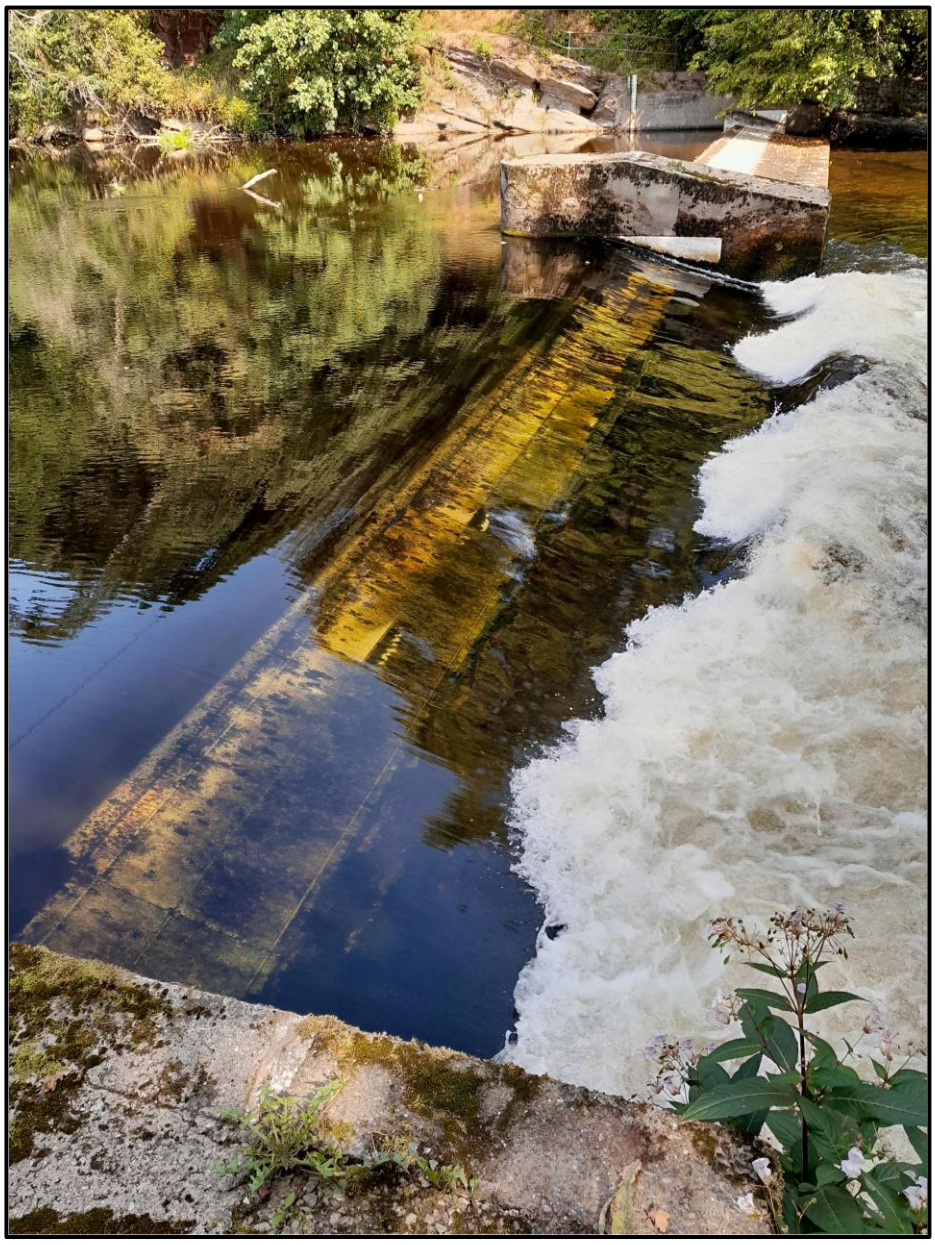
DEE STOCK ASSESSMENT PROGRAMME
ANGLER REPORT 2022



Cyfoeth Naturiol Cymru
Natural Resources Wales

Front cover: Manley Hall flow gauging weir and fish counter.

