Dee Stock Assessment Programme
Angler Report 2023

Cyfoeth Naturiol Cymru
Natural Resources Wales

Front cover: 5-min timed electrofishing site on the main River Dee at Corwen

Photos: Floy tagged salmon and VI (Visible Implant) tagged sea trout.

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1. Introduction

This Dee Angler Report report is one of a series produced by Natural Resources Wales (NRW) in recent years. *[For past reports see:*

https://naturalresources.wales/evidence-and-data/research-and-reports/index-river-monitoring-for-salmon-and-sea-trout-on-the-welsh-dee/?lang=en.]

Its main purpose is to provide annual feedback to fishermen and others on findings from the long-term monitoring programme for salmon and sea trout undertaken on the River Dee since the early 1990s.

The report describes the broad aims and objectives of the Dee programme alongside information on key monitoring activities and outputs. The format of the report remains similar year-on-year, but with sections updated to take account of the latest results.

2. The Dee programme

The River Dee is one of very few 'index' monitored rivers for Atlantic salmon and sea trout in Europe or the wider North Atlantic area. It is the only index river in Wales and a Special Area of Conservation for salmon under the EU Habitats Directive.

Index rivers are characterised by their intensive and long-term monitoring programmes collecting unique information on the key life-stages of these important fish species.

Over time, this builds a picture of changes in abundance and biology which helps to improve our understanding of complex population processes and the factors which influence them.

Salmon scale taken for ageing purposes

In turn, this detailed information is used to inform stock assessment and fisheries and environmental management in the widest sense: locally, nationally and internationally. Hence the benefits of this type of intensive monitoring programme are not just confined to the index rivers.

The index river programme on the Dee - or 'Dee Stock Assessment Programme' (DSAP) - began in 1991 with construction of a head-of-tide fish trap at Chester Weir.

This trap is designed to capture and sample upstream migrating adult fish to estimate their total return, as well as provide information on their biology (e.g. size, age, sex, etc.). Further details of the trapping programme are given below.

Other elements of the Dee programme include:

(i) lower river downstream trapping programmes in spring to estimate the abundance and survival of out-migrating smolts;

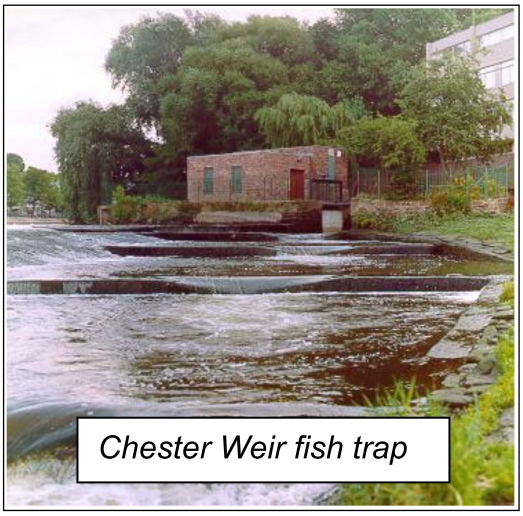
Rotary Screw Trap used to capture smolts on the lower Dee

(ii) extensive (5-minute timed) electrofishing surveys in late summer to monitor the abundance and distribution of juvenile salmon and trout (fry and parr) at 85+ tributary and main river sites.

(iii) circulation (with this report) of a fishing logbook to Dee anglers to collect detailed information on rod catch and fishing effort around the catchment - supplementing the licence-based catch return and fostering support for the Dee programme including the reporting of tagged fish.

3. Trapping and tagging at Chester Weir

Very few rivers have facilities (counters or traps) to estimate the numbers of salmon or sea trout returning each year. Out of more than 60 principal salmon rivers and around 80 principal sea trout rivers in England and Wales (E&W), only 10 currently provide run estimates for salmon (including the Taff, Teifi and Dee in Wales) and just 4 produce the same estimates for sea trout (only the Dee in Wales, although, in recent years, run estimates for larger sea trout have been produced for the Teifi). Among these rivers, four 'index' rivers: Tyne, Frome, Tamar and Dee, also collect biological information from adult fish via trapping or fishery-based sampling programmes (of which the Dee is one of the longest running).



Chester Weir fish trap

Trapping at Chester Weir is carried out throughout the year (January to December) but not continuously. When the trap is not being fished (~50% of the time) it becomes an 'open channel' through which fish can freely pass. For this reason, and because fish are able to cross the weir and bypass the trap in high flows and on big (~9m) tides, the trap is a 'partial' one. Tagging and recapture estimates (below) indicate that, on average, 20-30% of the run is trapped at Chester.

Virtually all salmon and the majority of sea trout captured at Chester Weir are tagged using Floy and VI (Visible Implant) tags, respectively (see photos on inside front cover). In both cases, run estimates require a second catch from which the ratio of tagged to untagged fish can be obtained. For salmon, this relies on anglers reporting the tagged and untagged fish they catch <u>in the same year they were tagged</u>. In the case of sea trout, however, (where, unlike salmon, multiple spawners are common) the second catch takes place back at Chester trap <u>one year after tagging</u>. In both instances, the ratio of tagged to untagged fish in the second catch is used to raise the total number tagged to obtain a run estimate. For example, if 1,000 salmon were tagged at Chester Trap, and 1 in 5 of the salmon caught by anglers were tagged, then it is assumed that 1/5th of the run has been tagged - producing a run estimate at Chester of 5,000 fish.

This tagging and recapture method means that run estimates for salmon and sea trout can be obtained from a partial trapping programme; i.e. they do not require trapping to be carried out all the time and do not depend on a constant trapping efficiency (as the latter can be estimated from tagging).

<u>A £10 reward is offered to encourage anglers to report any tagged salmon they catch. This reward is increased to £20 for anglers who returned a logbook in the previous season.</u> The reason for this is that records of tagged and untagged salmon submitted by logbook anglers are considered the most reliable - simply because of the diligence required to maintain a detailed record of each fishing visit. Hence, only the catch and recapture details from logbook anglers are used to generate salmon run estimates.

The run of salmon entering the Dee after the end of the angling season (on average around 5% or less of the total) is derived from the trap catch and an estimate of trap efficiency from the in-season period.

