# Juvenile Salmonids in the Rivers of Caithness:

# 2016 Electric-fishing Survey.

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## Introduction

This report documents the electric-fishing survey of juvenile salmonids carried out by Caithness District Salmon Fishery Board in September/ October, 2016. The objective was to build on the findings of previous surveys in 2013-2015. Since these had been consistently favourable overall, the 2016 survey was reduced in scale to cover a subset of the Board's core sites. However, the Berriedale/ Langwell catchment was fully covered in order to follow up on the low densities of fry observed there in 2015.

## Methods

In all, a total of 15 locations in the six Caithness rivers - Forss, Thurso, Wick, Dunbeath, Berriedale and Langwell - and a single location in the smaller, Wester catchment were surveyed. The sites themselves exactly replicated those electric-fished in previous years.

All the fish captured were the result of natural spawning, with the exception of the Achnaclyth site on Dunbeath Water which, as previously, had been stocked with fry.

In addition, The Clow site on Wick River and the Culvid site on Dunbeath Water had also been stocked with fry as part of an experiment (see below) carried out by the FCRT. The survey results for The Clow and Culvid are included in the Board's data set for completeness because stocking did not demonstrably enhance the number of fry present at either site.

| River | Site name | O.S. | Alt (m) | Date | Standard area ($m^2$) |
|---|---|---|---|---|---|
| Forss | Shurrery | ND 039 578 | 89 | 10th Sep | 90 |
| | Lythmore | ND 047 663 | 24 | 18th Sep | 184 |
| Thurso | Rumsdale | NC 988 408 | 159 | 4th Sep | 182 |
| | Dalemore | ND 144 491 | 70 | 4th Sep | 269 |
| Wester | Barrock Mill | ND 296 626 | 11 | 10th Sep | 173 |
| Wick | Sheriff's | ND 255 525 | 33 | 5th Sep | 170 |
| | The Clow | ND 233 524 | 35 | 5th Sep | 160 |
| Dunbeath | Achnaclyth | ND 105 337 | 120 | 6th Sep | 129 |
| | Culvid | ND 123 325 | 97 | 6th Sep | 215 |
| Berriedale | Gobernuisgach | NC 984 312 | 250 | 8th Sep | 131 |
| | Corrichoich | ND 034 297 | 200 | 8th Sep | 134 |
| | Braemore | ND 074 304 | 156 | 9th Sep | 179 |
| Langwell | Wag | ND 016 260 | 188 | 7th Sep | 212 |
| | Aultibea | ND 046 236 | 125 | 7th Sep | 241 |
| | Coille Braigh | ND 074 228 | 93 | 9th Sep | 171 |

*Table 1. Electric-fishing survey sites (2016).*

Table 1 shows the 2016 survey sites, identified by name and OS co-ordinates and the date on which they were fished. The standard wetted area of sites, as defined in the Board's 2013-15 consolidated report, were used to calculate fish densities from capture numbers.

The electric-fishing methods used were generally those described in the Scottish Fisheries Coordination Centre (SFCC) protocol[1] and were identical to those previously used by the Board. In short, three-pass depletion fishing was carried out using a portable Honda generator to supply power to an Electracatch WF7 control box. The three fishings were carried out over a period of about three hours and the fish captured on each electric fishing pass were recorded and documented separately. The presence of non-salmonid species was recorded.

Trout and salmon were distinguished by inspection. Body length was determined for all parr and for a large sample of fry. Scale samples were obtained from parr for age determination. Scales were also obtained from fry when these were sufficiently large to place visual classification in doubt. Based on scale reading, fry included among the fish from which scales were sampled were subsequently assigned to the correct age group.

On completion of the site survey all the fish were returned to the stream where they had been obtained.

At each site the number of fish captured was used to calculate observed density per unit wetted area of stream. Values for observed density were separately calculated for fry and for parr. These values were evaluated by comparison with the analysis of Scottish electric-fishing data carried out by Godfrey (2005) using SFCC data.

Additionally, for each site, Zippin corrections were applied to the three-pass depletion counts to obtain estimates of the true total number for fry and parr. Values were computed using the program *Removal Sampling II* [2]. Estimated true total number was used to calculate true density per unit wetted area in order to compare sites and years.

The body length of individuals was converted to an estimate of body weight. Mean body weight for fry, 1+ parr and 2+ parr was combined with the corresponding estimate for real density to generate an estimate of biomass density for each age-class at each site.

[1] http://www.scotland.gov.uk/Resource/Doc/295194/0096725.pdf
[2] http://www.pisces-conservation.com/

# Results

## Trout and other species.

Table 2 show that, as in previous years, trout fry were absent at many sites and present only at very low densities at the others. Trout parr were more frequent and more widely distributed but still only present at very low densities. Otherwise, only eels and sticklebacks were recorded.

| River | Site name | Observed density of trout ($n.m^{-2}$) | | |
|---|---|---|---|---|
| | | Fry | Parr | Other species |
| Forss | Shurrery | 0 | 0.01 | eel, stickleback |
| | Lythmore | 0.02 | 0.02 | eel |
| Thurso | Rumsdale | 0.02 | 0.08 | eel |
| | Dalemore | 0 | 0.01 | eel |
| Wester | Barrock Mill | 0.09 | 0 | eel, stickleback |
| Wick | The Clow | 0 | 0 | eel |
| | Sheriff's | 0 | 0.03 | eel, stickleback |
| Dunbeath | Achnaclyth | 0 | 0.09 | eel |
| | Culvid | + | + | eel |
| Berriedale | Gobernuisgach | + | 0.13 | - |
| | Corrichoich | 0 | 0.01 | - |
| | Braemore | 0.01 | 0.01 | - |
| Langwell | Wag | 0 | 0.04 | - |
| | Aultibea | 0 | 0.01 | eel |
| | Coille Braigh | 0 | 0.03 | - |

*Table 2. Presence of trout and non-salmonid species.*

## Salmon

Table 3 shows the primary electric fishing data for salmon fry and parr, being the number of each class captured on each of the three electric fishing passes.

The site at Corrichoich was fished only over a single pass before the survey was abandoned for H&S reasons following deterioration in the weather. The data for the first electric-fishing pass are shown.

| River | Site name | Fry | | | Parr | | |
|---|---|---|---|---|---|---|---|
| | | 1st pass | 2nd pass | 3rd pass | 1st pass | 2nd pass | 3rd pass |
| Forss | Shurrery | 31 | 10 | 3 | 58 | 11 | 2 |
| | Lythmore | 243 | 53 | 15 | 98 | 23 | 8 |
| Thurso | Rumsdale | 94 | 28 | 22 | 36 | 7 | 9 |
| | Dalemore | 359 | 92 | 59 | 44 | 16 | 16 |
| Wester | Barrock Mill | 0 | 0 | 0 | 7 | 2 | 0 |
| Wick | The Clow | 136 | 54 | 21 | 97 | 13 | 5 |
| | Sheriff's | 296 | 73 | 20 | 94 | 15 | 7 |
| Dunbeath | Achnaclyth | 73 | 24 | 9 | 43 | 8 | 4 |
| | Culvid | 54 | 16 | 9 | 48 | 11 | 8 |
| Berriedale | Gobernuisgach | 73 | 62 | 28 | 7 | 3 | 0 |
| | Corrichoich | 50 | - | - | 27 | - | - |
| | Braemore | 114 | 79 | 34 | 52 | 12 | 7 |
| Langwell | Wag | 157 | 54 | 12 | 3 | 2 | 0 |
| | Aultibea | 128 | 49 | 9 | 21 | 5 | 1 |
| | Coille Braigh | 35 | 21 | 5 | 19 | 8 | 4 |

