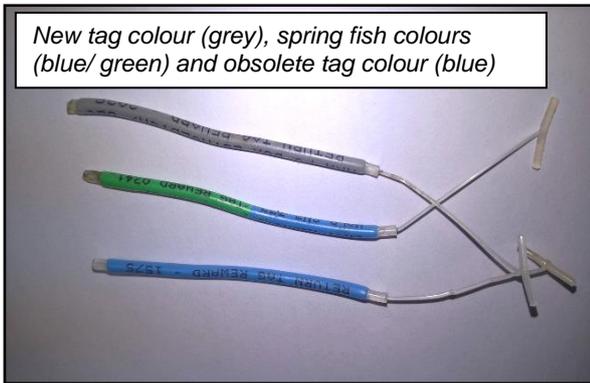
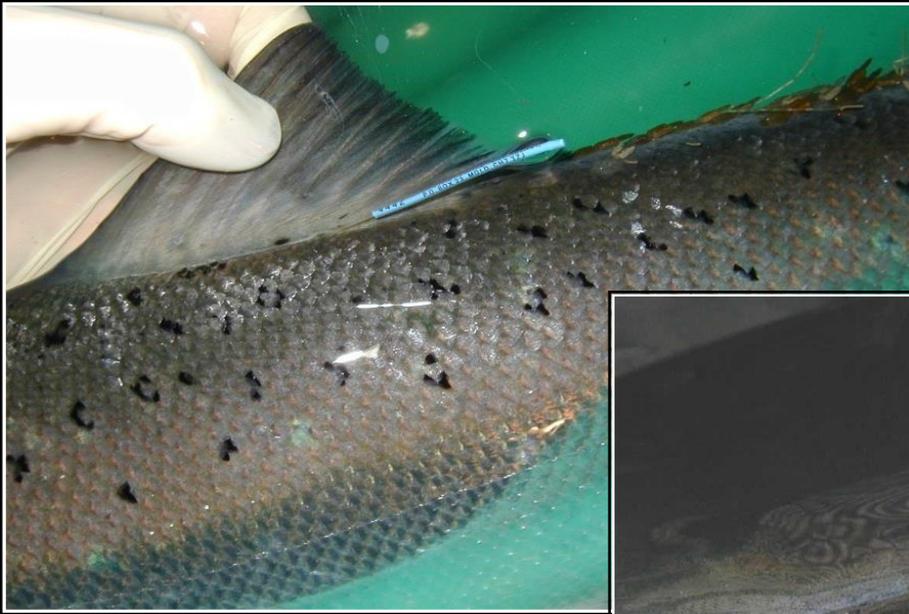


DEE STOCK ASSESSMENT PROGRAMME ANGLER REPORT 2021



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Front cover: Upstream view of the interior of Chester fish trap.



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

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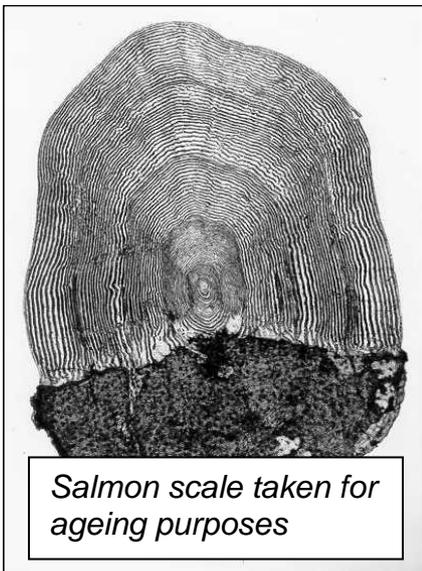
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1. Introduction

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 the abundance and biological characteristics of fish stocks in order to improve 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: local, national and international. Hence the benefits 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 and 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;
- (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.

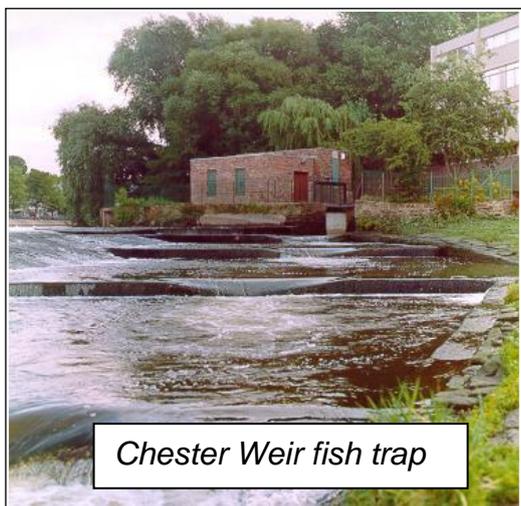


Salmon and trout fry sampled by electrofishing

The purpose of this report is to provide provisional findings on aspects of the Dee programme and related work for 2021. It is one of a series of annual reports on the Dee programme produced by Natural Resources Wales (NRW) and predecessor bodies.

2. 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 12 currently provide run estimates for salmon (including the Taff, Teifi and Dee in Wales) and just 5 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, five 'index' rivers: Tyne, Frome, Tamar, Dee and Lune, also collect biological information from adult fish via trapping or fishery-based sampling programmes (of which the Dee is one of the longest running).