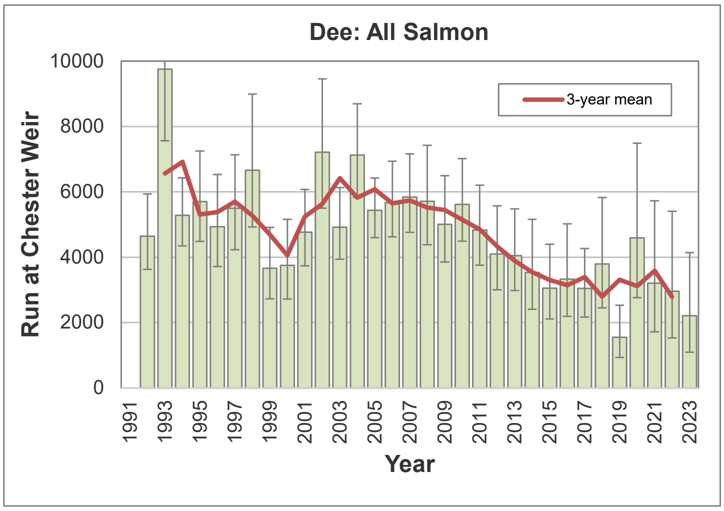
4. Dee salmon in 2023

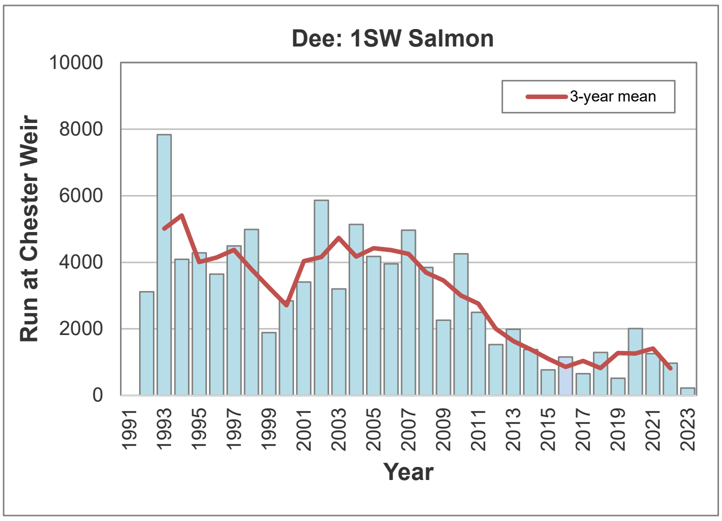
Run size and composition: Provisional results indicate a run of 2,209 salmon (fish of all sea ages) at Chester in 2023. This was the second lowest in the ~30-year time-series; the lowest return – 1,551 fish - was recorded in 2019, with the third and fourth lowest – 2,956 and 3,043 fish – recorded in 2022 and 2017 (Fig 1). The corresponding trap catch in 2023 was 324 salmon.

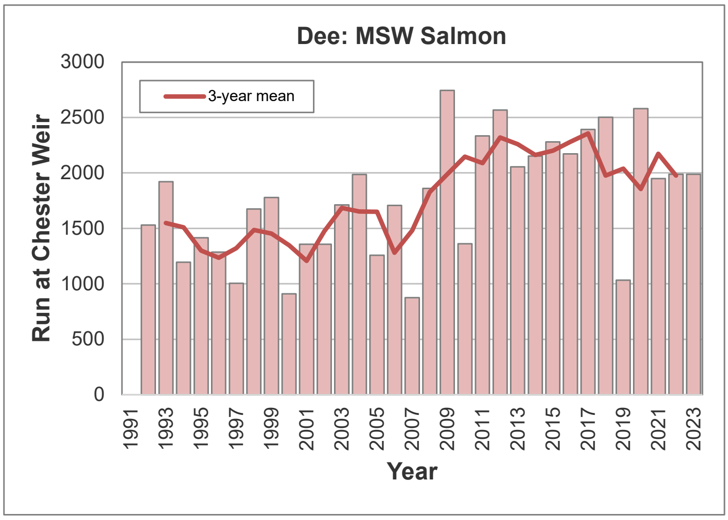
Multi-sea winter (MSW) fish continue to dominate the salmon run on the Dee comprising 90% of the total in 2023 – the highest percentage to date. In contrast, less than 20 years ago, grilse (or 1SW fish) made up 70-80% of a larger return.

The Dee is not alone in experiencing a recent marked reduction in the overall abundance of returning salmon linked to a decline in grilse numbers. For example, the same pattern of decline is also evident on most index/counted rivers in E&W. Provisional results for 2023 indicate that salmon counts on many of these rivers were at or close to the lowest recorded.

Fig. 1 Annual run estimates for salmon at Chester Weir, 1992-2023
(error bars indicate 95% confidence intervals)







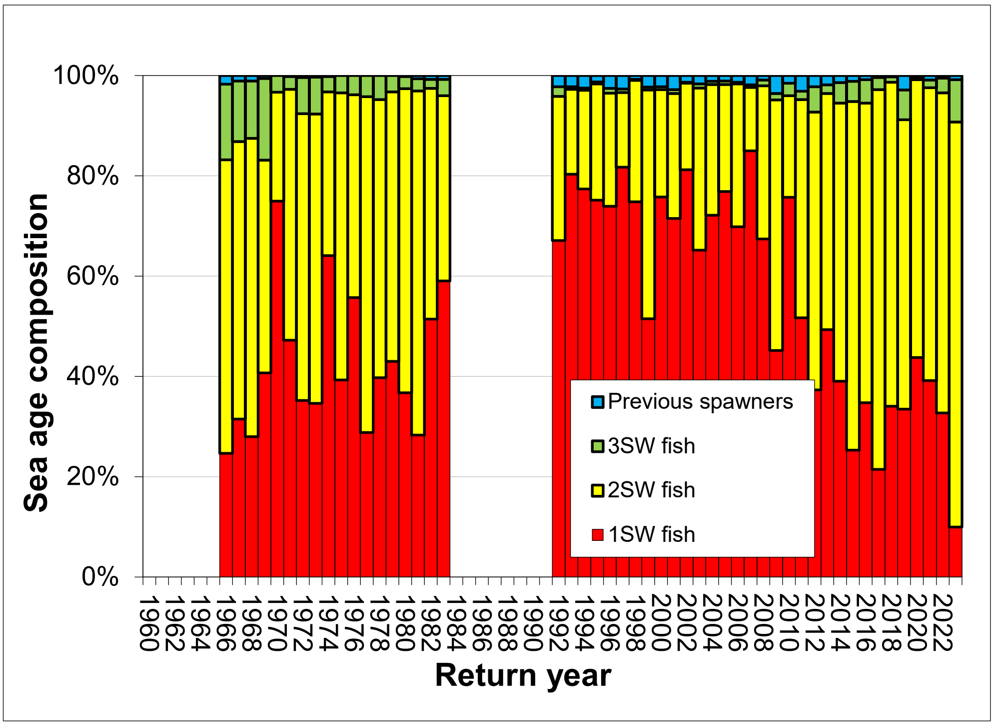
Data from the Dee indicate that changes in the sea age composition of returning salmon may be part of a cyclical pattern - with the contribution of 1SW salmon in the last few years appearing similar to that 50 years ago when close to 80% of the return was made up of MSW fish (Fig 2).

Long-term cyclical changes in abundance of grilse and multi-sea winter salmon, evident from historic data sets, have been linked to similar cyclical processes affecting environmental conditions in the North Atlantic.

While it is possible we may be experiencing the trough of such a cycle now, and that a reversal of this pattern might be expected at some point in the future, there is no certainty when or if this will happen. Factors such as global warming - not so evident or potentially damaging 50 years ago - may also be at play.

Hence, the precautionary management response is to seek to protect vulnerable stocks and their environment now so they are best placed to respond to the return of more favourable conditions in the future.