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

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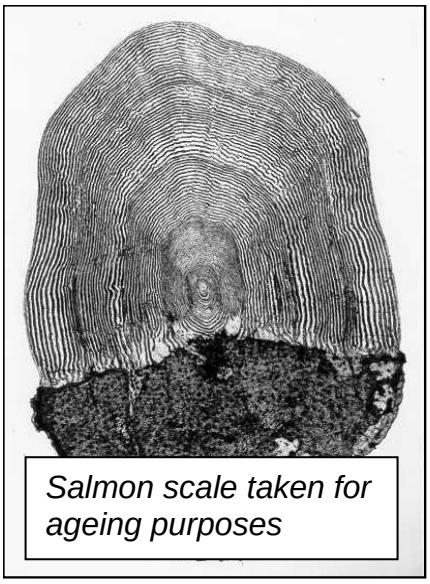
1. Introduction

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 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;

(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.

Salmon and trout fry sampled by electrofishing

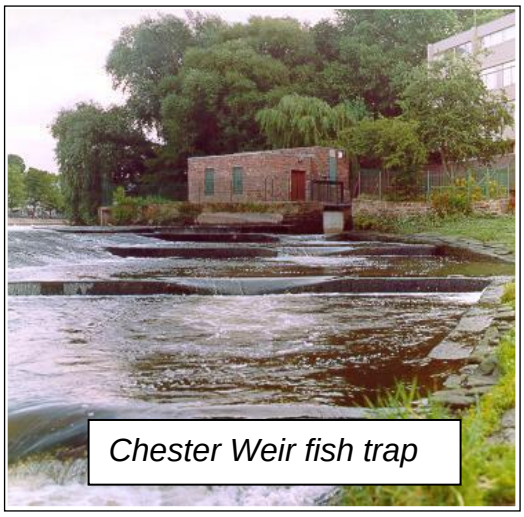
(iii) circulation (with this report) of a fishing logbook to Dee anglers to collect detailed information on rod catch and fishing effort around the

catchment - supplementing the licence-based catch return and fostering support for the Dee programme including the reporting of tagged fish.

The purpose of this report is to provide provisional findings on aspects of the Dee programme and related work for 2022. 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 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).



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 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 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).

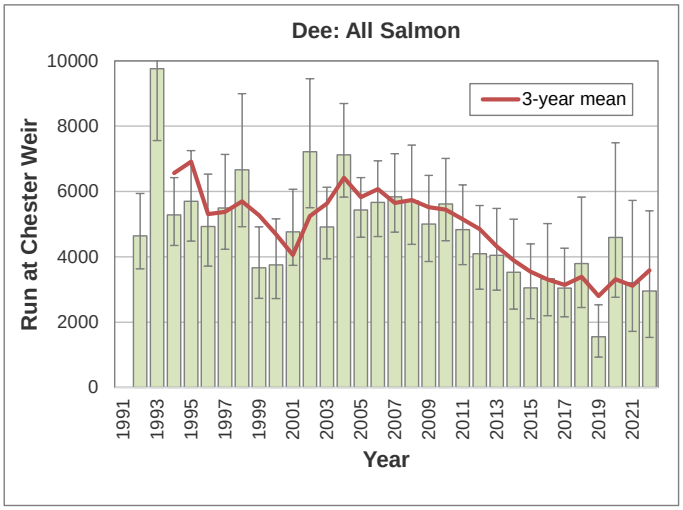
A £10 cash reward is offered to encourage anglers to report any tagged salmon they catch. This reward is increased to £20 for anglers who returned a logbook in the previous season. The reason for this is that records of tagged and untagged salmon submitted by logbook anglers are considered the most reliable - 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.