*Table 3. Numbers of salmon fry and parr captured at each site for each pass of 3-pass electric-fishing.*

Godfrey's procedure for assessing electric-fishing data considers only single-pass fishing. The observed densities of fry and parr observed on the first electric-fishing pass of the 3-pass fishing were compared with Godfrey's reference values. Six categories for density were defined based on the critical quintile values identified by Godfrey for salmon fry or parr (Table 4). Sites were graded and colour-coded as excellent (dark blue), very good (light blue), good (green), average (yellow), low (orange) or poor (red).

| | Critical percentile values for density (n.m$^{-2}$) and colour codings | | | | | |
|---|---|---|---|---|---|---|
| | < 20th | 20th - 40th | 40th - 60th | 60th - 80th | 80th -100th | > 100th |
| **Fry** | **0.05** | **0.13** | **0.28** | **0.33** | **0.67** | |
| **Parr** | **0.04** | **0.07** | **0.13** | **0.19** | **0.28** | |

*Table 4. Critical percentile values for classification of observed density (n.m$^{-2}$) of salmon fry or parr based on single-pass fishing (Godfrey, 2005).*

Table 5 provides an evaluation of salmon fry and parr densities for all the survey sites, using these colour codings. It should be noted that this method uses only part of the survey information and applies the same standard values to all sites irrespective of their nature. The method is superficially attractive but potentially misleading. It is intended to replace it in time by using the new methods based on biomass density that are gradually being refined by the Board.

| Site | Salmon | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fry | | | | Parr | | | |
| | 2013 | 2014 | 2015 | 2016 | 2013 | 2014 | 2015 | 2016 |
| Cnoc-glas | | | | | | | | |
| Shurrery | | | | | | | | |
| Lythmore | | | | | | | | |
| Rumsdale | | | | | | | | |
| Dalganachan | | | | | | | | |
| Dalnagleton | | | | | | | | |
| The Fanks | | | | | | | | |
| Smerrary | | | | | | | | |
| Tacher | | | | | | | | |
| Inshag | | | | | | | | |
| Dalemore | | | | | | | | |
| Hoy | | | | | | | | |
| Barrock Mill | | | | | | | | |
| Acharole | | | | | | | | |
| The Clow | | | | | | | | |
| Sheriff's | | | | | | | | |
| Bilbster | | | | | | | | |
| Achnaclyth | | | | | | | | |
| Culvid | | | | | | | | |
| Gobernuisgach | | | | | | | | |
| Corrichoich | | | | | | | | |
| Braemore | | | | | | | | |
| Strathcoull | | | | | | | | |
| Wag | | | | | | | | |
| Aultibea | | | | | | | | |
| Coille Braigh | | | | | | | | |

*Table 5. Comparisons of fry and parr densities at survey sites for 2013, 2014, 2015 and 2016. Colour codings as per Table 4.*

The majority of the Berriedale and Langwell (Gobernuisgach to Coille Braigh on Table 6) sites were surveyed in 2016 as a response to the low levels of fry observed there in 2015. It can be seen that fry densities recovered in 2016, although the effects of the poor year-class of fry in 2015 were evident in the 2016 parr densities – notably at Gobernuisgach and Wag the highest altitude sites on the Berriedale and Langwell, respectively.

Elsewhere, fry levels were “very good” or “excellent” with the exception only of Culvid on Dunbeath Water and Barrock Mill which performs poorly every year. Outside Berriedale/ Langwell, parr levels were very satisfactory and in line with previous values although Barrock Mill was again an exception.

Table 6 shows the observed densities of fry and parr for 3-pass fishing. Corrichoich is not included because the survey was abandoned after only one pass.

| River | Site name | Observed Density (n.m$^{-2}$) and year of hatch | | | |
|---|---|---|---|---|---|
| | | 0+ fry (2016) | 1+ parr (2015) | 2+ parr (2014) | All parr |
| Forss | Shurrery | 0.49 | 0.68 | 0.11 | 0.79 |
| | Lythmore | 1.69 | 0.69 | 0.01 | 0.70 |
| Thurso | Rumsdale | 0.79 | 0.26 | 0.03 | 0.29 |
| | Dalemore | 1.90 | 0.26 | 0.02 | 0.28 |
| Wester | Barrock Mill | 0 | 0.05 | 0 | 0.05 |
| Wick | The Clow | 1.32 | 0.69 | 0.02 | 0.71 |
| | Sheriff’s | 2.29 | 0.67 | 0.02 | 0.69 |
| Dunbeath | Achnaclyth | 0.82 | 0.33 | 0.09 | 0.42 |
| | Culvid | 0.37 | 0.29 | 0.02 | 0.31 |
| Berriedale | Gobernuisgach | 1.24 | 0.05 | 0.03 | 0.08 |
| | Corrichoich | - | - | - | - |
| | Braemore | 1.27 | 0.35 | 0.04 | 0.40 |
| Langwell | Wag | 1.05 | 0 | 0.02 | 0.02 |
| | Aultibea | 0.77 | 0.09 | 0.02 | 0.12 |
| | Coille Braigh | 0.36 | 0.14 | 0.04 | 0.18 |

*Table 6. Observed density of salmon fry and parr from 3-pass fishing.*

Observed density values for fry and parr were transformed by Zippin correction to values for estimated true density - the most precise values than can be derived from the primary data set. The Corrichoich estimate was from derived first-pass fishing based on efficiency values from previous surveys of the same site. All the values are shown in Table 7.

| River | Site name | Estimated true density (n.m$^{-2}$) | | |
|---|---|---|---|---|
| | | Fry | 1+ parr | 2+ parr |
| Forss | Shurrery | 0.50 | 0.68 | 0.11 |
| | Lythmore | 1.71 | 0.70 | 0.01 |
| Thurso | Rumsdale | 0.86 | 0.28 | 0.03 |
| | Dalemore | 1.99 | 0.32 | 0.03 |
| Wester | Barrock Mill | 0 | 0.05 | 0 |
| Wick | The Clow | 1.41 | 0.69 | 0.03 |
| | Sheriff's | 2.32 | 0.68 | 0.02 |
| Dunbeath | Achnaclyth | 0.85 | 0.34 | 0.09 |
| | Culvid | 0.39 | 0.31 | 0.02 |
| Berriedale | Gobernuisgach | 1.73 | 0.05 | 0.03 |
| | Corrichoich | 0.73 | 0.22 | 0.04 |
| | Braemore | 1.56 | 0.36 | 0.05 |
| Langwell | Wag | 1.08 | 0 | 0.02 |
| | Aultibea | 0.80 | 0.09 | 0.02 |
| | Coille Braigh | 0.39 | 0.15 | 0.04 |