Trapping at Chester Weir is carried out throughout the year (Jan-Dec) 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 in the same year they were tagged. In the case of sea trout, however, (where, unlike salmon, multiple spawners are common) the second catch takes place back at Chester Weir trap one year after tagging. 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.

The 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).

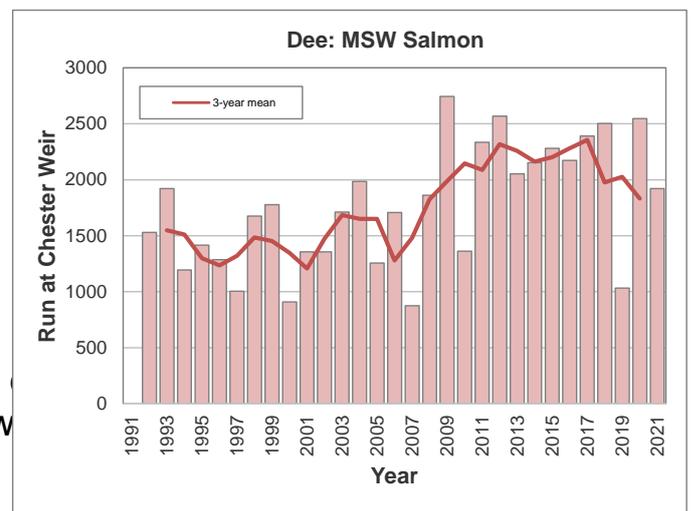
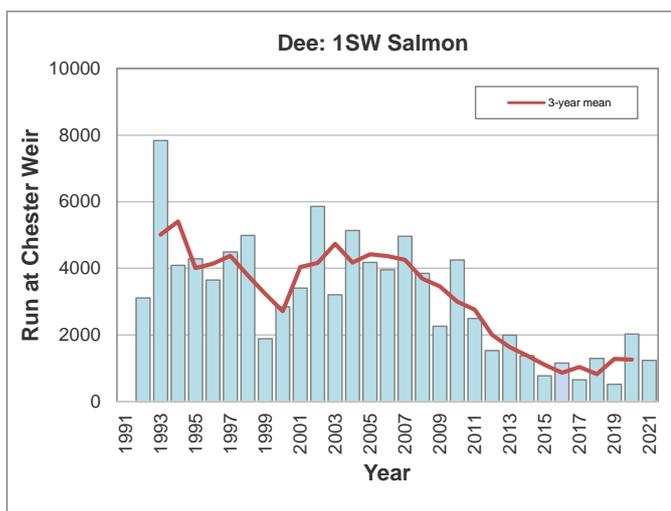
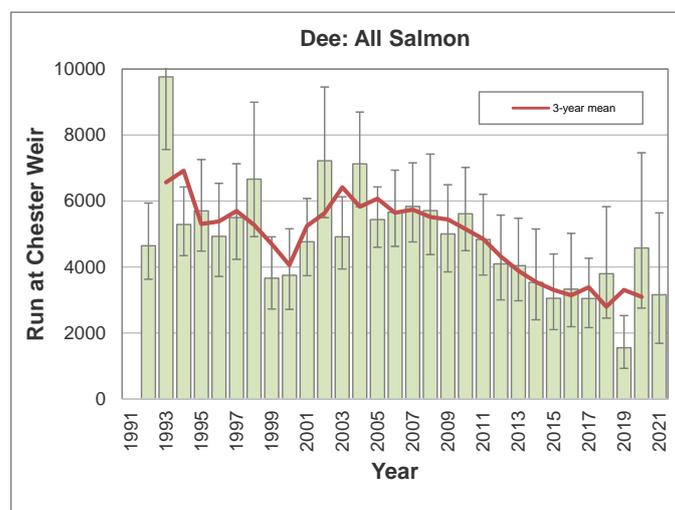
A £10 cash reward (increased from £7 in 2020) is offered to encourage anglers to report any tagged salmon they catch. This reward is increased to £20 (from £14 in 2020) for anglers who returned a logbook in the previous season. The reason for this is that records of tagged and untagged salmon submitted 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.

3. Dee salmon in 2021

Run size and composition: Provisional results indicate a run of 3,158 salmon (fish of all sea ages) at Chester in 2021. This was the fourth lowest return in the 30-year time-series; the lowest return – 1,551 fish - was recorded in 2019, with the second and third lowest – 3,043 and 3,051 fish – recorded in 2017 and 2015 (Fig 1). The corresponding trap catch in 2021 was 513 salmon.