Fig. 2 Sea age composition of salmon on the Dee, 1960-2023



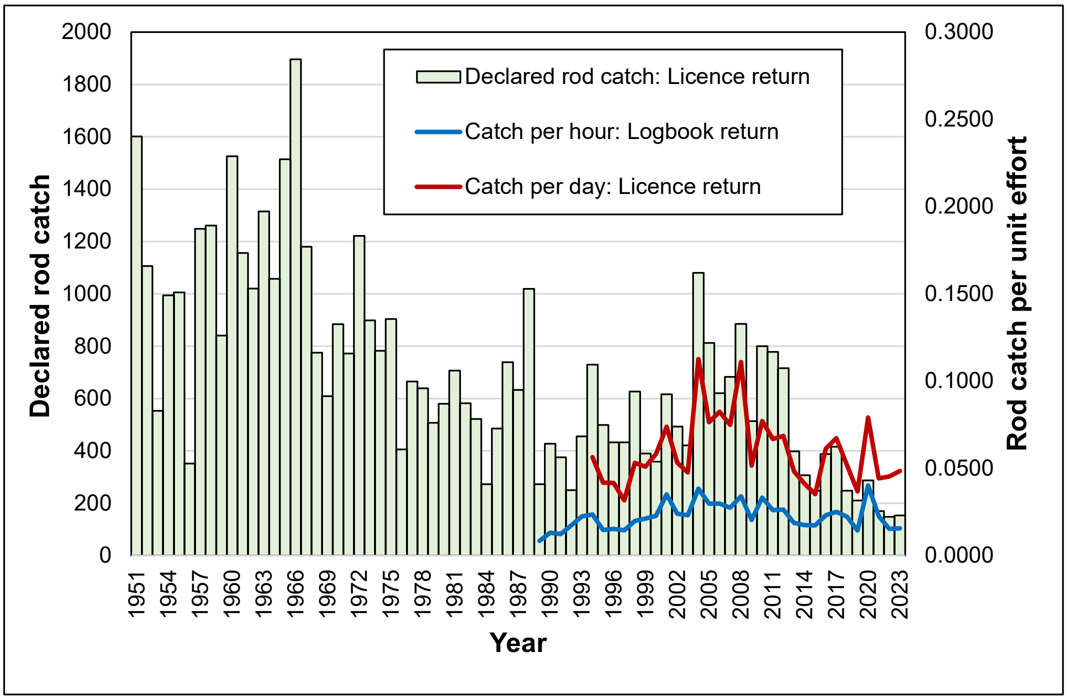
Rod catch: Provisional licence return data indicate a declared rod catch on the Dee of 153 salmon in 2023. This is the second lowest catch in records going back to 1951 – the lowest declared catch was reported in 2022 at 148 salmon (Fig 3).

A single national rod licence and catch return-reminder system was introduced in E&W in 1992, but has operated in its current (broadly unchanged) format since 1994. Prior to that, licences were issued regionally and (from the mid-1980s onward) many incorporated catch return-reminder systems similar to the current system.

Uniquely among many jurisdictions, the current rod licencing system in E&W collects fishing effort as well catch data. While this is a fairly coarse measure of effort – recording 'angler days' fished over the whole season for each river visited, for the Dee at least, the 'catch per day' statistics produced show a similar pattern to the more refined 'catch per hour' data generated by logbook returns. Both these measures of 'catch per unit effort' are also strongly aligned to the rod catch data alone (Fig 3) as well as to estimates of salmon returns at Chester Weir. The fishing effort data generated by the national rod licence system serves as a key variable in modelling angling exploitation rates (i.e. the proportion of the annual run caught by rod fishermen) on the non-counted rivers – a pre-requisite to deriving run estimates from catches for stock assessment purposes.

For the Dee, the angling exploitation rate estimated for salmon in 2023 (i.e. the proportion of the annual run caught by rod fishermen) was 7.6%, an increase on the all-time low rate of 5.5% estimated in 2022 and closer to the previous 10-year average rate of 9.9%.

Fig. 3 Dee salmon rod catch and catch per unit effort, 1951 onward



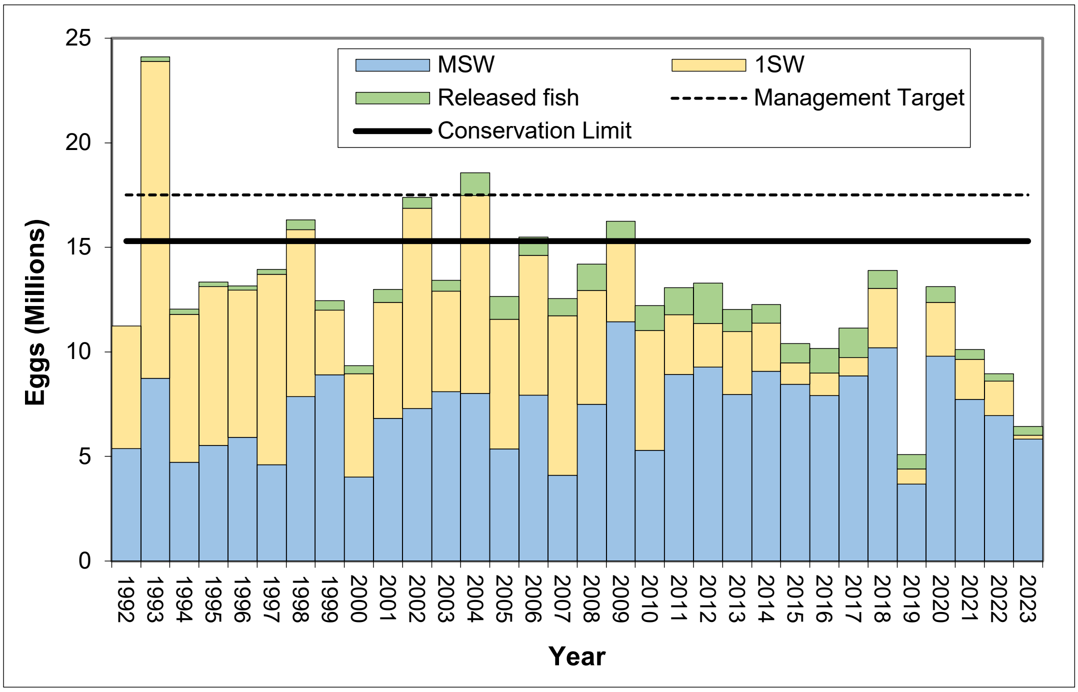
Spawning escapement: Estimates of the numbers of spawning salmon and the eggs they deposit are based on the run at Chester Weir minus losses to the rod fishery and other sources of mortality. Estimates also take account of the sex ratio of returning fish sampled at Chester (as judged from external appearance) and their average size (which relates to their likely egg contribution).

The provisional estimate of egg deposition on the Dee in 2023 is 6.43 million eggs - produced by ~2,000 spawners. Of these, ~135 spawners were estimated to have been rod-released fish contributing 0.43 million eggs. Egg deposition estimates for Dee salmon last met the Conservation Limit (15.3 million eggs) in 2009 (Fig 4).