*Table 7. Estimated true density of salmon fry and parr.*

The individual site assessments given below are based on the numerical densities presented in Table 7. In addition, biomass density estimates were derived by combining the numerical densities given in Table 7 with body weights as derived from the length measurements given in Table 8.

| River | Site name | Mean body length (S.D.) | | |
|---|---|---|---|---|
| | | Fry | 1+ parr | 2+ parr |
| Forss | Shurrery | 55.8 (5.91) | 92.0 (7.00) | 114.6 (6.79) |
| | Lythmore | 57.0 (5.21) | 99.9 (10.69) | 138.5 (-----) |
| Thurso | Rumsdale | 55.6 (4.00) | 98.1 (7.06) | 121.0 (3.11) |
| | Dalemore | 52.9 (6.19) | 96.8 (8.78) | 123.5 (4.59) |
| Wester | Barrock Mill | - | 139.9 (9.49) | - |
| Wick | The Clow | 54.3 (5.25) | 95.3 (8.07) | 116.5 (-----) |
| | Sheriff's | 57.1 (5.67) | 95.2 (10.17) | 119.3 (-----) |
| Dunbeath | Achnaclyth | 58.2 (4.90) | 97.9 (9.37) | 119.7 (14.13) |
| | Culvid | 54.1 (5.00) | 93.3 (11.21) | 121.8 (-----) |
| Berriedale | Gobernuisgach | 51.8 (3.39) | 101.5 (5.89) | 127.5 (-----) |
| | Corrichoich | 51.0 (4.63) | 93.9 (10.43) | 124.5 (-----) |
| | Braemore | 56.0 (3.77) | 92.3 (8.75) | 116.5 (4.87) |
| Langwell | Wag | 65.7 (4.87) | - | 120.0 (9.70) |
| | Aultibea | 60.0 (5.19) | 101.4 (7.14) | 120.8 (4.79) |
| | Coille Braigh | 60.5 (4.52) | 98.8 (8.54) | 126.7 (5.62) |

*Table 8. Mean body lengths of fry, 1+ parr and 2+ parr. Where appropriate the Standard Deviation is indicated.*

## Assessments

In the consolidated report for the years 2013-2015 a new way of interpreting electric-fishing data was explored. In the past, focus has been solely on the numerical densities of the separate year-classes at particular sites (ie. how many fry or how many parr are present in each square meter). However, the quality of sites varies. This affects the number of fish that sites can support and therefore the number of hatchlings that are needed each year to maximise production later on. Moreover, fish compete with each other for food and for territory and this affects both survival (and therefore density) and growth. Growth and survival are reduced when competition is more intense. Fry compete with fry and parr with parr but, in addition, fry also compete with parr and likewise parr inhibit the performance of fry.

All these interactions lead to complex outcomes that affect the densities of both fry and parr and their body sizes at any particular time of year. For this reason, the Board survey is carried out as late as practically possible in the year. This allows relative stability to be reached among fry and parr when the survey is carried out.

The interactions between and among fry and parr are not fully understood at this stage although the picture becomes clearer as each new annual survey is added to the list of past surveys. However, it is becoming evident that each site has a different, somewhat fixed capacity to support a particular weight of fish and that this limit refers to weight of all the year-classes combined. It is now becoming clear that the effects of competition mean that it is not possible to consider, for example, fry densities as a measure of spawning sufficiency or site production without also considering the ceiling on the site's ability to support fish, the density of the competing parr, and the body sizes of both the fry and parr.

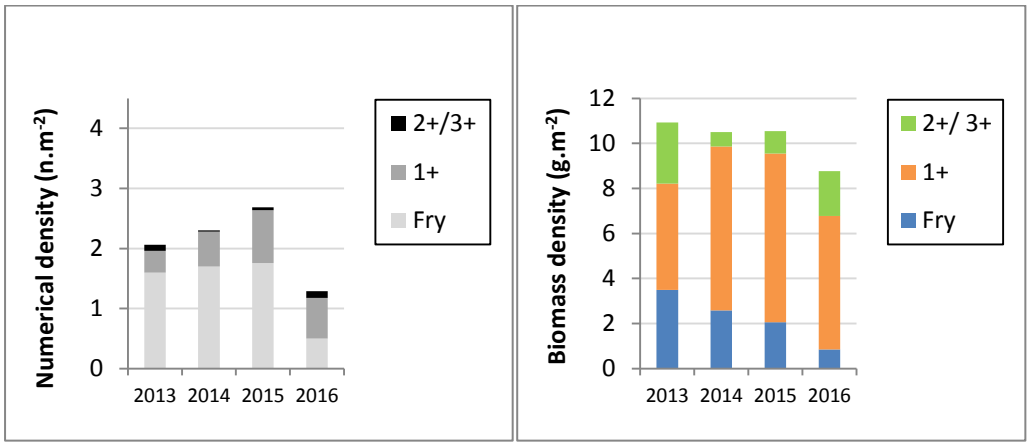
In this particular case, body size means body weight because weight reflects how much energy the fish have previously drawn from the stream and also the size of their current energy requirements. It is not possible to measure body weight accurately in field conditions but body length is routinely measured. The body length of individuals can be converted to an estimate of body weight as discussed in previous reports. It should be noted that apparently minor differences in length hide a much greater disparity in weight. So for example, a fry of 50mm weighs about 1.1g and a fry of 60mm weighs almost twice as much at 2.1g. Likewise, a parr of 90mm weighs about 8.0g and one of 100mm about half a much again at 11.4g.

The density of each year class (fry, 1+ and 2+ parr) measured in each site survey and the average body weight of the individuals belonging to each year-class were combined to estimate biomass density (ie. the weight of each year-class present in each square meter of the site in question). In this way, all the information available from surveys can be combined in two panels (as below) that give the most complete picture of the condition of all the salmon present at each survey site in each year.

This approach is used again in what follows. As a preliminary, Figures 1 and 2 update the average length measurements across survey years (2013-16) for both fry and 1+ parr, respectively.

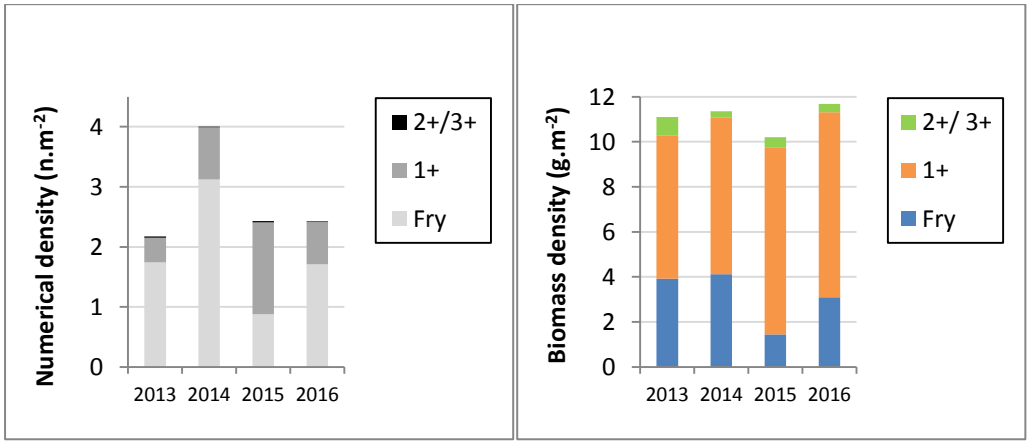
## Individual site assessments

### Shurrery, Forss




Fry density was markedly lower (30%) in 2016 indicating a shortfall at spawning and reduced input of fry. Parr densities were similar to previous years. The reduction in fry density was only partially compensated by greater body size. Total biomass density was reduced to around 9g/m$^2$ compared with values for previous years around 10-11g/m$^2$. The reduction directly reflects the low density of fry. Shurrery should be re-surveyed in 2017 to establish (a) whether the 2016 shortfall in fry was a random, one-off event and to check whether (b) low 1+ parr densities will result from the low fry numbers or (3) compensation will occur by way of inwards movement of fish from elsewhere in the vicinity.