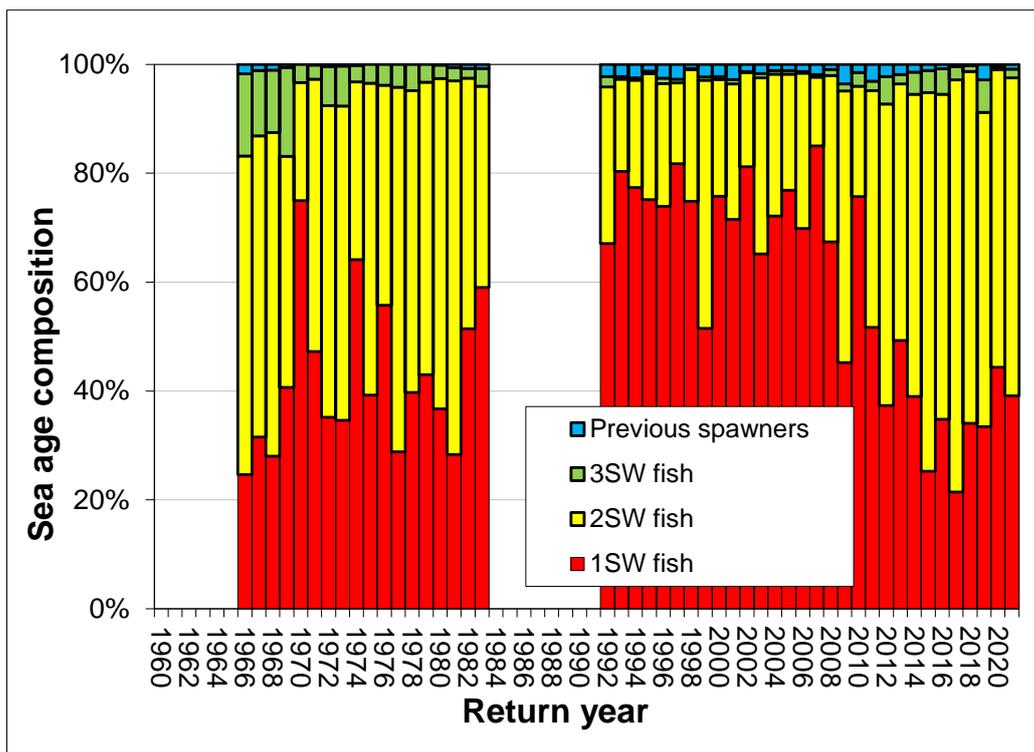
Fig. 1 Annual run estimates for salmon at Chester Weir, 1992-2021
(error bars indicate 95% confidence intervals)



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.

The long-term data set from the Dee indicates that this 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 salmon (Fig 2).

Fig. 2 Sea age composition of salmon on the Dee, 1960-2021



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, there is no certainty that this is the case. Factors such as global warming - not so evident or potentially damaging 50 years ago, may also be at play.

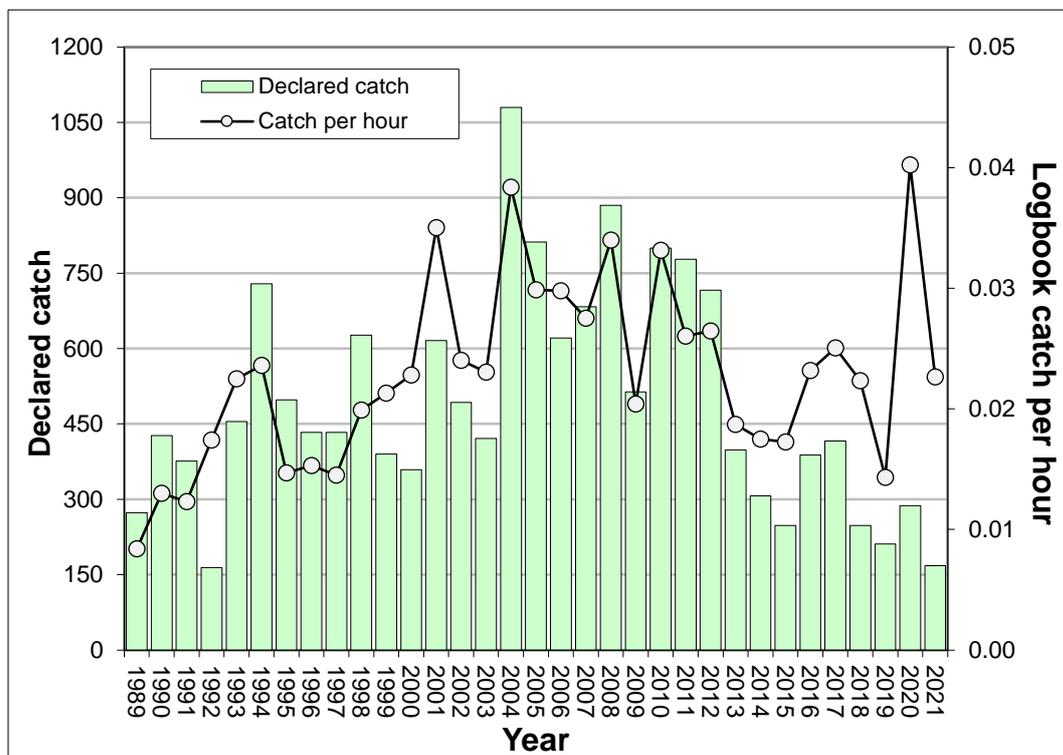
Hence, the precautionary management response is to protect vulnerable stocks now so they are best placed to respond to the return of more favourable environmental conditions in the future.

Rod catch: Licence returns to date indicate a declared rod catch on the Dee of 168 salmon. This is the second lowest reported catch in records going back to 1951. The lowest rod catch - 164 fish - was recorded in 1992, but was affected by the national licence system operating in that year. This offered only one type of licence allowing angling for both migratory and non-migratory species, and omitted the usual catch return reminder. As a consequence, the declared salmon (and sea trout) catch in 1992 would have represented a smaller proportion of the actual catch than was usual. Adjusting for this anomaly, a reported catch in 1992 close to 300 salmon would be a fairer comparison with catches in subsequent years, and would make 2021 the lowest catch in the time-series.