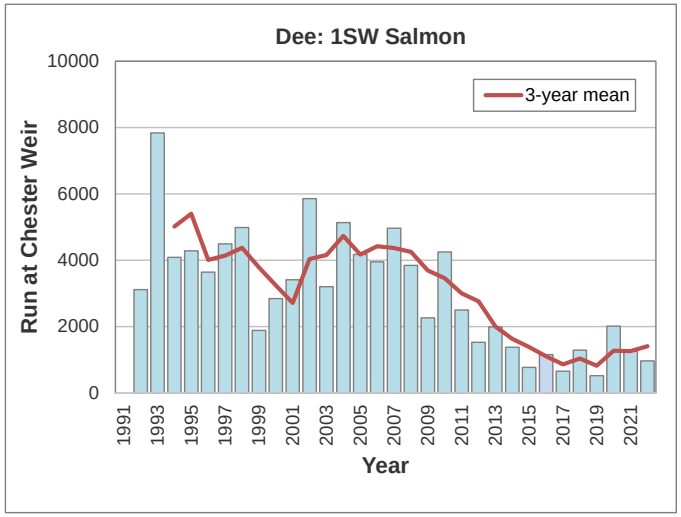
The run of salmon entering the Dee after the end of the angling season (on average around 5% or less of the total) is derived from the trap catch and an estimate of trap efficiency from the in-season period.

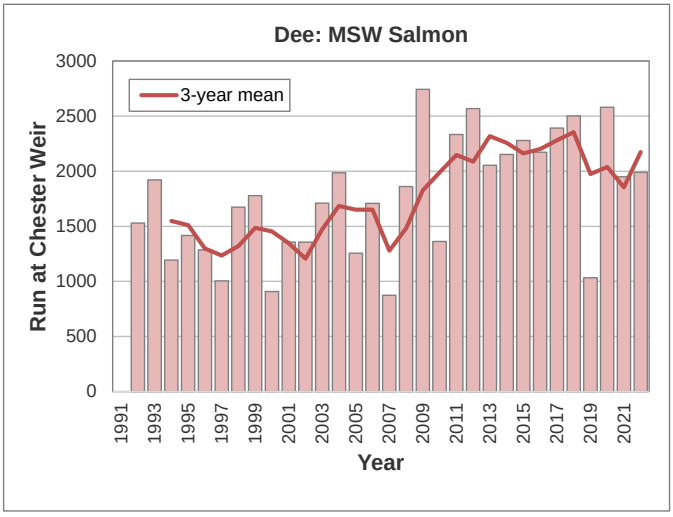
3. Dee salmon in 2022

Run size and composition: Provisional results indicate a run of 2,956 salmon (fish of all sea ages) at Chester in 2022. 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 – 3,043 and 3,051 fish – recorded in 2017 and 2015 (Fig 1). The corresponding trap catch in 2022 was 657 salmon.

Fig. 1 Annual run estimates for salmon at Chester Weir, 1992-2022
(error bars indicate 95% confidence intervals)