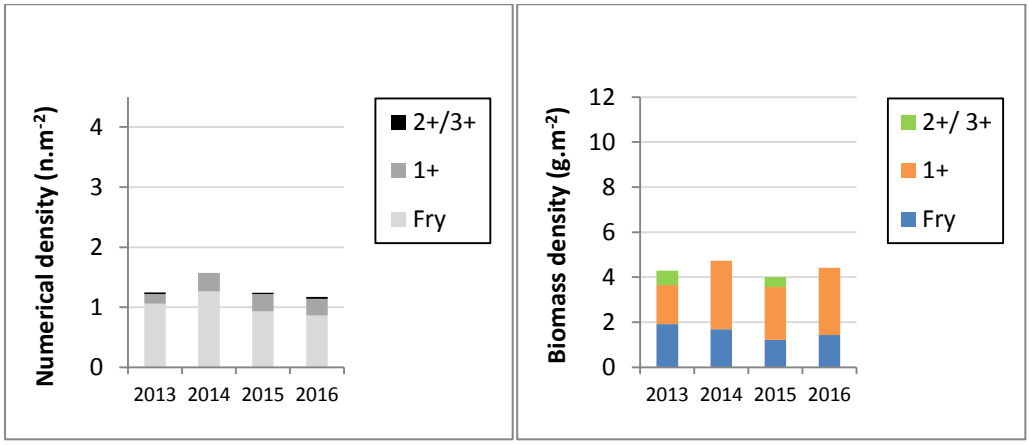
### Lythmore, Forss




Lythmore was not on the original list of sites targeted for survey in 2016. However, it was added in response to the evident lack of fry at Shurrery in order to check whether the shortfall was local or river-wide. Fry densities at Lythmore were again found to be high and

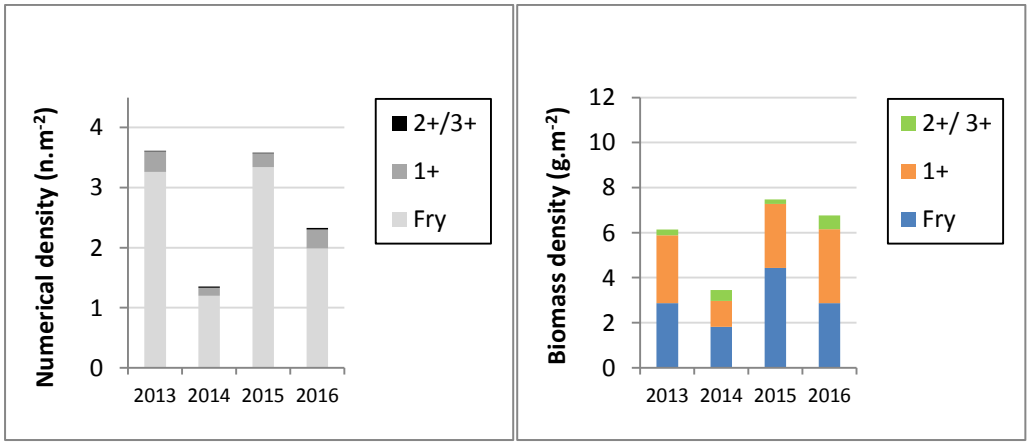
fully comparable with previous years. 1+ parr densities were relatively low due to the relatively low fry numbers in 2015. The total biomass density closely matched that of all preceding years at around 10 or 11g/$m^2$. This stability is again attributable to compensations in the growth achieved by fry and/ or 1+ parr each year.

## Rumsdale, Thurso



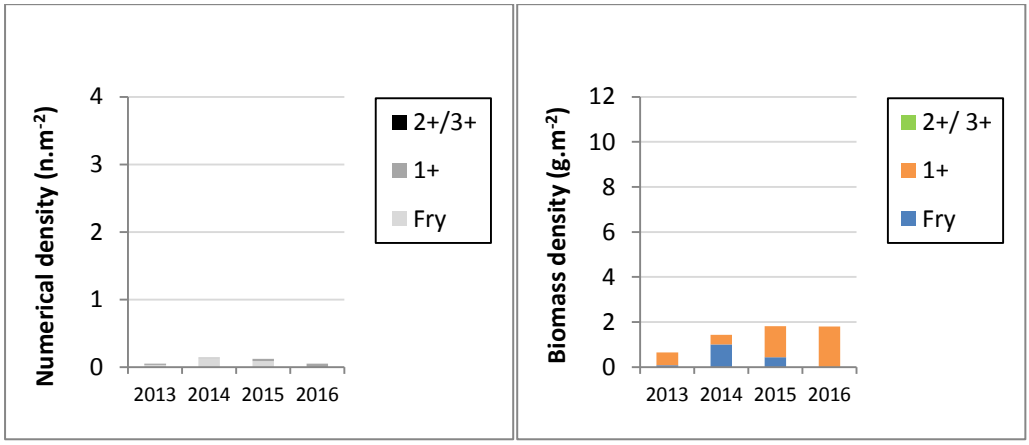

Rumsdale was again fully in line with emerging expectations. Both fry and parr densities were closely comparable to previous values. This stability extends to biomass density values and the 2016 value was again around 4g/$m^2$.

## Dalemore, Thurso



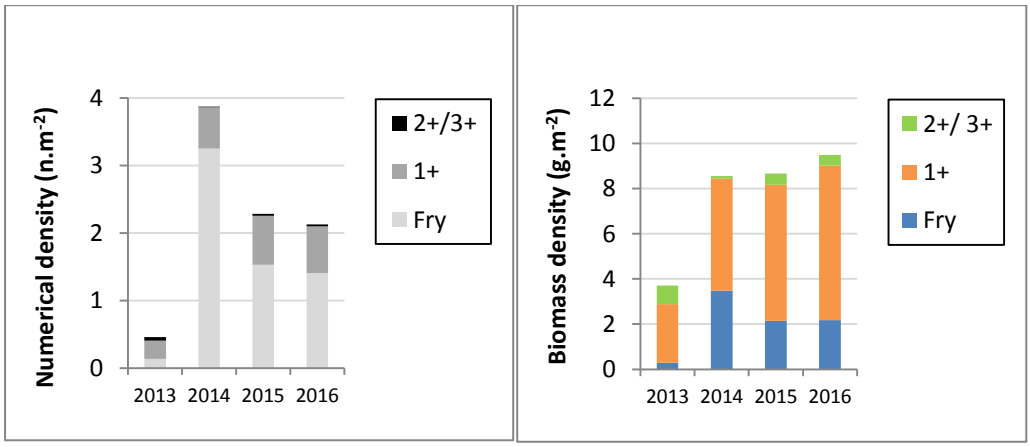

Fry density was lower than in 2013 and 2015 but still very high by Scottish standards at 2/ $m^2$. Parr density was in line with expectation based on previous years. Biomass density was again around 7g/$m^2$, very close to the site's apparent upper limit.