The ‘Management Objective’ for all salmon rivers in Wales (and England) is that stocks should meet or exceed their Conservation Limit 80% of the time, or 4 years out of 5, in the long term.

To assess whether this Management Objective is being met, a trend based statistical compliance procedure is applied to egg deposition estimates from the last 10 years. This procedure tests whether a stock is formally passing (‘not at risk’) or failing (‘at risk’) its Conservation Limit, or has some intermediate status (‘probably not at risk’ or ‘probably at risk’). On this basis, ‘risk’ status is usually reported for the current year and (based on an extrapolation of the trend line) 5-years into the future.

Fig. 4 Salmon egg deposition 1992-2023



The Management Target (~17 million eggs) provides an indication of the average number of spawners required (expressed as eggs or adults) to ensure compliance with the Management Objective.

The Management Target is a 'target' reference point (i.e. something to 'aim at') whereas the Conservation Limit is a 'limit' reference point (a lower threshold below which stocks become increasingly vulnerable and which we want to avoid). Statistical compliance procedures ensure there is a high probability (i.e. the 4 years out of 5 rule) that stocks classified as healthy are indeed above their Conservation Limit.

This terminology and the associated assessment procedures - in place in E&W since the early 1990s - are in line with the now long-standing recommendations of ICES (International Council for the Exploration of the Sea) and NASCO (North Atlantic Salmon Conservation Organisation). Conservation Limits are applied in a similar way by other jurisdictions (e.g. in Ireland and Scotland), with similar management consequences for failing stocks.

Results from Conservation Limit compliance assessment in Wales in 2022 indicated that all river stocks of salmon were 'at risk' or 'probably at risk' – both in the current year and projected 5-years into the future, with most stocks exhibiting a declining trend over the last decade (most salmon stocks in England were classified as similarly poor). The salmon stock on the Dee was assessed as being 'at risk' both in 2022 and projected to 2027. Provisional results from the latest assessment indicate that stock status remains very poor on most rivers in E&W and unchanged on the Dee (i.e. 'at risk' both in 2023 and projected to 2028).

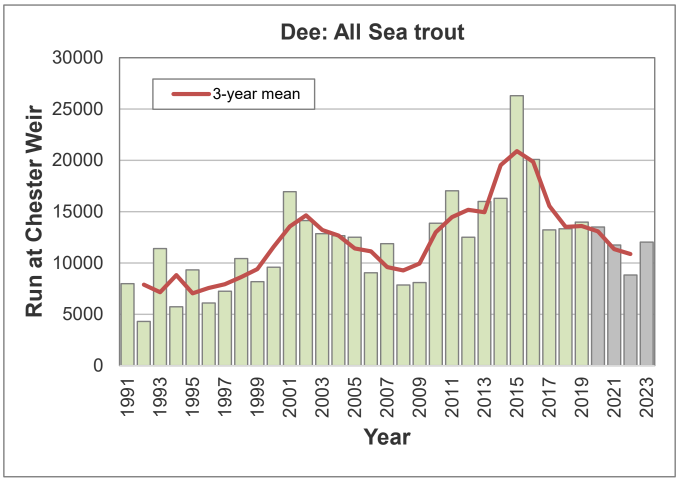
5. Dee sea trout in 2023

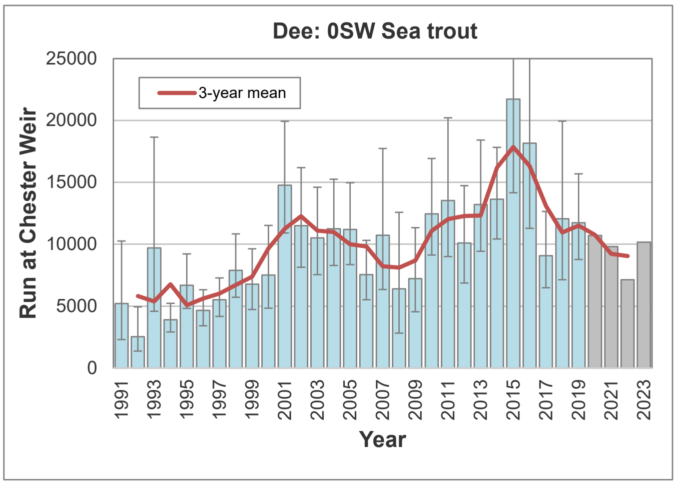
Run size and composition: As described in Section 3, run estimates for sea trout on the Dee are based on the recapture of fish back at Chester trap in the year after tagging - and so are 12 months behind those of salmon.

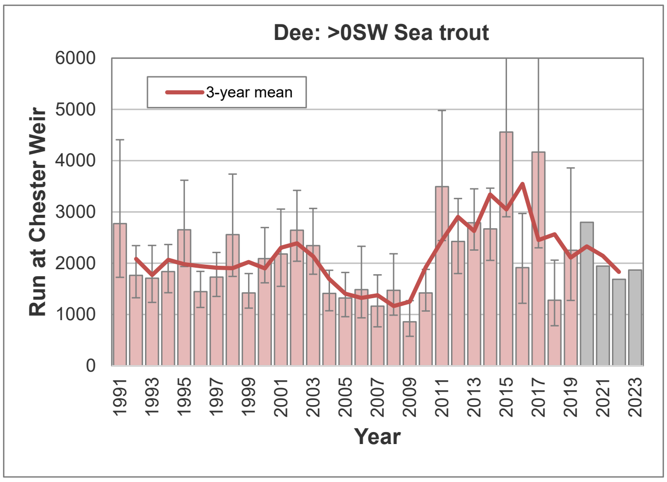
Separate run estimates are obtained for whitling (0SW) sea trout (i.e. fish which spend only a few months at sea and weigh around 1lb or less on their return) and older (>0SW) fish. In 2019, the run estimates for whitling and older sea trout were 11,738 and 2,253, respectively – both above the long-term average returns of ~9,800 and 2,100 fish, respectively (Fig 5).

Run estimates for sea trout for the years 2020-2023 remain provisional subject to QA of scale readings (and in the case of 2023, recaptures at Chester trap in 2024). These estimates continue the downward trend in the sea trout return evident since ~2015, although an estimated total return of ~12,000 fish in 2023 was the best since 2020 (~13,500).

