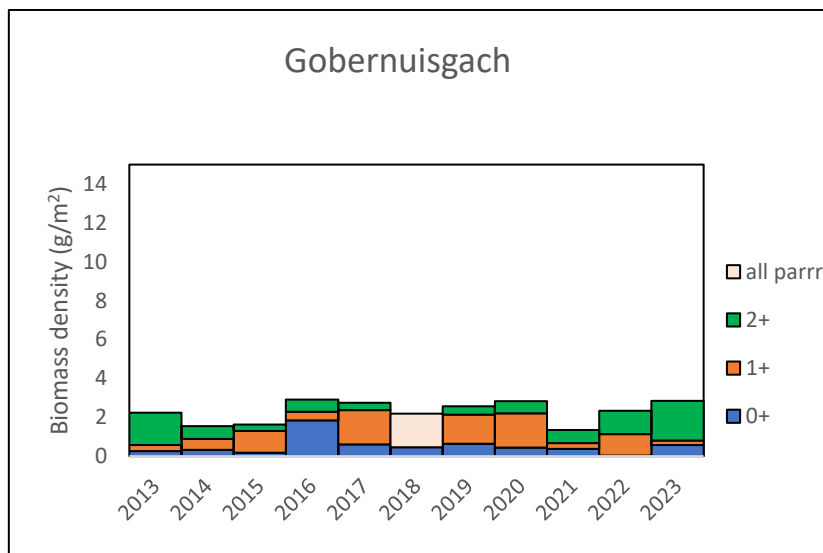
2.5. Berriedale/ Langwell Rivers

In 2023, four survey sites were examined – two each on the Berriedale and the Langwell. The Gobernuisgach (Berriedale) and Wag (Langwell) sites have been surveyed every year since 2013. The Braemore (Berriedale) and Aultibea (Langwell) sites were examined over the early years of the survey series and, after a break, they were revisited from around 2020 when summer droughts began to impose new pressures on the rivers.

Gobernuisgach

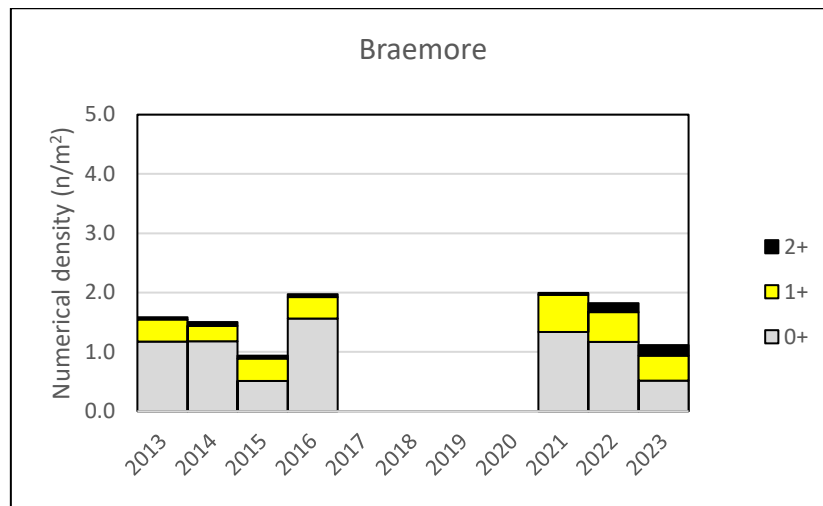


In 2023, fry density was about average for the site at $0.24/m^2$. Following on from the poor fry year in 2022, the density of 1+ parr was only $0.02/m^2$. However, parr density was about average overall because 2+ parr were more abundant than usual ($0.13/m^2$).