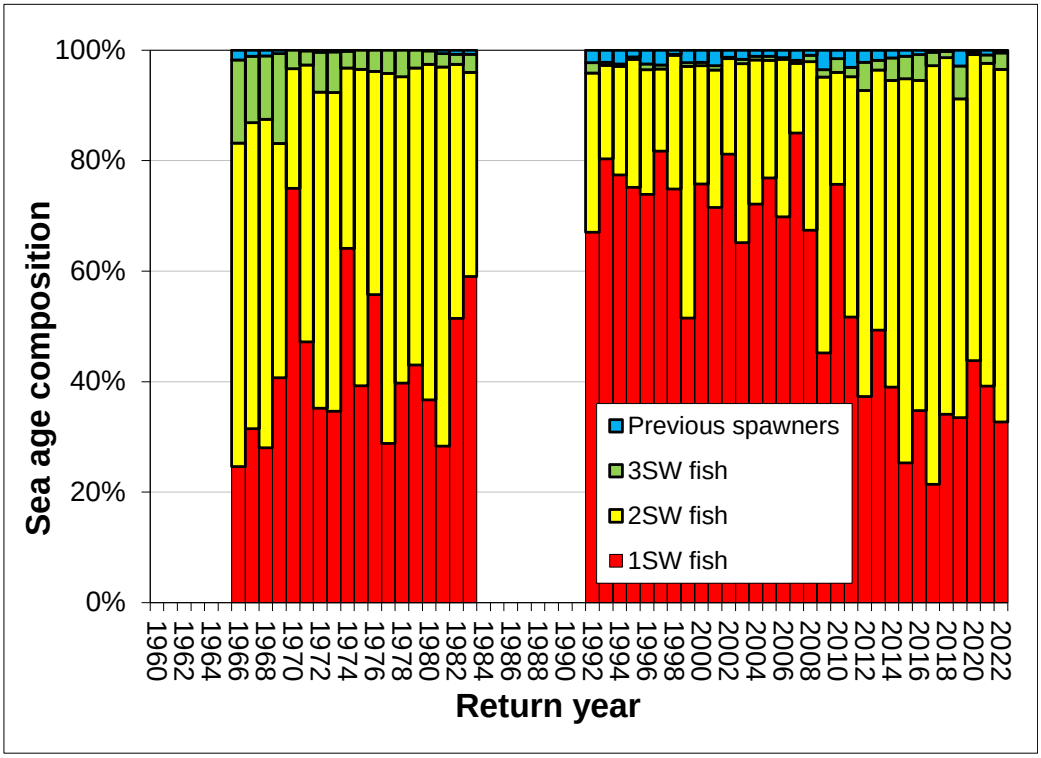


Multi-sea winter (MSW) fish continue to dominate the salmon run on the Dee comprising 68% of the total in 2022, when, less than 20 years ago, grilse made up 70-80% of a larger return.

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.

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, 1960-2022



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.

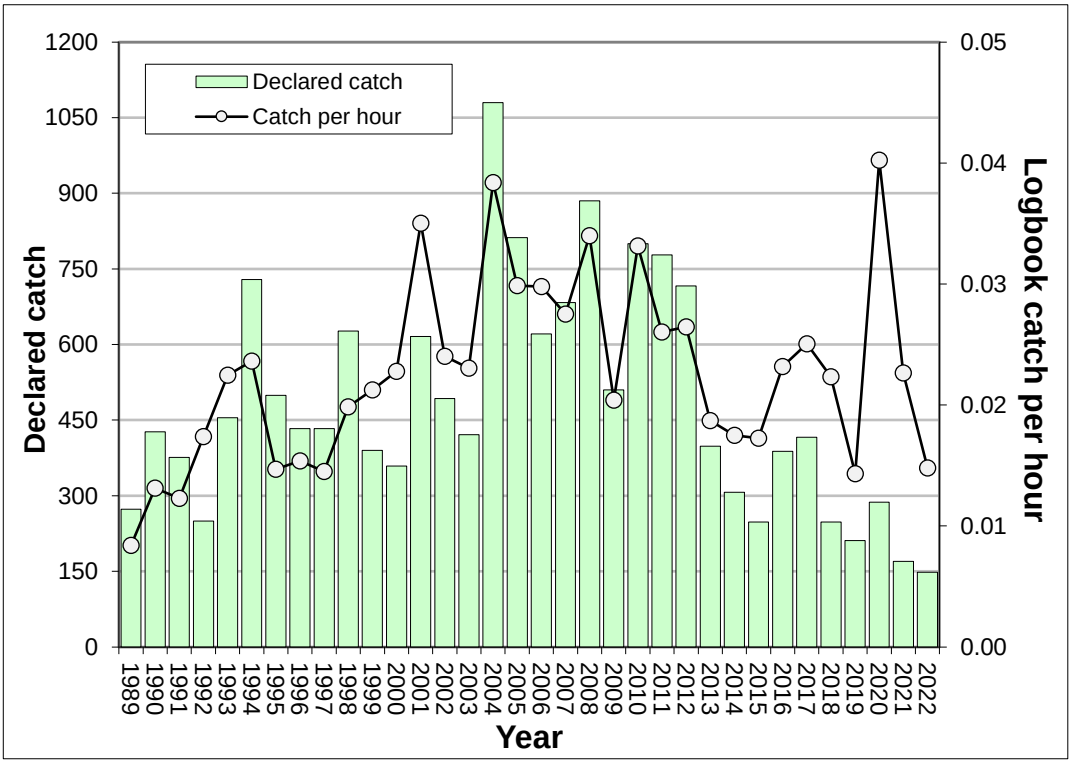
Hence, the precautionary management response is to protect vulnerable stocks now so they are best placed to respond to the return of more favourable environmental conditions in the future.