Fig. 5 Annual run estimates for sea trout at Chester Weir, 1991-2023
(error bars indicate 95% confidence intervals)

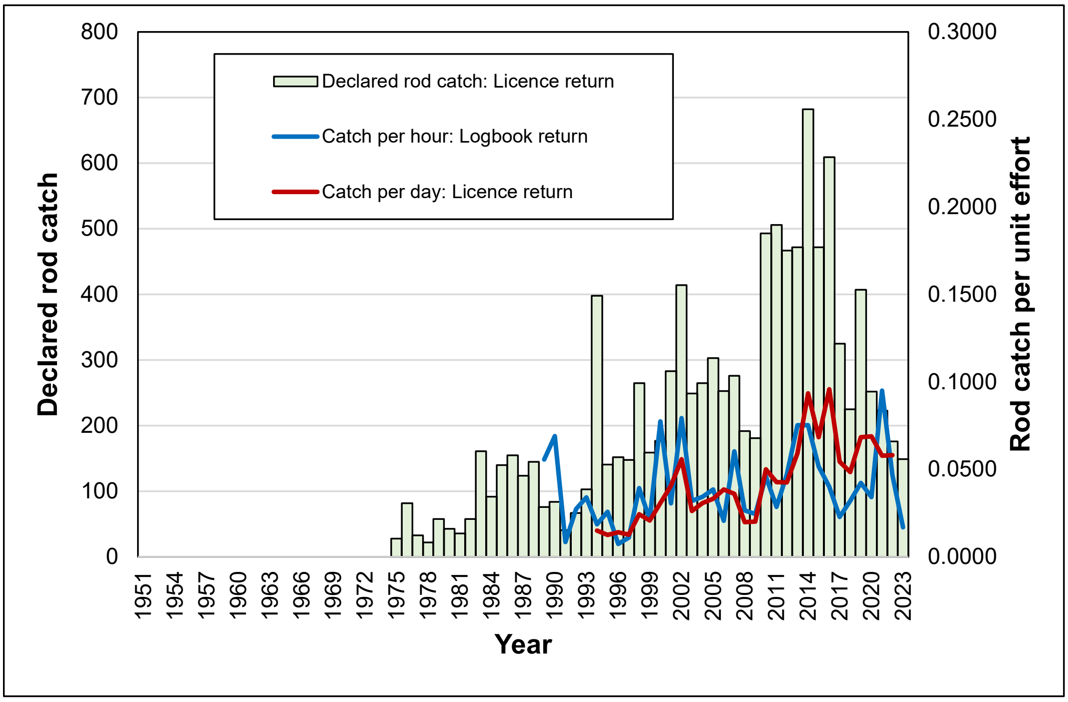






Rod catch: Provisional licence return data indicate a rod catch on the Dee of 149 sea trout in 2023. As with salmon (Fig 3), declared rod catches of sea trout on the Dee are shown from 1951 onwards in Fig 6. The absence of catches pre-1975 reflects the absence records in the early part of the time-series. Like salmon, measures of catch per unit effort from licence returns (catch per day) and logbook returns (catch per hour) are strongly correlated with each other and with catch and run figures (Fig 6).

Fig. 6 Dee sea trout rod catch and catch per unit effort, 1951 onward

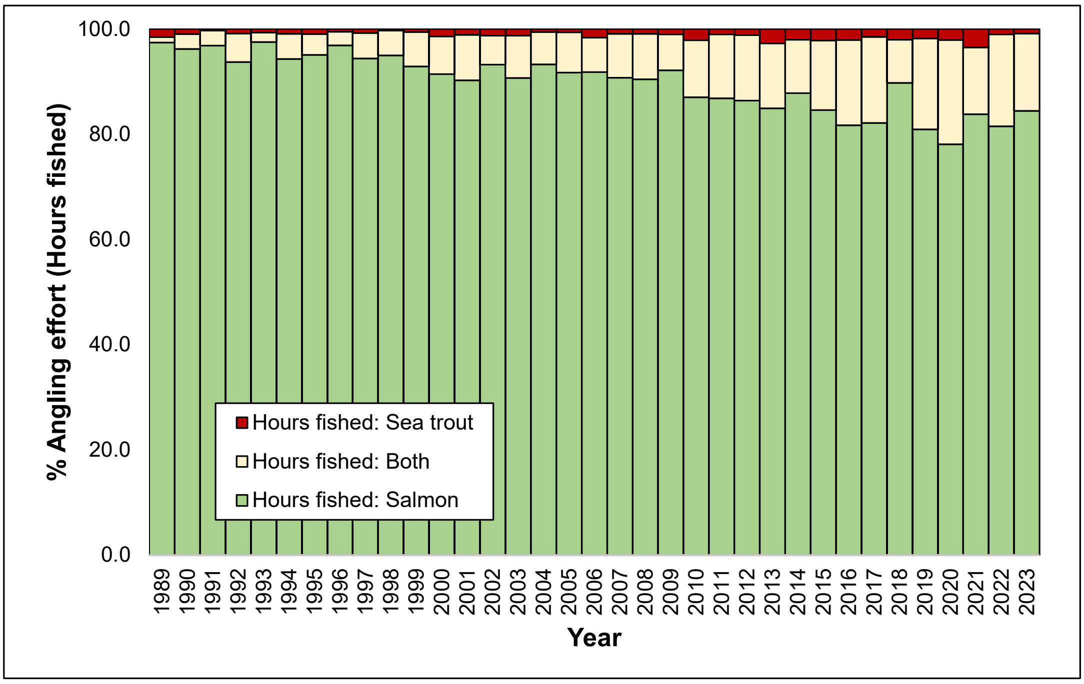


In general terms, the sea trout rod catch on the Dee has been increasing over most of the last ~50 years, averaging less than 100 fish up to the mid-1980s and peaking at 682 fish in 2014. Since then, however, catches have declined sharply. In 2013, the declared catch of sea trout on the Dee (472) exceeded the salmon catch (398) for the first time, and this has been the case in 6 of the 10 years since.

Despite this increase in the sea trout rod catch (in absolute terms and as a proportion of the combined catch of both species), the percentage of total logbook angling effort directed specifically at sea trout has remained low at less than 5%, although the percentage of effort classed as targeting both salmon and sea trout at the same time has grown (Fig 7).

Of the sea trout caught by logbook anglers, most (on average) have been taken by anglers targeting either salmon only (~40%) or both species at the same time (~40%). However, in terms of catch per unit effort, the highest catch rates for sea trout tend to be recorded by those who target sea trout only. For example, recent 10-year average catch rates for sea trout were 11.9, 3.6 and 0.6 fish per 100 hours for those targeting sea trout only, both species, or salmon only, respectively.