Catch per hour figures from logbook returns show a broadly similar pattern to the declared catch, although with some departure from this pattern in recent years - most notably in 2020 and 2021 (Fig 3). This may reflect changes in angler behaviour at low stock levels with more accomplished fishermen contributing proportionally more effort and less accomplished fishermen proportionally less effort when few fish are encountered. The estimated angling exploitation rate on Dee salmon in 2021 (i.e. the proportion of the annual run caught by rod fishermen) was the lowest to date at 5.8% and less than half of the recent 10-year average rate of 12.5%. Angling conditions were difficult for much of the summer due to low flow conditions.

Of the 168 salmon caught in 2021, all were released by anglers – complying with the byelaws introduced in 2020.

Fig. 3 Salmon rod catch and catch per hour, 1989-2021



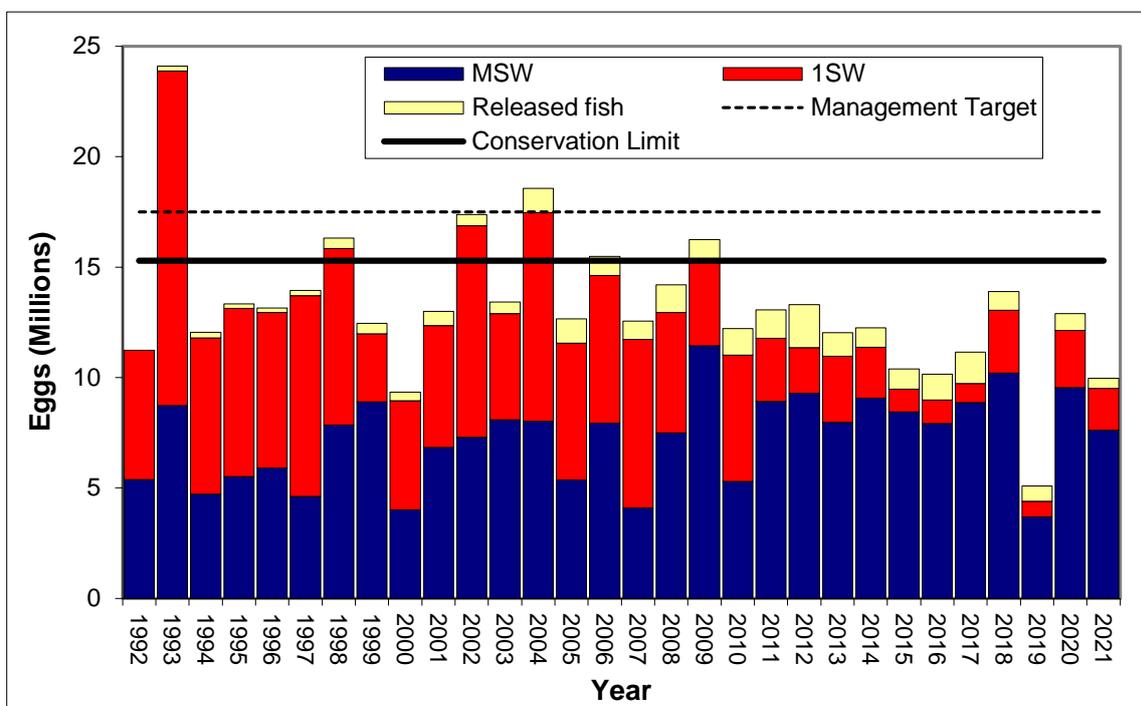
Spawning escapement: Estimates of the numbers of spawning salmon and the eggs they deposit are based on the run at Chester Weir minus losses to the rod fishery and other sources of mortality. Estimates also take account of the sex ratio of returning fish sampled at Chester (as judged from external appearance - the ratio is usually close to 1:1) and their average size (which relates to their likely egg contribution).

The provisional estimate of egg deposition on the Dee in 2021 is 10.0 million eggs - produced by ~3,000 spawners. Of these, ~170 spawners were estimated to have been rod-released fish contributing 0.46 million eggs. For the twelfth year running, egg deposition was below the Conservation Limit for the Dee of 15.3 million eggs and well short of the associated Management Target of ~17 million eggs.

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) in 5-years time.

Fig. 4 Salmon egg deposition 1992-2021



The Management Target 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 2020 indicated all river stocks of salmon as being '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 'probably at risk' both in 2020 and projected to 2025. Provisional results from the latest assessment indicate stock status remains poor on most rivers in E&W, with the Dee now classified as 'at risk' both in 2021 and projected to 2026.