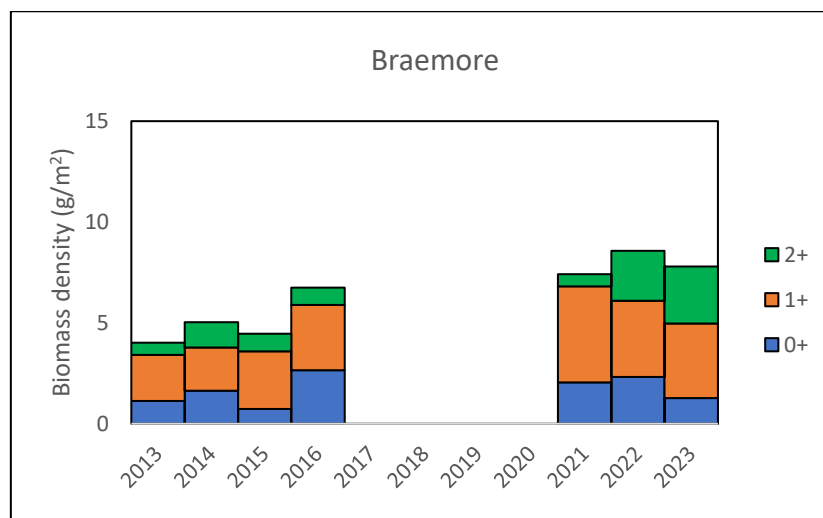


Total biomass density was greater than average at $2.8g/m^2$ due to the contribution made by older, larger parr.

Braemore

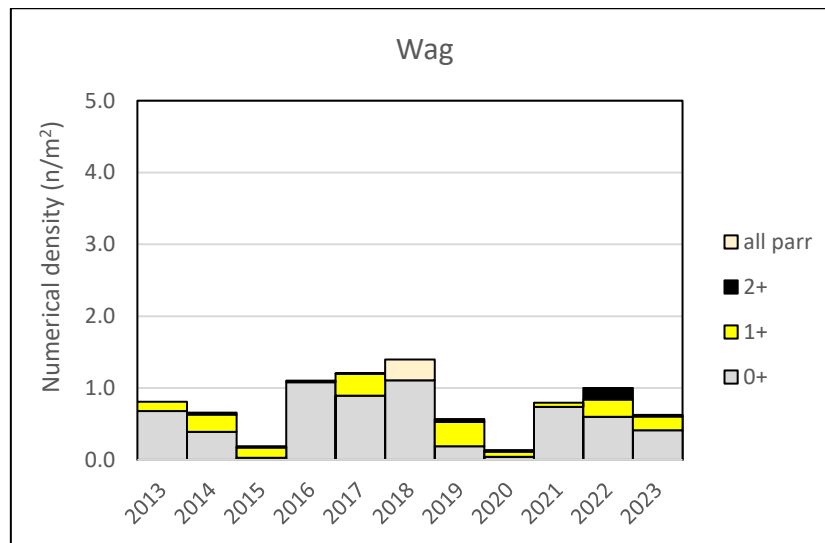


At Braemore, fry density was lower than average but still substantial at $0.5/\text{m}^2$. Densities of parr were around average for the site.

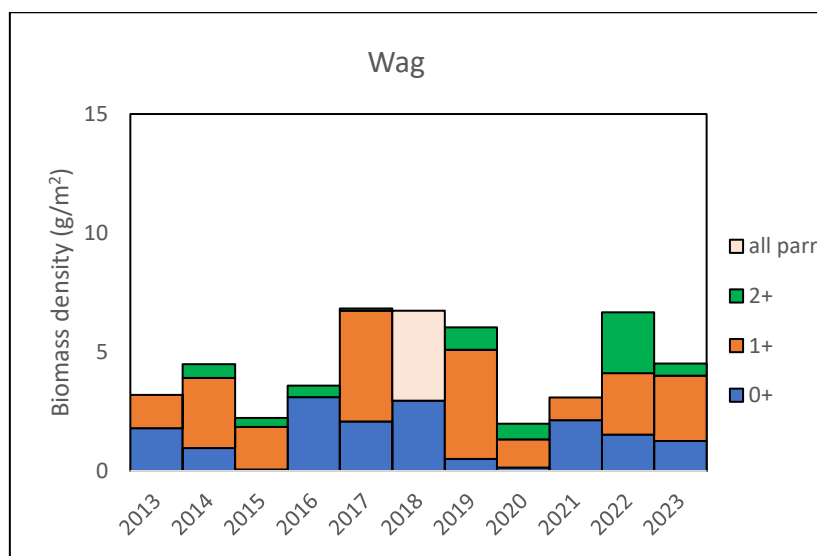


Total biomass density was greater than average at $7.8\text{g}/\text{m}^2$ driven by the contribution made by 2+ parr; otherwise the year-class contributions were more-or-less typical of those observed in previous years.