## Barrock Mill, Wester




Barrock Mill again produced a very low density of very large fish. Despite the high growth rates achieved biomass density was again less than 2g/m$^2$ much less than expected for a site of its type. The low densities, coupled with the high growth achieved each year, suggests that the input of young fish to the site is grossly sub-optimal. In fact, no salmon fry were present in 2016 indicating that the supply of young fish is also sporadic. A more general survey of the River Wester (additional 7 sites) was carried out in 2016 by the FCRT (see report at FCRT.org). This showed that the Barrock Mill site is not fully representative of the Wester because some more productive sites were identified elsewhere in the catchment. Nevertheless, the Barrock Mill site does capture some of the rivers systemic problems and these are mostly associated with widespread modification of stream habitat.

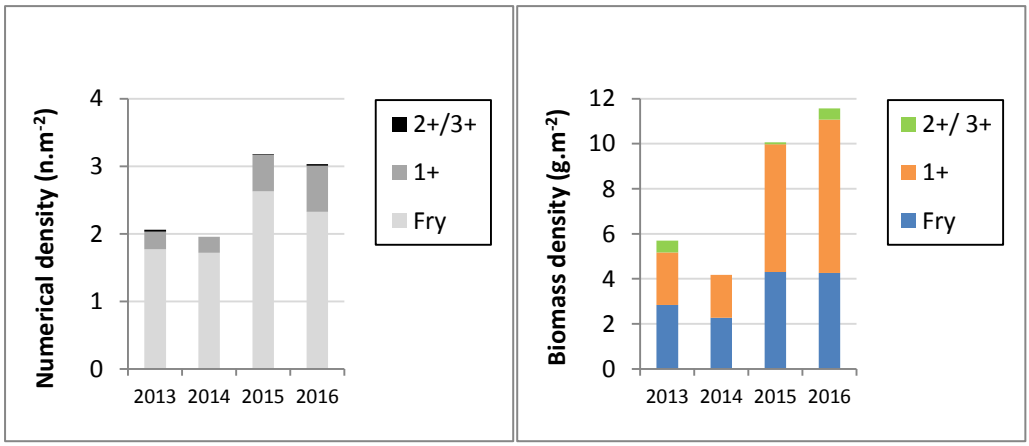
## The Clow, Wick




The Clow was stocked with fry in 2016 as part of an experiment carried out by FCRT. The aim was to determine whether the total biomass values achieved could be raised by increasing the availability fry. Accordingly, hatchery fry were planted in aquatic plant baskets to achieve an additional input of approximately 10 fry/m$^2$, roughly equivalent to the

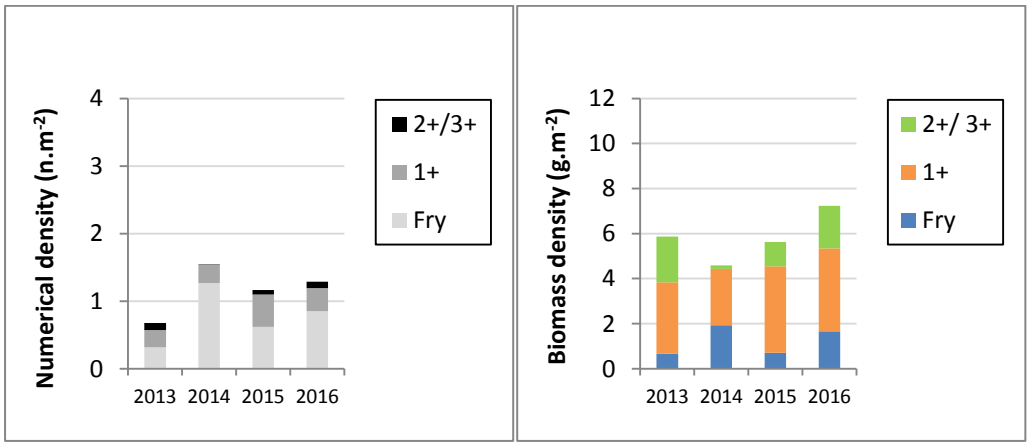
presence of a single redd on-site. Evidently, stocking did not increase fry density as might have been predicted. Instead, both fry and parr densities were in line with expectations in the aftermath of the anomalous low fry year in 2013 and the rebound in 2014. Total biomass density was the greatest achieved to date at around 9.5g/$m^2$ but only a by small margin. The failure of stocking to increase fry density suggests that the site was already at capacity.

## Sheriff's, Wick




Sheriff's was well in-line with recent expectations. Both fry uptake and 1+ production were excellent. Growth rate was also high in both groups. As a result, total biomass density reached the highest value so far recorded at about 11.5 g/$m^2$.

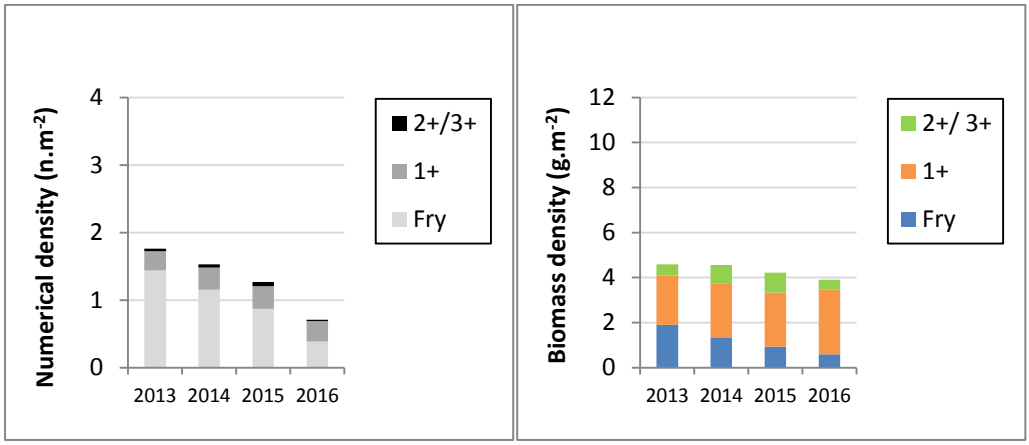
## Achnaclyth, Dunbeath




Achnaclyth put in a particularly strong performance. Fry and 1+ parr densities were good and growth rate was high for both year-classes. The sum of fry and 1+ biomass densities was greater than previously achieved at the site and, with the addition contribution of a small