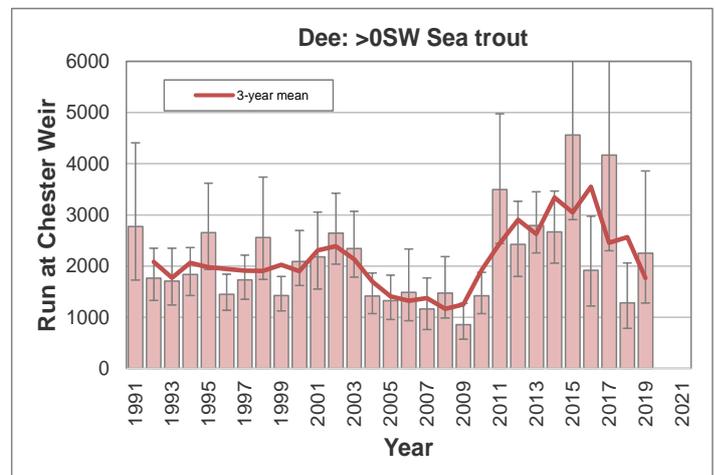
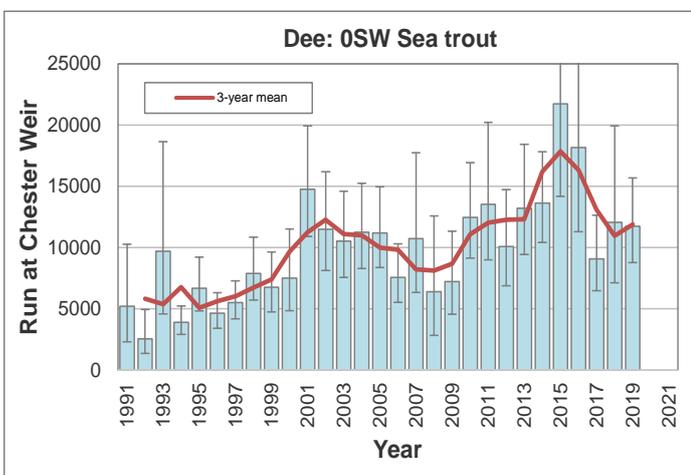
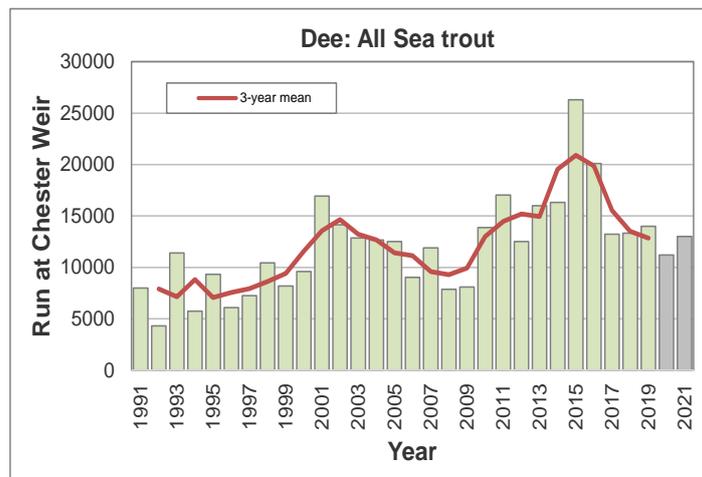
4. Dee sea trout in 2021

Run size and composition: As described in Section 2, 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. Run estimates for 2020 are still being worked on. 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).

On the basis of trap catch rates, tentative run estimates for all sea trout in 2020 and 2021 of ~11,200 and ~13,000 fish are shown in Fig 5. These estimates continue the downward trend in the sea trout return evident since 2015, but are close to the long-term average.

Fig. 5 Annual run estimates for sea trout at Chester Weir, 1991-2021
(error bars indicate 95% confidence intervals)



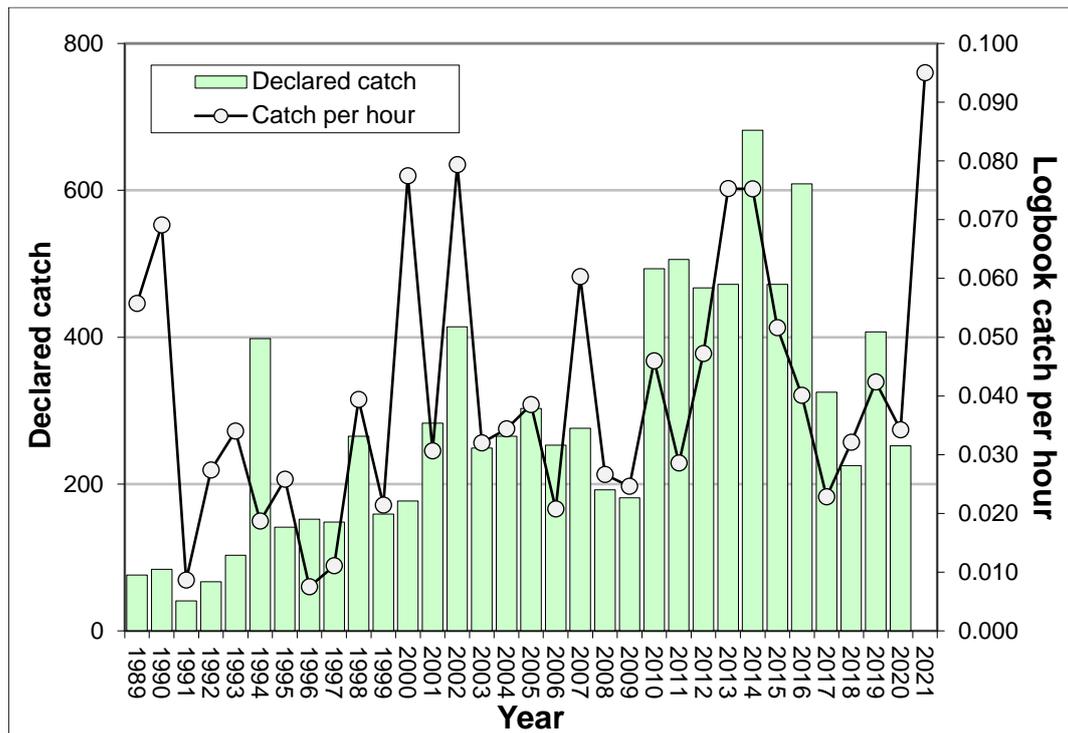
Rod catch: Sea trout rod catch figures from the national licence return in 2021 are not yet available. Declared rod catches on the Dee to 2020 are shown in Fig 6 along with catch per hour figures obtained from logbook anglers. For the latter, a catch rate of 0.0950 fish per hour in 2021 is the highest on record and probably indicative of a good return of sea trout last year.