Rod catch: Provisional licence return data indicate a declared rod catch on the Dee of 148 salmon in 2022. This is the lowest reported catch in records going back to 1951 but similar to the second lowest rod catch of 170 salmon declared in 2021.

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 2022 (i.e. the proportion of the annual run caught by rod fishermen) was the lowest to date at 5.5%. This was similar to the 5.8% rate in 2021 and less than half of the recent 10-year average rate of 11.3%. Angling conditions were difficult for much of the summer due to low flow conditions and high river temperatures (see Section 5).

Of the 148 salmon caught in 2022, all were released by anglers – complying with the byelaws introduced in 2020.

Fig. 3 Salmon rod catch and catch per hour, 1989-2022



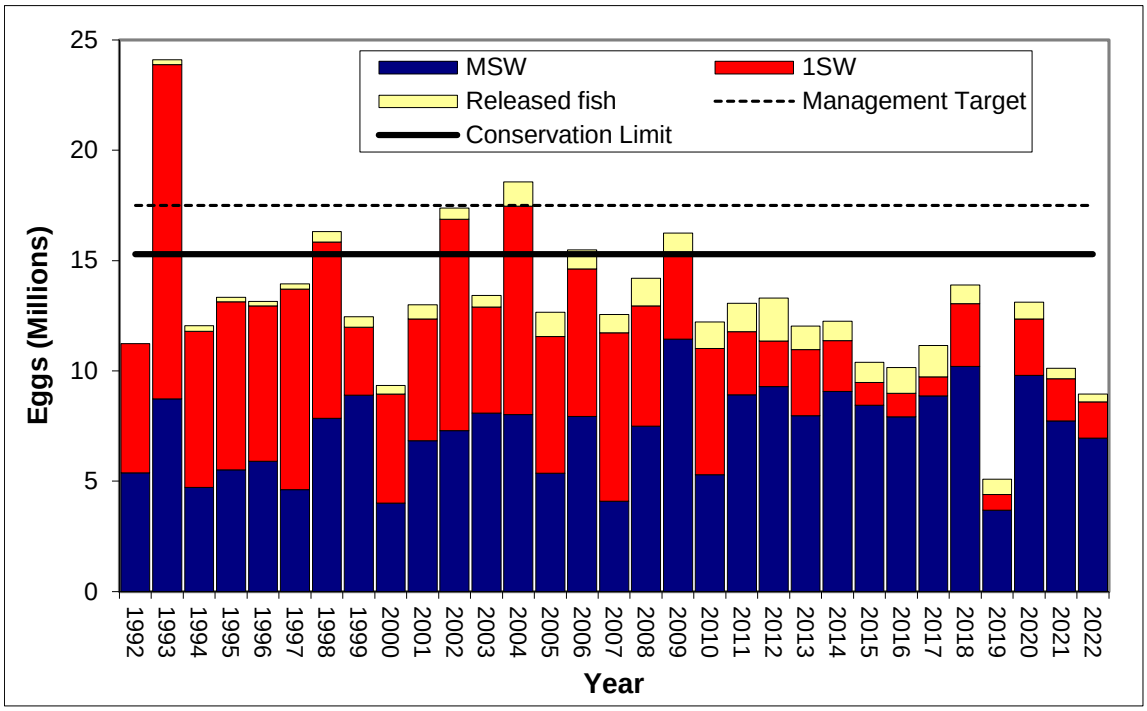
Spawning escapement: Estimates of the numbers of spawning salmon and the eggs they deposit are based on the run at Chester Weir minus losses to the rod fishery and other sources of mortality. Estimates also take account of the sex ratio of returning fish sampled at Chester (as judged from external appearance)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