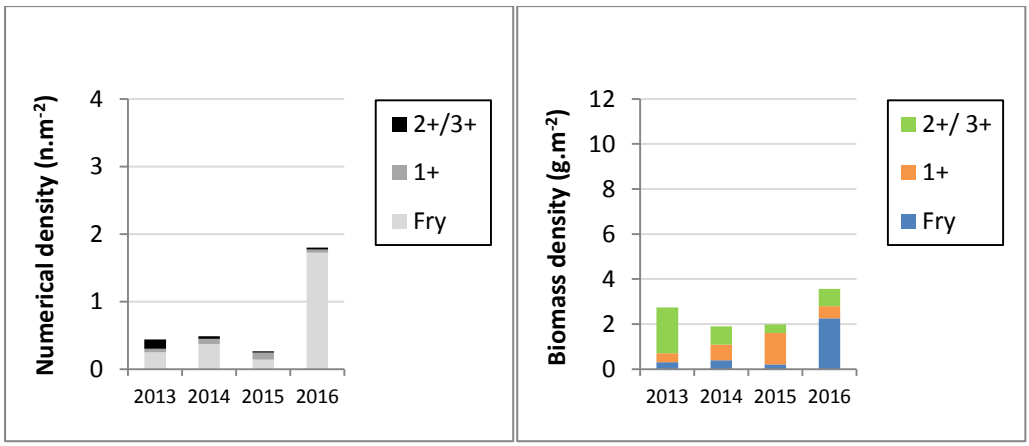
number of 2+ parr, total biomass density achieved the highest value recorded at around 7g/m$^2$. Achnaclyth is trickle-stocked with fry each year.

## Culvid, Dunbeath



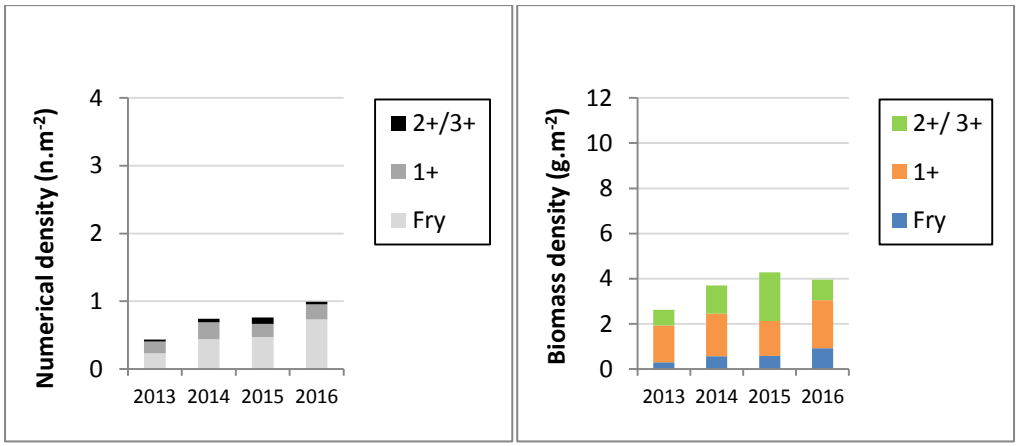

Culvid is an enigma. Like Achnaclyth, the Culvid site is routinely trickle-stocked with fry each year. In addition, in 2016, fry were stocked at around 10/m$^2$ as part of the experiment of which The Clow on Wick River (see above) was also part. Yet despite the extra stocking, fry recruitment was only 30-50% of the values recorded previously. Indeed, fry uptake has declined steadily each year since the first survey of 2013. Despite this, the density of 1+ parr has remained steady at around 0.3/m$^2$. In 2016, both the fry and the 1+ year-classes grew exceptionally well suggesting that the site was not at capacity – and the reasons for this cannot be easily explained. Given the strong growth performance of both the fry and parr, total biomass density was again typical of the site at around 4g/m$^2$. Culvid should be surveyed again in 2017 to check progress.

## Gobernuisgach, Berriedale.



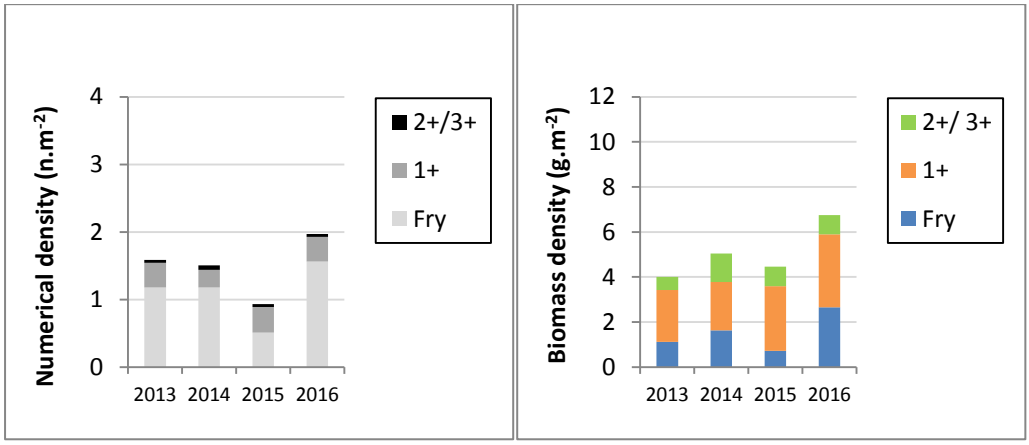
In 2015 the density of fry present at Gobernuisgach was low, probably as a result of poor spawning. As a result of the lack of fry in 2015, few 1+ parr were present in 2016. Given the weak 1+ year-class, the uptake of fry was by far the greatest recorded for the site. Despite their high density, the fry grew extremely well, probably because of low levels of competition from 1+ fish. As a result of the compensatory increases in fry number and their good growth, the total biomass density reached a new high value of 3.5g/m$^2$ despite only a small contribution from the 1+ year-class. The strong year-class of fry in 2016 will result in a strong year-class 1+ fish in 2017 and, presumably, this will inhibit the update of fry in 2017. Gobernuisgach, should be surveyed again in 2017 to learn how sites like this stabilise in the aftermath of a poor fry-year.

## Corrichoich, Langwell



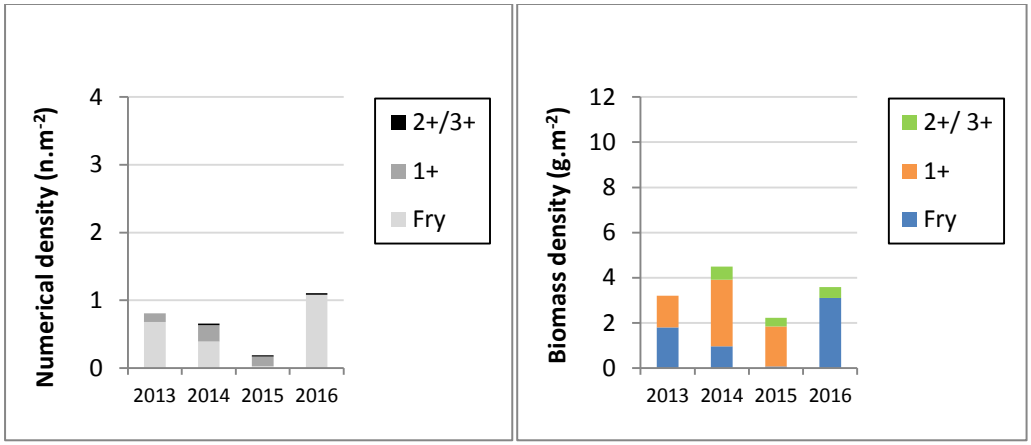

Unlike Gobernuisgach 6km upstream, Corrichoich performed in the expected way in both 2015 and 2016. In 2016, fry uptake was very good and the 1+ parr density was as expected. Growth was good for both year-classes and the combined biomass of the fry and the 1+ parr was greater than previously recorded. Given a weak 2+ year-class, total biomass density was less than in 2015 but fully in line with expectation at around 4g/m$^2$.