In 2017, a new method was introduced in Wales to evaluate the status of sea trout stocks. 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 ‘probably at risk’ both in 2020 and projected to 2025.

Fig. 6 Dee sea trout rod catch and catch per hour 1989-2021

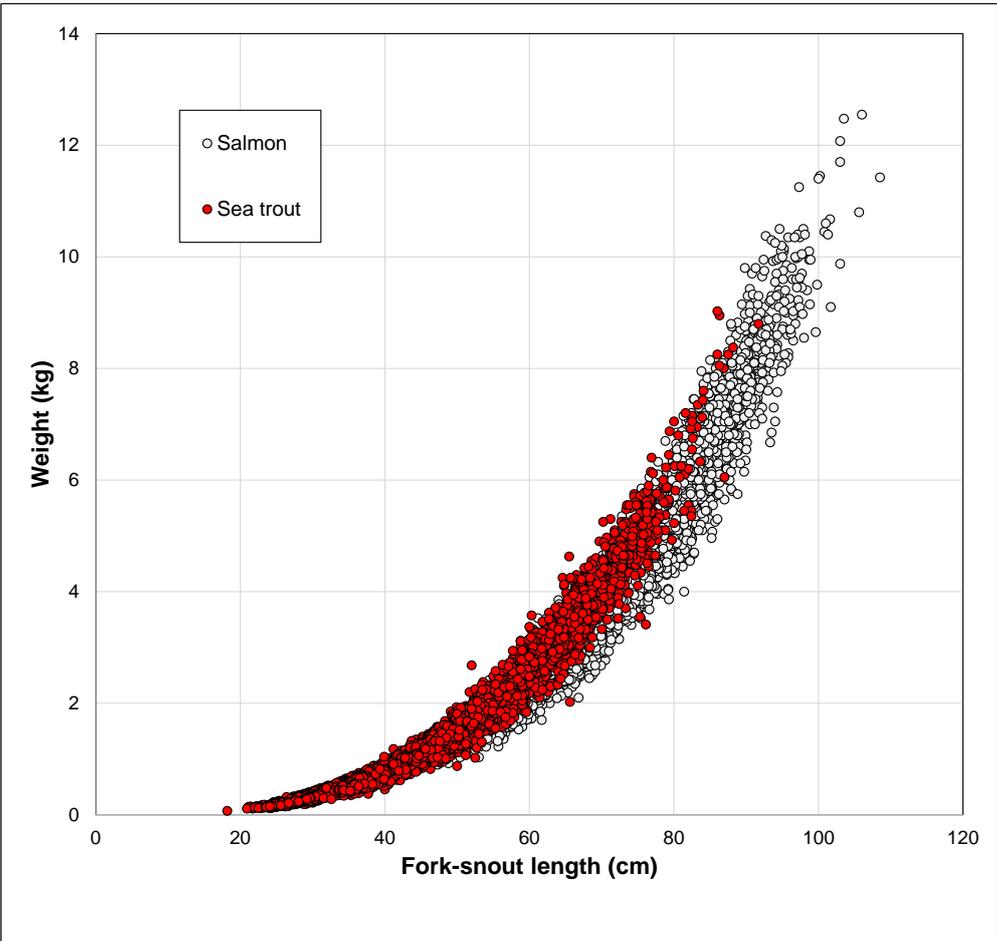


5. Age and size of Dee sea trout

Sea trout on the Dee and other UK rivers are generally a longer-lived species than salmon, although most individuals won't attain the sizes associated with salmon.

That said, per unit length, sea trout tend to be heavier than salmon. This is evident from the length-weight relationship for Dee sea trout and salmon shown in Fig 7 and from the table of predicted weights for fish of various lengths given below this figure. In the case of the latter, a single predicted (mean) weight value is given for each length but, as is clear from Fig 7, fish of a given length can, in reality, record a range of weights. For example, at the low and high end of this range a sea trout or salmon measuring 50cm in length (or ~20") could, for the most part, weigh from 1.25-1.84 kg in the case of sea trout and 1.12-1.56 kg in the case of salmon (2lbs 12oz-4lbs 1oz and 2lbs 8oz-3lbs 7oz, respectively).