The provisional estimate of egg deposition on the Dee in 2022 is 8.96 million eggs - produced by ~2,700 spawners. Of these, ~130 spawners were estimated to have been rod-released fish contributing 0.35 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 (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) in 5-years time.

Fig. 4 Salmon egg deposition 1992-2022



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 2021 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 'at risk' both in 2021 and projected to 2026. 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 2022 and projected to 2027).

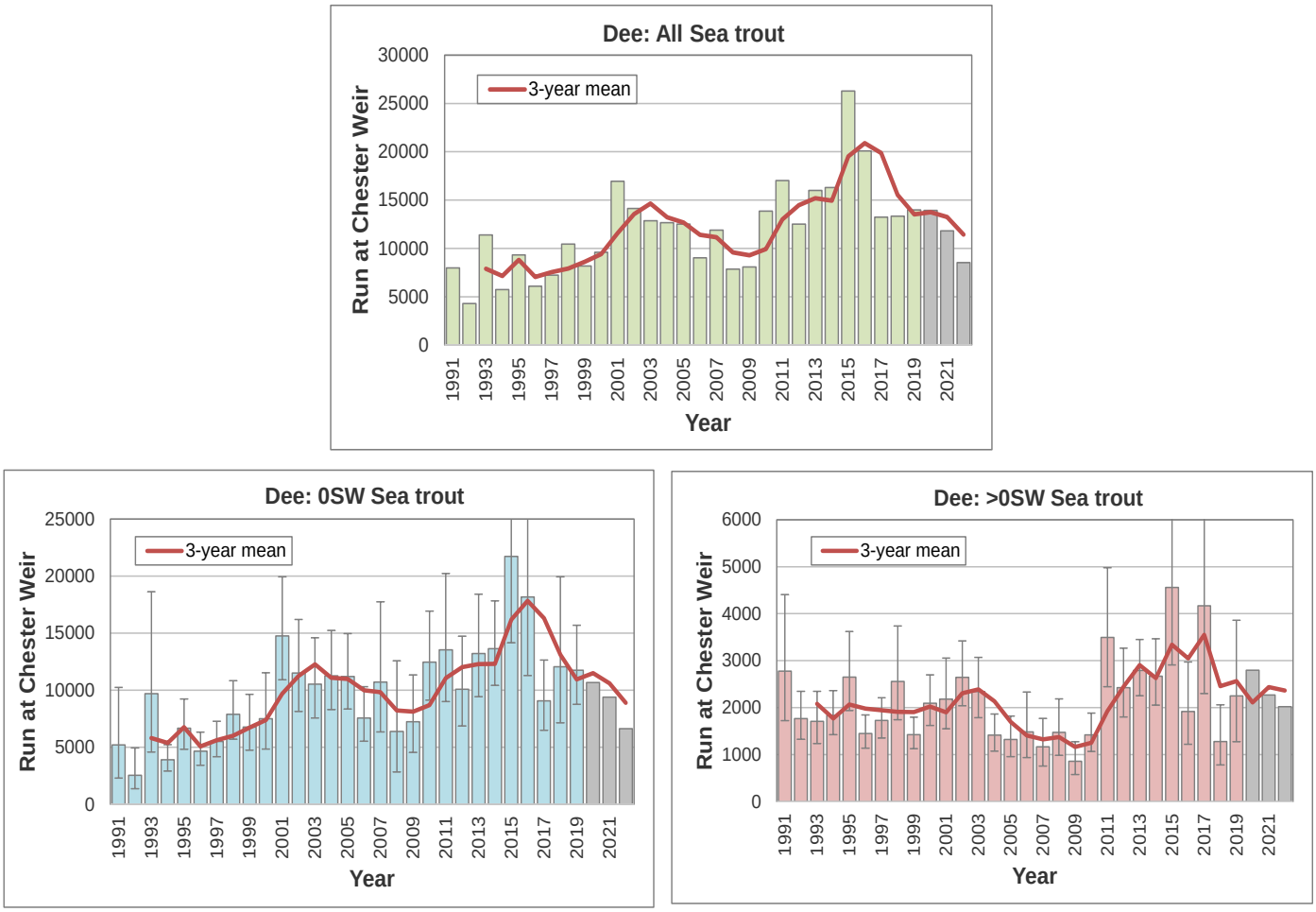
4. Dee sea trout in 2022