## Braemore, Berriedale



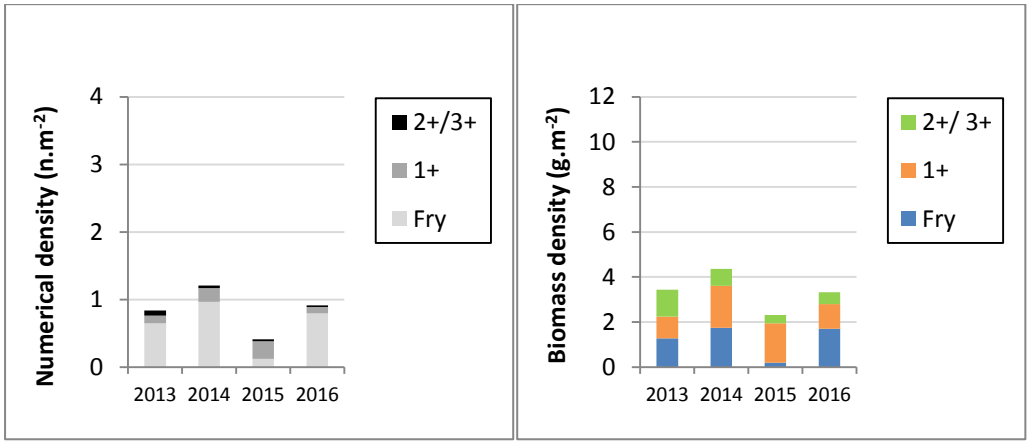

At Braemore, 2015 was a poor fry year as for some other sites in Berriedale/ Langwell. Despite this the density of the 2016 year-class of 1+ parr was about average. Fry uptake in 2016 was greater than previously by around 30%. Both the main age-groups grew strongly and as a result, total biomass density was greater than in any previous year at around 6.7g/m$^2$.

## Wag, Langwell



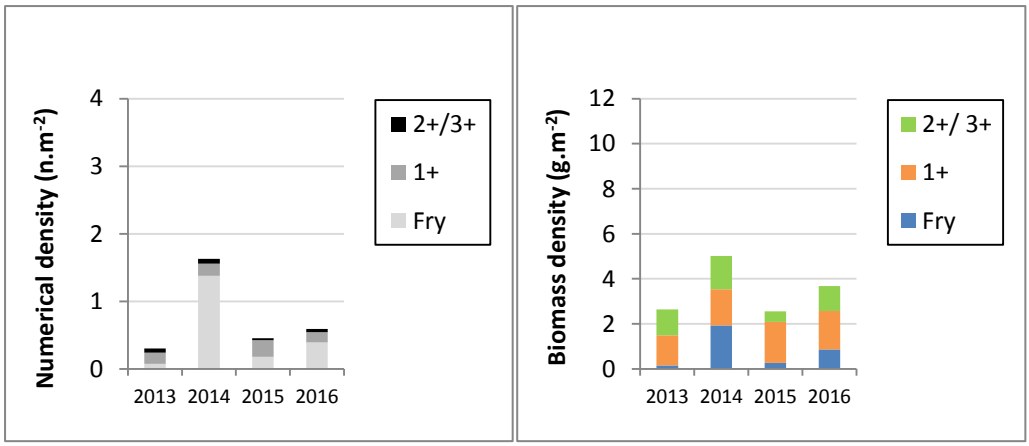

As for Gobernuisgach at the head of the Berriedale, the Wag site at the head of the Langwell suffered a very poor fry year in 2015. As a result, no 1+ parr were present in 2016. As for the case of Gobernuisgach, fry uptake in 2016 was exceptionally high in the absence of a 1+ over-class. The fry also grew very well and as a result total biomass density was still about average despite the lack of any contribution from 1+ fish. Like Gobernuisgach, the Wag site should be surveyed again in 2017 to check its continuing recovery from the low fry-year of 2015.

## Aultibea, Langwell




Aultibea was also affected by poor fry uptake in 2015 and 1+ parr were consequently scarce in 2016. Yet fry uptake was about average for the site. Good growth by the fry and excellent growth by the few 1+ fish resulted in a total biomass density that was about average for the site.

## Coille Braigh, Langwell




Fry uptake at Coille Braigh has usually been low. The site and its surroundings is an extreme habitat for fry and probably for also spawners. The high level of fry uptake in 2014 suggests that the site's potential to hold fry is quite high but that spawning nearby is sparse and/ or sporadic. Fry uptake in 2016 was low but still in line with expectation. Fry and parr growth was excellent and as a result the total biomass density was relatively high at 3.5g/m2.