Fig. 7 Length-weight relationships for sea trout and salmon on the River Dee, 1991-2020



Length (cm)	Length (inches)	Predicted Weight Sea Trout:		Predicted Weight Salmon:	
		Mean (kg)	Mean (lbs)	Mean (kgs)	Mean (lbs)
30.0	11.8	0.329	0lbs 12oz	0.281	0lbs 10oz
34.0	13.4	0.479	1lbs 1oz	0.411	0lbs 14oz
38.0	15.0	0.668	1lbs 8oz	0.576	1lbs 4oz
42.0	16.5	0.901	1lbs 16oz	0.780	1lbs 12oz
46.0	18.1	1.183	2lbs 10oz	1.027	2lbs 4oz
50.0	19.7	1.518	3lbs 6oz	1.323	2lbs 15oz
54.0	21.3	1.911	4lbs 3oz	1.670	3lbs 11oz
58.0	22.8	2.366	5lbs 3oz	2.074	4lbs 9oz
62.0	24.4	2.888	6lbs 6oz	2.539	5lbs 10oz
66.0	26.0	3.482	7lbs 11oz	3.069	6lbs 12oz
70.0	27.6	4.152	9lbs 2oz	3.668	8lbs 1oz
74.0	29.1	4.902	10lbs 13oz	4.341	9lbs 9oz
78.0	30.7	5.738	12lbs 10oz	5.092	11lbs 4oz
82.0	32.3	6.664	14lbs 11oz	5.925	13lbs 1oz
86.0	33.9	7.684	16lbs 15oz	6.846	15lbs 1oz
90.0	35.4	8.803	19lbs 7oz	7.857	17lbs 5oz
94.0	37.0	10.025	22lbs 2oz	8.964	19lbs 12oz
98.0	38.6	11.356	25lbs 1oz	10.171	22lbs 7oz

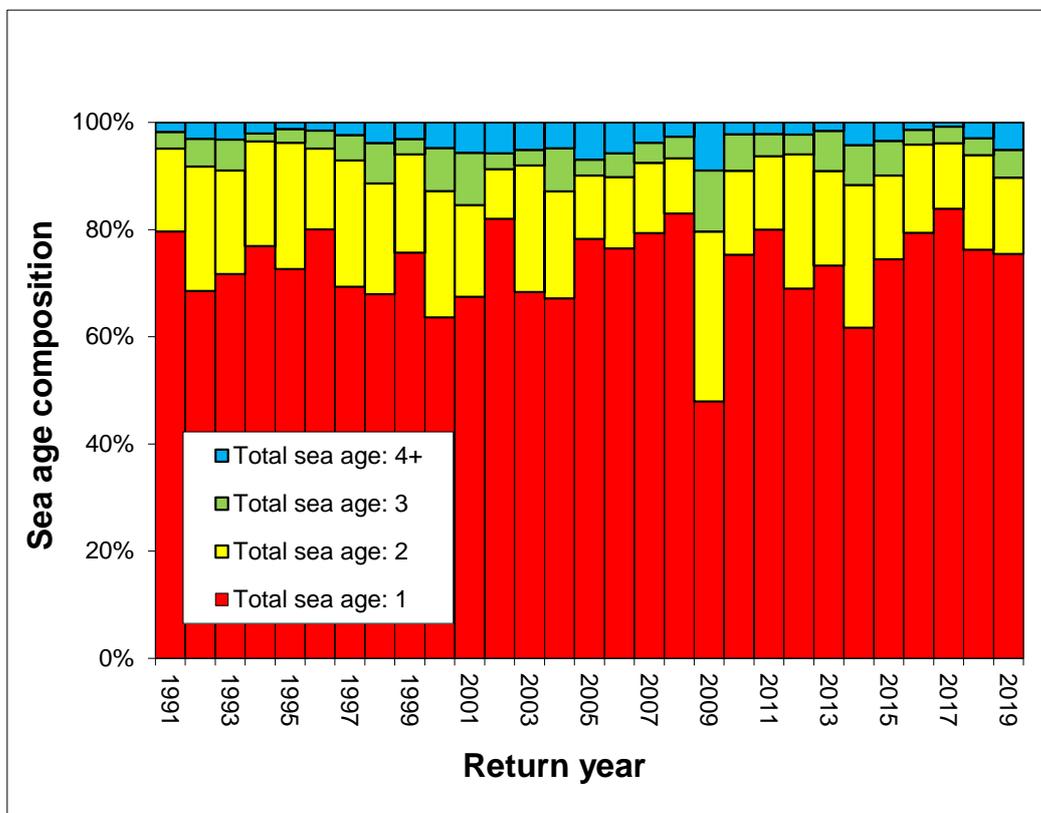
As mentioned earlier, the great majority of sea trout returning to the Dee (and most west coast rivers) are 0SW fish (sea age notation '.0+') which spend only a few months at sea and weigh, on average, around 0.5kg (or ~1lb) on their return. In 2019 for example, this sea age group comprised 84% of an estimated total run of sea trout at Chester of ~14,000 fish.

The remaining 'older' sea trout (e.g. 16% of the total return in 2019) are made up of (i) other maiden fish spending 1 or (rarely) 2 winters at sea (sea age notation '.1+' and '.2+') and (ii) repeat spawners - including the occasional fish which has spawned up to 9 times (the sea age notation in that case was '.0+9SM+' - i.e. a fish which first returned as a .0+ maiden and went on to spawn in 9 successive winters, the 'SM' part of the notation indicating 9 successive 'spawning marks' on the scale).

Among 'older' sea trout, the combination of maiden age at first return and the number of past spawning events means that several sea age groups can be present in the population in any one year (up to 24 have been recorded altogether – excluding .0+ or 0SW sea trout returning for the first time).