Wag

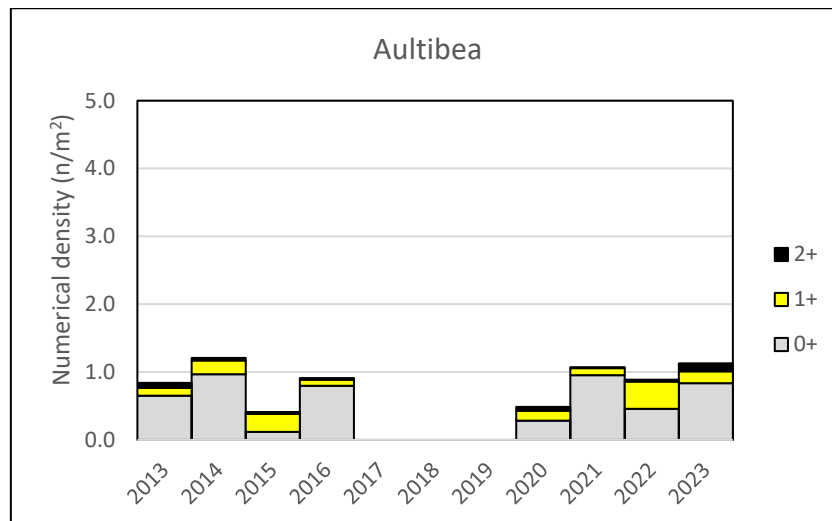


At the Wag survey site on upper Langwell, fry ($0.42/m^2$) and 1+ parr ($0.19/m^2$) densities were average for the site.

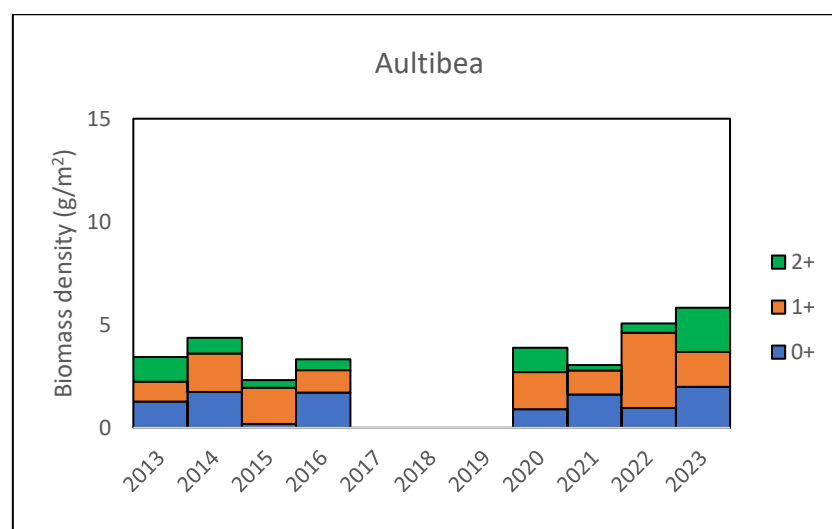


Total biomass density was about average for the site at $4.5g/m^2$.

Aultibea



At Aultibea, fry density was $0.83/\text{m}^2$, the density of 1+ parr was about average at $0.18/\text{m}^2$ and the density of 2+ parr was slightly greater than usual at $0.12/\text{m}^2$.



Total biomass density was $5.83\text{g}/\text{m}^2$. This is the greatest value observed to date and was driven by the greater than average density of 2+ parr.

Summary

All the values for all four sites on Berriedale/ Langwell were around the average values observed over previous survey years. There were no particular points of note in the 2023 survey of Berriedale/ Langwell and the same sites should be repeated at survey in 2024 to maintain a watching brief.

3. Conclusions

The Caithness rivers have responded differently to the stresses imposed - in one way or another - by the droughts of recent years. The Thurso has proved most resilient of all the Caithness rivers and was again shown to be in good condition in 2023 although assessment was based on a more limited survey set than usual because work was curtailed by the high river levels that pertained in late summer. In 2024, survey work on Thurso should be expanded to its previous level if weather permits.

Berriedale/ Langwell also appeared stable. No extra steps are warranted but a watching brief should be maintained by repeating the 2023 survey sites in 2024.

On Dunbeath River, the 2023 survey results for Achnaclyth were again atypically poor although the results at Culvid further downstream were as expected. Both sites should be repeated in 2024 and survey work should be extended upstream to two additional sites for which the Board has survey information obtained in previous years.