Fig. 7 Percentage of fishing effort directed at salmon, sea trout or both species: from Dee Angler Logbook returns, 1989-2023



A new method was introduced in 2017 to evaluate the status of sea trout stocks in Wales, including on the Dee. This derives Conservation Limits for individual river stocks and assesses compliance using approaches similar or identical to those used in salmon; for further details see:

https://naturalresourceswales.gov.uk/guidance-and-advice/business-sectors/fisheries/salmon-and-sea-trout-stocks-in-wales/?lang=en

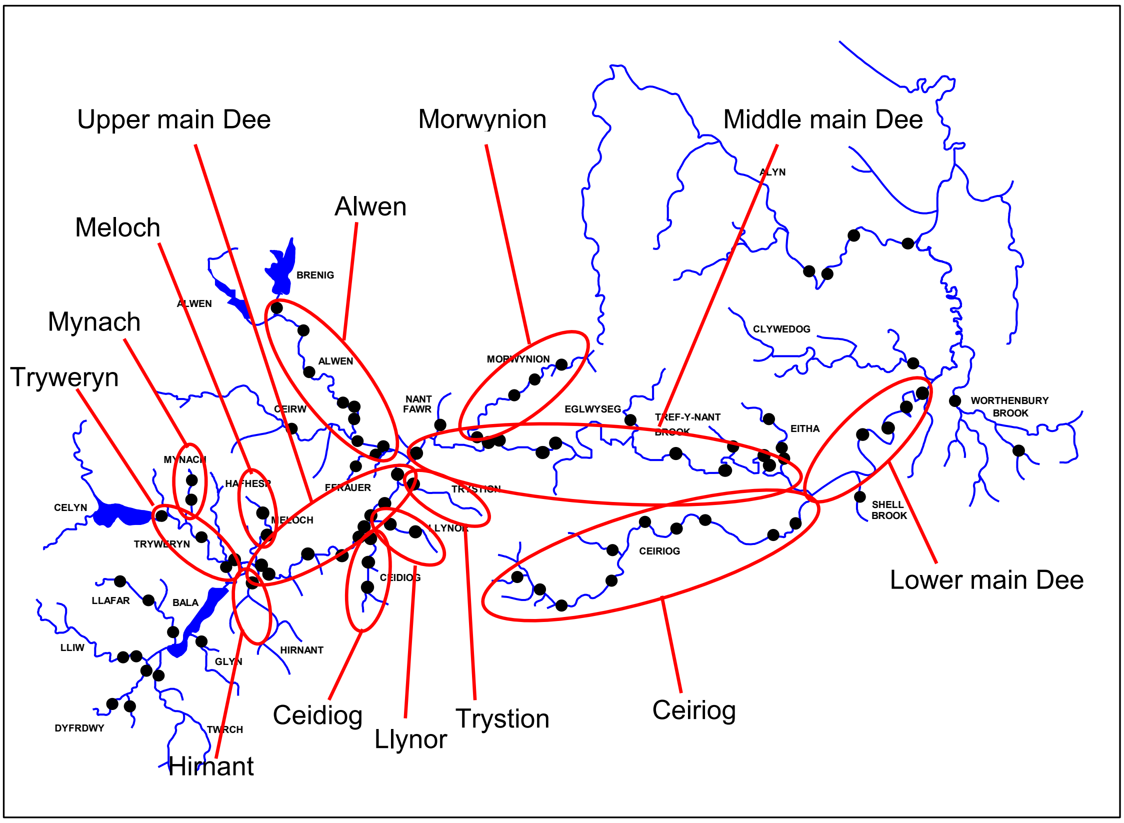
Using these approaches the Dee sea trout stock was classified as 'at risk' both in 2022 and projected to 2027.

6. Electrofishing surveys for juvenile salmon and trout

Extensive late summer electrofishing surveys for juvenile salmon and trout (fry and parr) have been carried out annually as part of the Dee programme since the early 1990s. These surveys involve timed (5-minute) sampling of shallow reach sites dominated by riffle and run habitats and generally favoured by salmon fry (but also containing both species/life stages). Sites (85+) are spread throughout the Dee catchment (Fig 8) and involve bank-to-bank sampling on smaller streams as well as partial sampling of wider channels on the main Dee or larger tributaries (e.g. Alwen and Tryweryn).

Survey results are summarised in Fig 9a-d below for some of the most productive tributaries and sections of the main Dee. The faint individual points (and error bars) in these plots represent yearly average salmon and trout fry abundances expressed as counts per 100m2. These averages are derived from all sites sampled in a tributary or main river reach – this includes single sites on the smaller tributaries Hirnant and Trystion, up to 8 or 9 sites on the larger tributaries Alwen and Ceiriog and on the middle and upper main Dee.

Fig. 8 Dee timed (5-minute) electrofishing survey sites: main salmon producing reaches indicated



To help explore common patterns in these data, 3-year rolling means have been calculated for each tributary and main river reach and are shown as the bold coloured lines in Fig 9a-d below.

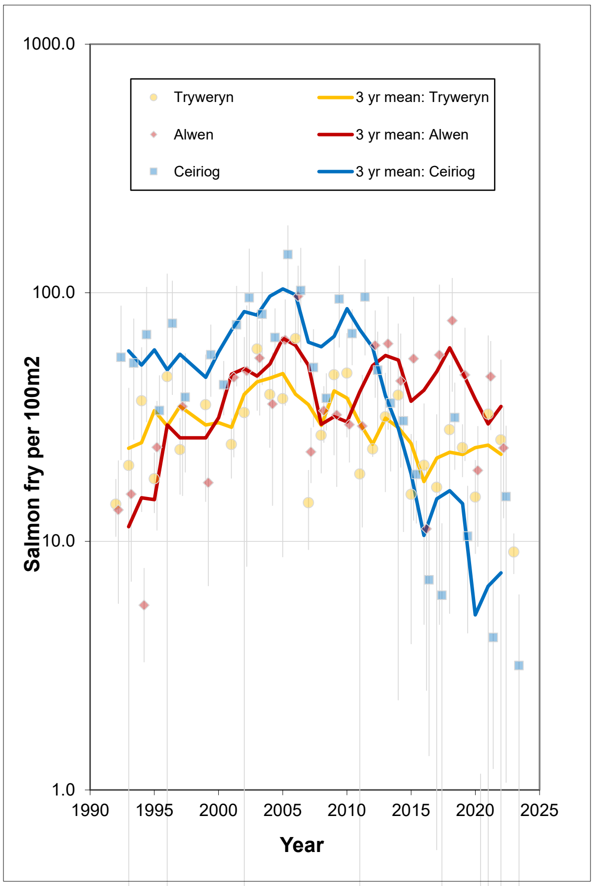
While there is clearly a good deal variation in the abundances of salmon and trout fry among the tributaries and main river reaches of the Dee, it appears there are also some common patterns.