Fig 8 shows year-to-year variation in sea age composition within the 'older' sea trout group, but in this case ages have been simplified to represent total (post smolt) years.

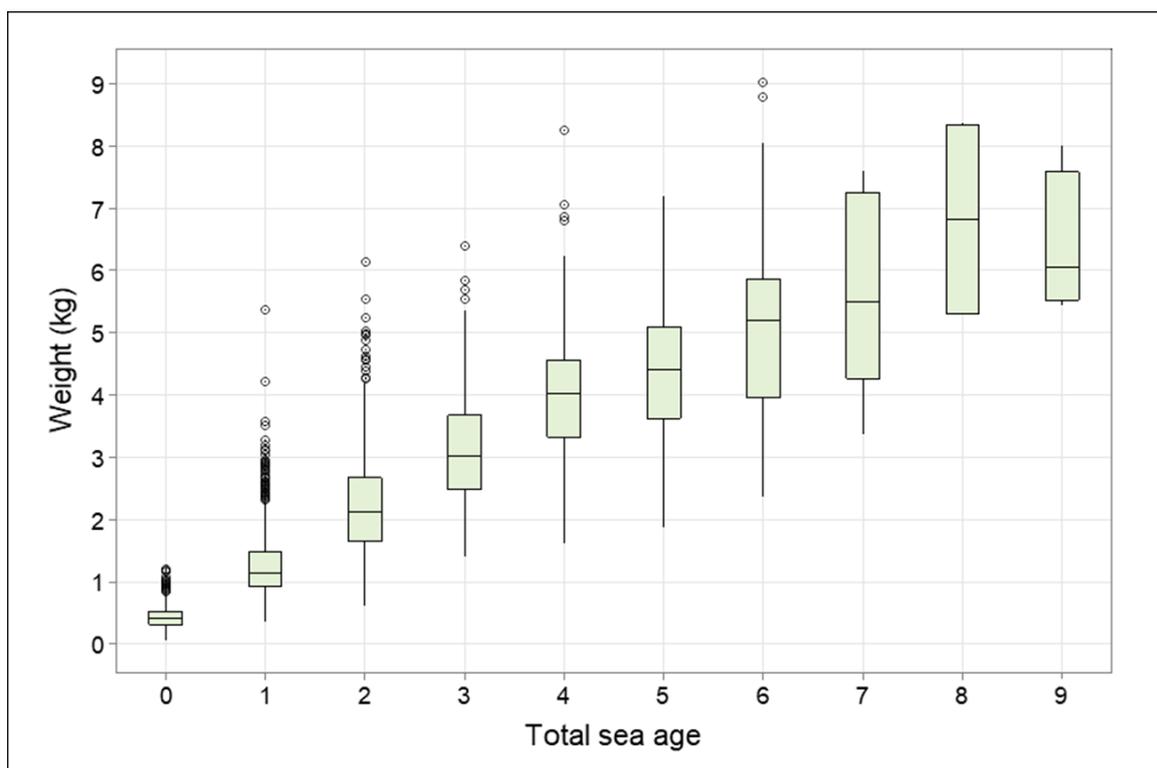
Fig. 8 Total sea age composition of >0SW sea trout on the River Dee, 1991-2019



From Fig 8, it is apparent that the great majority (73% on average) of sea trout in the >0SW group have a total sea age of '1'. This group is made up of .1+ maiden fish and .0+SM+ fish which have spawned on just one occasion previously. Sea trout of total sea age '2' make up most of the remainder (18% on average). This group comprises a few .2+ maiden fish plus .0+2SM+ fish and .1+SM+ fish. The rest of the >0SW group consists of fish up to total sea age 9, but represents only a small proportion of the population.

As fish attain a greater sea age, they grow larger but also become progressively less numerous in the population. Fig 9 below shows the increase in the size of Dee sea trout with total sea age. The horizontal line through the central area of each green box on this plot identifies the median weight (kg) of fish in each sea age group, and the box itself spans the middle 50% of observations (25% either side of the median line). The thin vertical line at the top and bottom of each box represents the remaining 25% spread of data above and below the inner quartiles (this excludes outlying points which feature individually).

Fig. 9 Total sea age of Dee sea trout and mean weight, 1991-2019



As noted above, among 'older' sea trout (i.e. excluding 0SW fish with total sea age '0'), fish of total sea ages 1 and 2 account for an average of 91% of the return (i.e. 73% plus 18%), and so are most likely to be encountered by anglers. Fish in these sea age groups have average weights of 1.23 and 2.21 kg, respectively (close to 3lbs and 5lbs).

A 4.5kg sea trout or ~10lb fish would be a much rarer occurrence (likely total sea age 4+) and a 7.0kg sea trout or ~15lb fish, rarer still (likely total sea age 6+). The heaviest sea trout sampled at Chester fish trap to date (in 2014) weighed just over 9.0kg or ~20lbs, had a fork-snout length of 860mm (~34") and a sea age of .1+5SM+ (i.e. a total sea age of 6).

*Monitoring of Atlantic salmon and European eel in Wales is part-funded by the EU Data Collection Framework 2014-2020.
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Cronfeydd Strwythurol a Buddsoddi Ewropeaidd
European Structural and Investment Funds



Photos: Examples of 0SW and >0SW sea trout sampled at Chester Weir fish trap.