Forss and Wick rivers have been particularly impacted by the recent succession of drought years although the effects of low, warm summer flows have been mediated in different ways. The downturn in Wick Rivers around 2021 may have been associated with water quality issues but the downturn in Forss from 2019 onwards was attributable to the effects of *Saprolegnia* on potential adult spawners, probably exacerbated by the low summer flows. The summer of 2023 was relatively cool and both Wick and Forss held improved crops of fry raising hopes of incipient recovery of juvenile salmon populations. Both rivers should therefore be closely monitored in 2024 to track any further recovery as it develops. This will be particularly important for the River Forss since the results are likely to affect the range of options available under the Forss Recovery Plan for ensuring the rapid recovery of a viable fishery.

Acknowledgements

Thanks are due to Jamie McCarthy, Simon Harrison, Molly Miller, Jamie Loughlin and Mac Young for carrying out the field work.

Appendix 1. Survey data

Table 1. Survey site details.

	Site	Date	OS Coordinates	Site area (m ²)
Forss	Torran	15/9	ND 03773 52090	90
	Cnoc-glas	15/9	ND 03399 51815	193
	Shurrery	8/9	ND 03918 57806	106
	Lythmore	8/9	ND 04636 66341	184
Thurso	Rumsdale	4/9	NC 98743 40788	182
	Tacher	4/9	ND 17011 46917	131
Wick	Sheriffs	3/9	ND 24583 52234	170
	Scorriclet	3/9	ND 24729 50248	149
	Acharole1	2/9	ND 23210 51752	134
	Clow	2/9	ND 23246 52307	160
Dunbeath	Achnaclyth	5/9	ND 10543 33613	129
	Culvid	5/9	ND 12354 32404	215
Berriedale	Gobernuisgach	7/9	NC 98415 31239	166
	Braemore	7/9	ND 07323 30389	156
Langwell	Wag	6/9	ND 01624 25961	212
	Aultibea	5/9	ND 04809 23348	241

Table 2. Numbers of salmon and trout observed at survey by electric-fishing pass-number and age.

	Salmon fry			Salmon parr			Trout fry			Trout parr		
	Pass 1	Pass 2	Pass 3	Pass 1	Pass 2	Pass 3	Pass 1	Pass 2	Pass 3	Pass 1	Pass 2	Pass 3
Torran	19	6	1	2	0	0	52	9	3	1	0	0
Cnoc-glas	29	10	3	2	0	0	23	6	1	0	0	0
Shurrery	19	6	0	1	1	0	5	3	1	0	0	0
Lythmore	105	45	9	3	0	0	49	14	7	0	4	1
Rumsdale	205	66	33	39	10	2	13	1	4	2	1	1
Tacher	136	36	18	33	4	3	3	0	0	1	0	1
Sheriffs	156	51	31	20	6	4	0	0	0	0	3	0
Scorriclet	195	57	25	13	4	0	2	2	0	2	0	1
Acharole1	102	20	7	1	0	0	2	0	0	4	1	1
Clow	46	8	4	1	0	0	3	3	2	1	1	2
Achnaclyth	11	5	0	8	2	0	0	0	0	1	1	0
Culvid	103	35	9	23	6	4	0	0	0	1	0	0
Gobernuisgach	13	15	3	23	2	1	0	0	0	13	0	0
Braemore	56	18	4	71	17	5	0	0	0	2	1	0
Wag	71	13	3	35	6	3	0	0	0	10	2	0
Aultibea	155	107	13	53	10	7	0	0	0	10	2	1

Table 3. Zippin corrected densities of salmon fry and salmon parr.

	Zippin corrected density (n/m ²)		
	Fry	1+ Parr	2+ Parr
Torran	0.30	0.02	0.00
Cnoc-glas	0.23	0.00	0.00
Shurrery	0.24	0.00	0.02
Lythmore	0.90	0.01	0.01
Rumsdale	1.76	0.27	0.02
Tacher	1.57	0.25	0.06
Sheriffs	1.51	0.12	0.07
Scorriclet	1.93	0.05	0.06
Acharole1	0.98	0.00	0.01
Clow	0.37	0.01	0.00
Achnaclyth	0.12	0.04	0.05
Culvid	0.71	0.14	0.01
Gobernuisgach	0.24	0.02	0.13
Braemore	0.51	0.42	0.18
Wag	0.42	0.19	0.02
Aultibea	0.83	0.18	0.12

Table 4. Average body length of salmon fry and 1+ salmon parr. Where only a sample of fry was lengthed, the sample size is indicated. Unless otherwise specified all the average values were for > 10 individuals. Standard Deviation is indicated where appropriate.