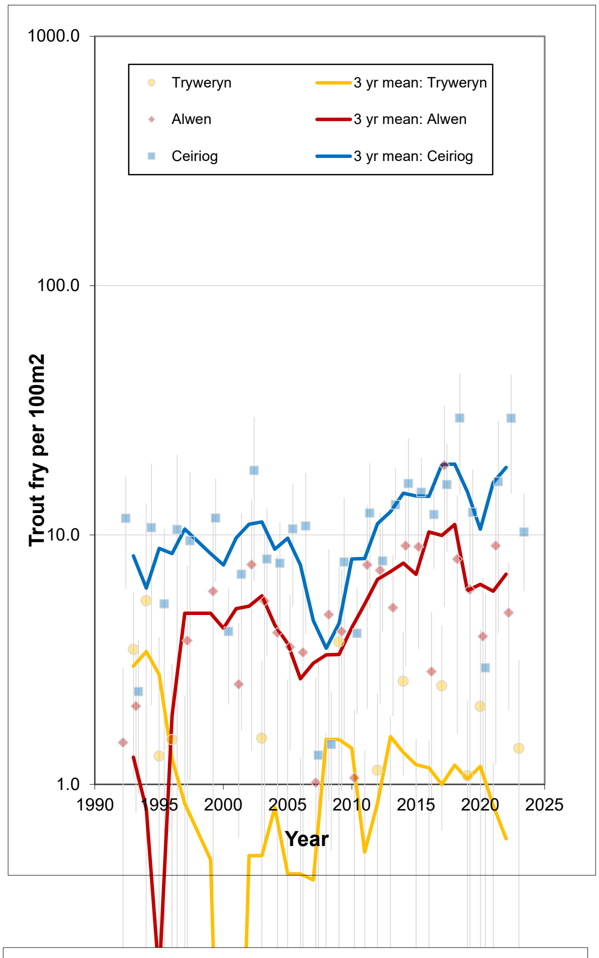
For example, in several cases salmon fry numbers have declined markedly in the last 10-15 years. The most stark example of this is probably the Ceiriog, which was one of the most productive tributaries for salmon on the Dee, but has seen average fry densities fall from counts of ~100 fry per 100m2 in the mid-2000s down to less than 10 fry per 100 m2 in recent years. Similarly marked declines in salmon fry numbers also appear to have occurred on the Meloch and Lower main Dee.

Elsewhere, declines in salmon fry numbers appear more gradual, e.g. Tryweryn, Mynach and Hirnant, or numbers have remained relatively stable (e.g. Alwen, Ceidiog and middle main Dee), or are showing signs of recent recovery (Llynor, Trystion, Morwynion and upper main Dee).

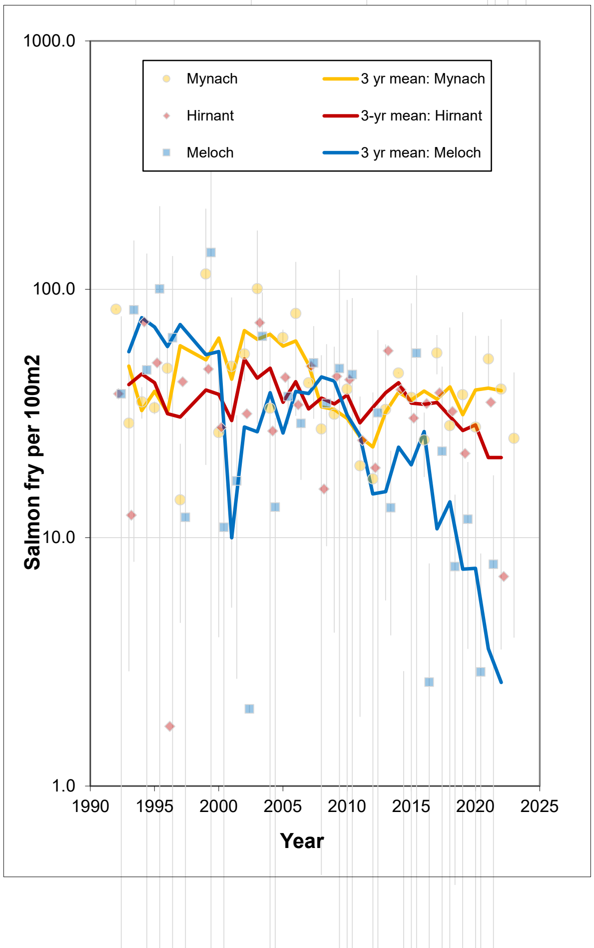
Fig. 9 Abundance estimates for salmon and trout fry (left and right-hand plots, respectively) from 5-min timed electrofishing surveys on the tributaries and main river reaches of the River Dee, 1992-2023

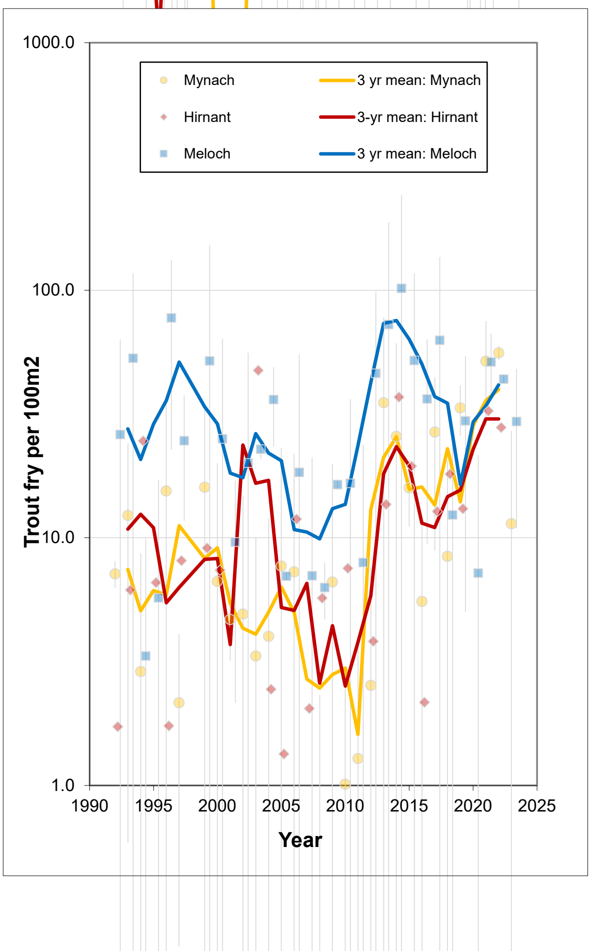
a. Tryweryn, Alwen and Ceiriog:



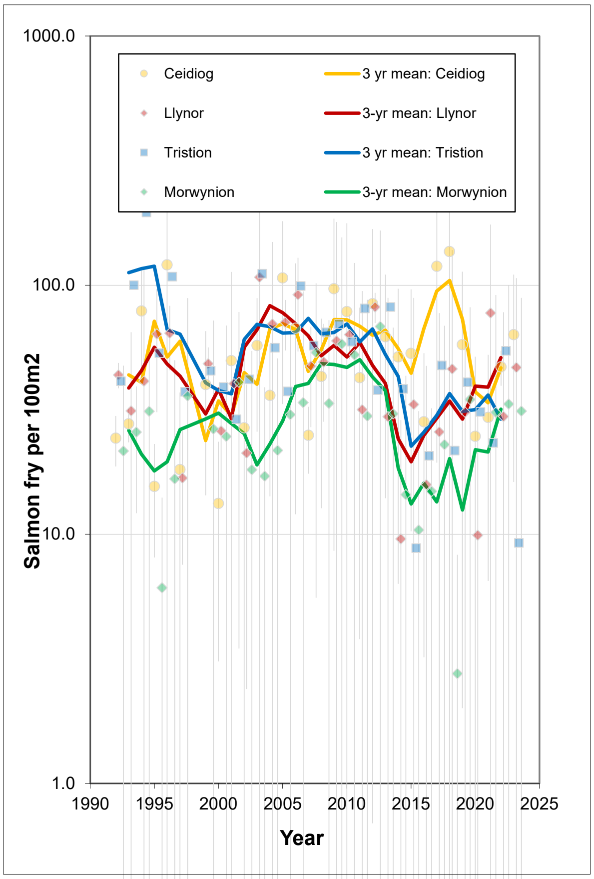


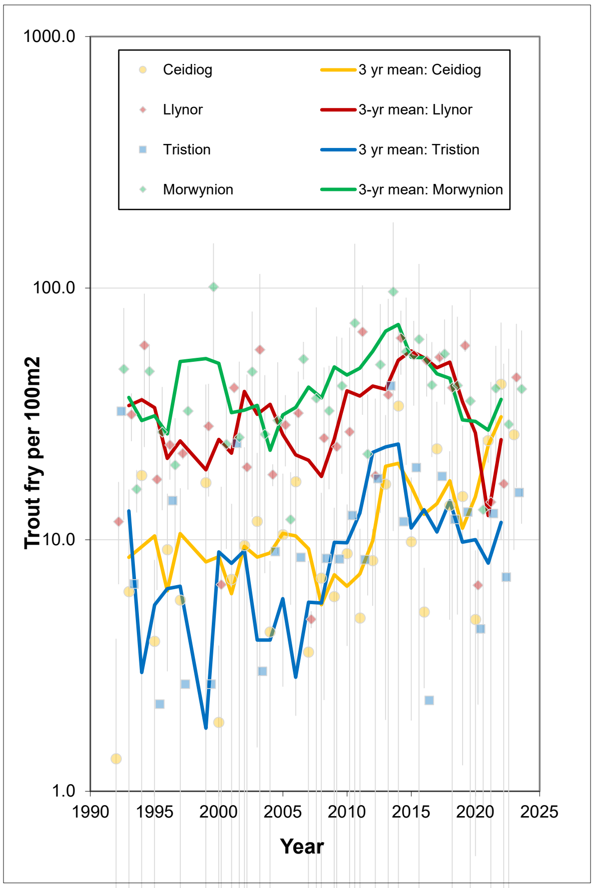
b. Mynach, Hirant, Meloch:



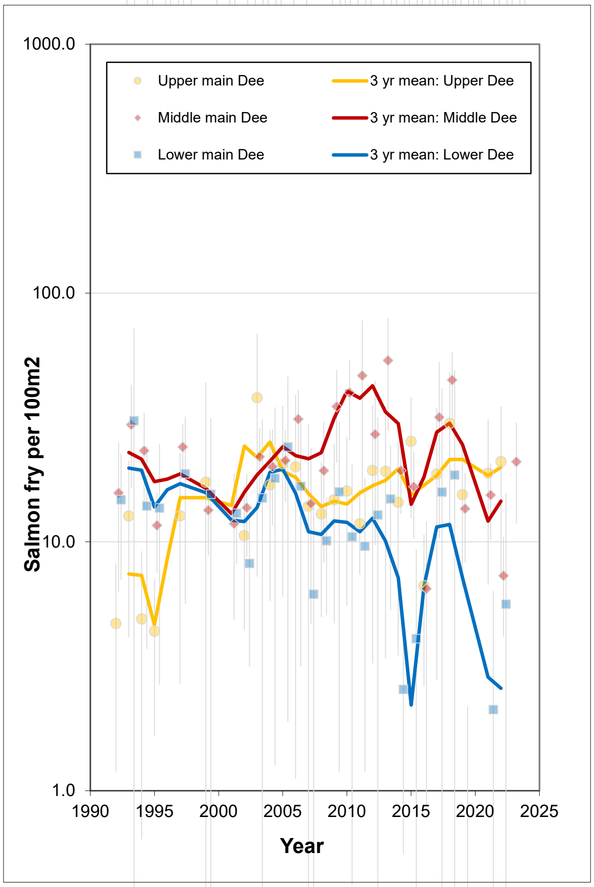


c. Ceidiog, Llynor, Trystion, Morwynion:





d. Main River Dee (salmon only):



Salmon and trout fry sampled by electrofishing

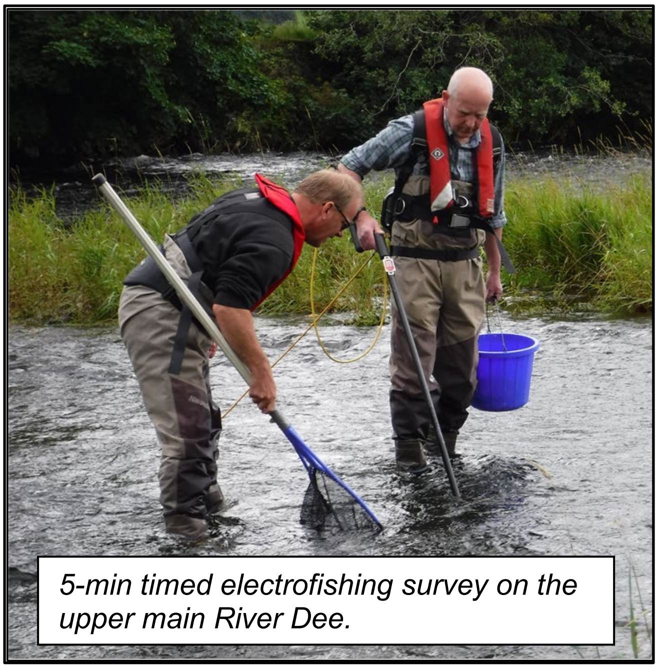
A general decline in juvenile salmon numbers might be expected given the fall in adult returns, but the effect may differ between systems depending on how reliant those systems have been (or continue to be) on the contributions of 1SW and MSW spawners.

For example, as discussed in the 2019 Dee Angler Report, evidence from salmon tracking studies on the Dee in the 1990s suggested that late running grilse – the component of the stock which has all but disappeared on the Dee (and other rivers) in recent years - had a greater tendency than other sea age groups to spawn in the lower catchment. This factor may be an important consideration in helping to explain the marked decline in juvenile salmon numbers on the Ceiriog and lower main Dee.

For trout fry the picture in the latter half of the time-series appears far more positive and in marked contrast to the pattern seen in salmon. For example, on many tributaries, including on the Ceiriog and Meloch, fry densities have been recorded at their highest ever average levels in the last 15 years or so (although a number systems have also shown recent declines).

As with salmon, these patterns appear to mirror to some degree the returns of adult sea trout to the Dee – an obvious biological link that requires further exploration. This suggests that spawning levels rather than environmental conditions in these river systems have probably been the main influence on the observed patterns in juvenile numbers (salmon or trout).

That said, high quality riverine environments are essential if salmon and trout populations are to thrive. Conditions can change rapidly and in unpredictable ways - the well documented and widespread (e.g. E&W) crash in juvenile salmonid recruitment in 2016 linked to extreme winter weather events is a prime example of this. Hence the focus on the Dee (e.g. through the LIFEDee project) and elsewhere on protecting and improving river quality in the face of climate change and other man-made pressures.



5-min timed electrofishing survey on the upper main River Dee.