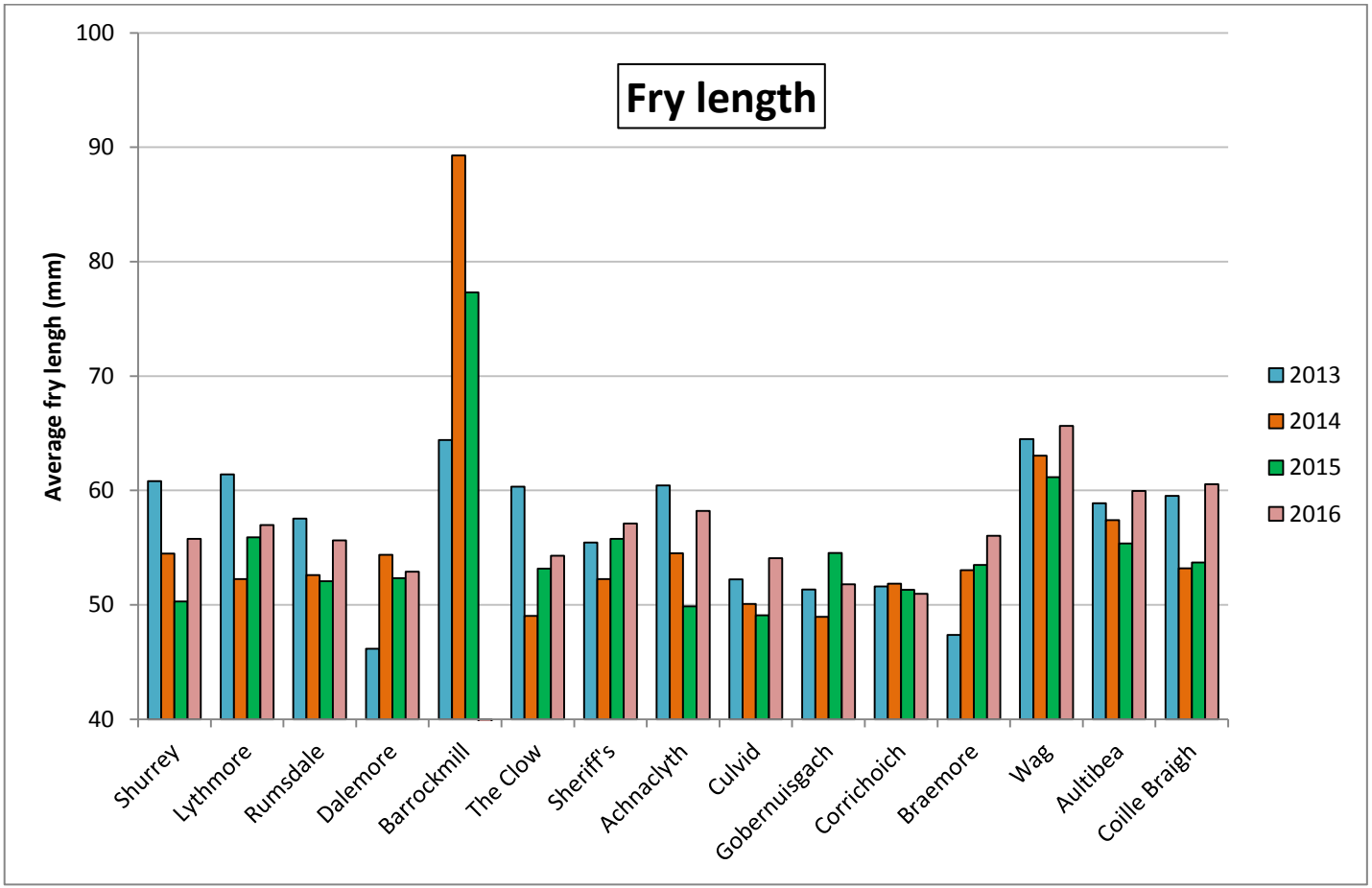
## Summary.

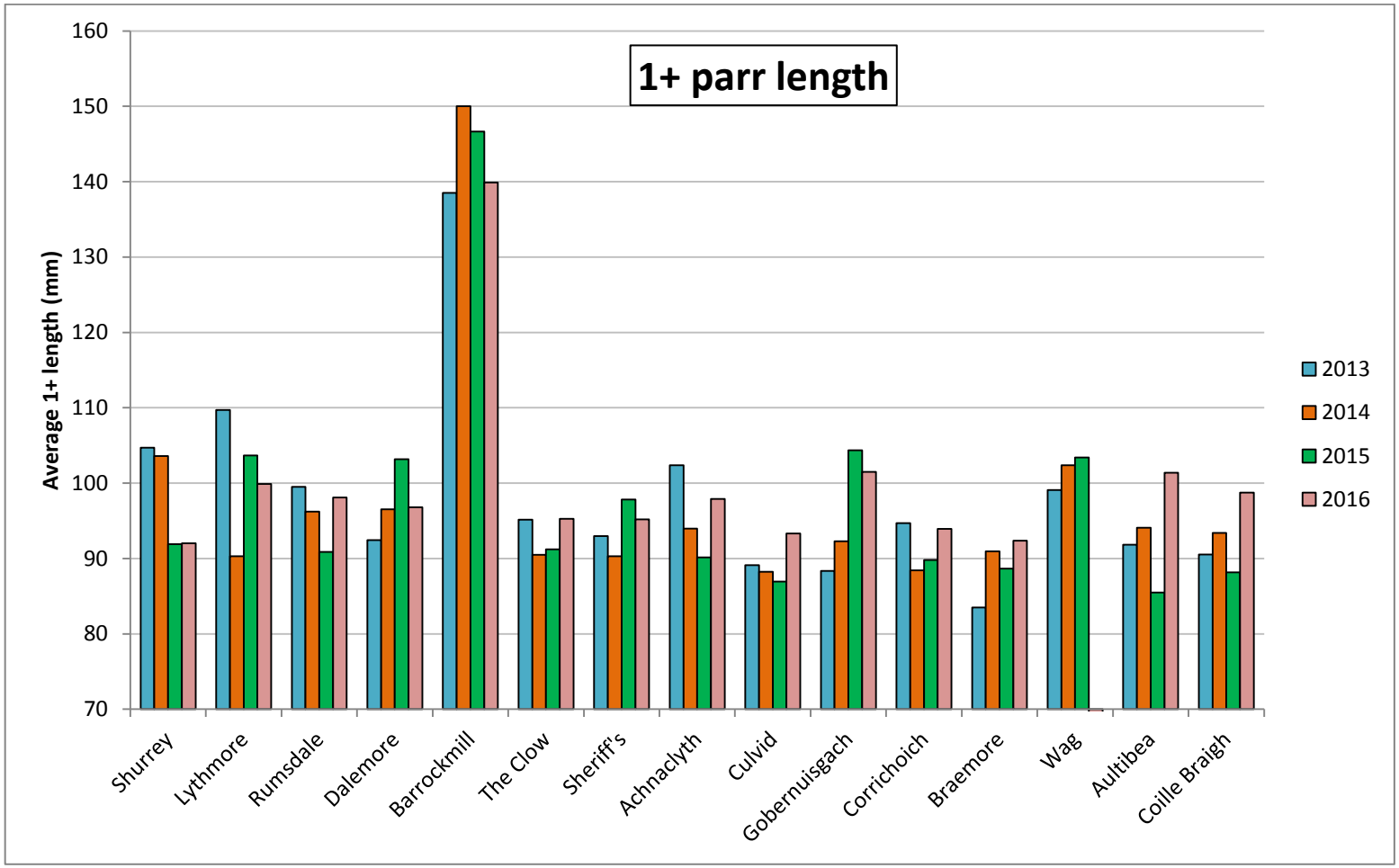
Few issues were raised by the 2016 survey. The poor fry-year that affected parts of Berriedale and Langwell in 2015 was not replicated in 2016. In fact, the most affected sites showed rapid recovery through high uptakes of fry and large biomass densities. The only

low anomalies of note were at Culvid and Shurrery. Comparisons with Achnaclyth and Lythmore, respectively, indicate that both anomalies reflect unexplained one-off events rather than river-wide phenomena. Barrock Mill performed poorly but was consistent with low expectations based on previous years. Otherwise, all the sites performed as well as, or better than, previously suggesting that the Caithness rivers generally continue to be in very good heart.

**Acknowledgements.** The contributions made by the members of the field team are acknowledged. Geordie Doull Jnr, Neil Groat, Jamie McCarthy John Mackay and Pat Quinn all participated at various times. Neil Groat read the scales.

## Appendix: Body length




1+ parr length
Average 1+ length (mm)
160
150
140
130
120
110
100
90
80
70
2013
2014
2015
2016
Shurrey
Lythmore
Rumsdale
Dalemore
Barrockmill
The Clow
Sheriff's
Achnaclyth
Culvid
Gobernuisgach
Corrichoich
Braemore
Wag
Aultibea
Coille Braigh