	Salmon fry			1+ Salmon parr		
	Average length (mm)	Number sampled	Standard deviation	Average length (mm)	Note	Standard deviation
Cnoc-glas	69.9		9.59	123	2 only	n/a
Torran	73.5		5.33	109	2 only	n/a
Shurrery	85.0		7.69		No fish	
Lythmore	76.7	69 of 159	9.38	140	2 only	n/a
Rumsdale	58.1	53 of 304	4.18	98.1		6.26
Tacher	52.9	50 of 190	5.99	95.9		7.16
Sheriffs	66.5	59 of 238	7.80	100		6.73
Scorriclet	57.6	52 of 277	5.66	91.4		9.77
Acharole1	74.4		8.74		No fish	
Clow	78.7		9.75	140	1 only	n/a
Achnaclyth	71.9		5.26	107	5 only	7.03
Culvid	65.1	50 of 147	4.91	105		7.71
Gobernuisgach	62.0		4.52	94.2	4 only	n/a
Braemore	63.2	50 of 78	3.23	92.6		5.77
Wag	66.9	50 of 87	3.15	108		5.08
Aultibea	61.9	51 of 275	5.29	94.8		5.02

Table 4. Zippin corrected density of trout fry.

	Observed density (n/m ²)	True density (n/m ²)
Torran	0.71	0.72
Cnoc-glas	0.16	0.16
Shurrery	0.08	0.08
Lythmore	0.38	0.40
Rumsdale	0.10	0.11
Tacher	0.02	0.02
Sheriffs	zero	
Scorriclet	0.03	0.03
Acharole1	0.01	0.01
Clow	0.05	0.06
Achnaclyth	zero	
Culvid	zero	
Gobernuisgach	zero	
Braemore	zero	
Wag	zero	
Aultibea	zero	

Appendix 2. Wick smolt ages.

As suggested previously, the sometimes low yield of 1+ parr in Wick River from the previous year's fry may be due to decreases in fry survival rates caused by water quality issues during recent hot, dry summers. However, there are further possibilities that might explain what has been observed.

First, fry grow more quickly when their density is low and some very large fry may smolt at one-year-of-age. If any fish can achieve this, they will leave the river in April/ May, between the September survey dates, thereby evading census at the 1+ parr stage. Second, fish may move away from depleted survey sites during summer drought conditions. If so, fish caught as fry may evade capture at the 1+ parr stage by moving to pools or deep glides which are not readily accessible for electric-fishing.

Normally, it would not be possible to investigate either of these questions further. However, Adam Piper of the Zoological Society of London captured 123 salmon smolts at Bilbster for the Wick Tracking Project between 12th and 23rd April, 2023. Before tagging, scale samples were obtained to establish the age of each fish.

It proved possible to determine age for 121 of the 123 individuals captured. 80 of the captured smolts were 2 years-of age, 39 were 3 years-of-age and 2 were 4-years-of age. No 1-year-old fish were captured indicating that, even at the low densities observed at survey in September 2022, none of the fry had grown sufficiently quickly between September and April to reach the size-threshold for smolting by April.

It can also be noted that, in April 2023, the representation of 3-year-old smolts relative to two-year-old smolts in the fyke-net catches was much higher than anticipated from the electric-fishing results in 2022. The electric-fishing data from the Strath and Scouthal Burns suggested a ratio of one 2+ parr per eleven 1+ parr. Six months later the equivalent ratio among the smolts was one 3-year-old smolt per two 2-year-old smolts. In other words, proportionately more 3-year-old smolts were captured at Bilbster in April 2023 than was expected from the electric-fishing results for the Board's survey sites in September 2022.

However, smolt runs tend to be structured by age/ size with the larger/ older fish running earlier than younger/ smaller individuals. It is therefore possible that the mismatch was due to 3-year-old smolts tending to precede 2-year-old smolts. For the same reason, it is also possible that 1-year-old smolts were present in May during the latter part of the smolt run after the fyke trap had been removed.

This point could be specifically examined in future but only by committing the large amount of resources required to trap and sample smolts throughout April and May.

The Wick smolt tracking project is scheduled to be repeated by the Zoological Society of London in April 2024. It would be worthwhile taking the opportunity to look again for any 1-year olds and, more generally, to compare the sizes and relative numbers of the 2024 smolts with those in 2023.