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 and 2021 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).

Tentative run estimates for sea trout in 2020, 2021 and 2022 – estimated from trap catch rate and flow - 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, 1991-2022
(error bars indicate 95% confidence intervals)



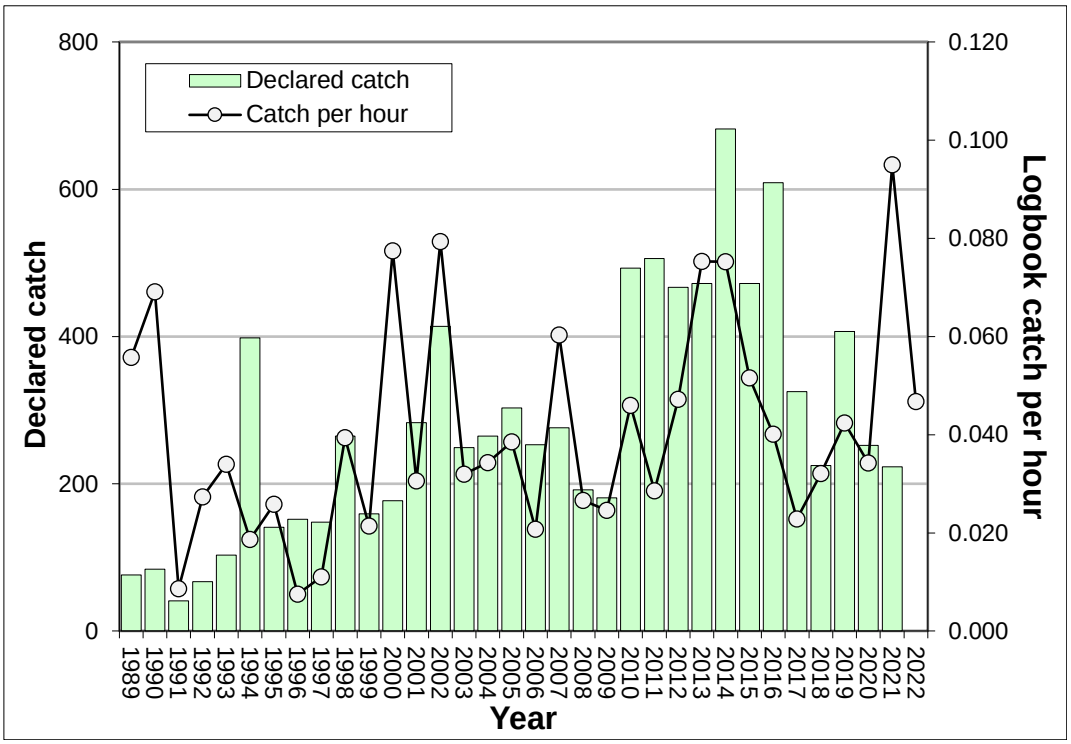
Rod catch: Sea trout rod catch figures from the national licence return in 2022 are not yet available. Declared rod catches on the Dee to 2021 are shown in Fig 6 along with catch per hour figures obtained from logbook anglers (up to 2022). For the latter, a catch rate of 0.0468 fish per hour in 2022 was well down on the previous year, but just above the long-term average rate of 0.0404 fish per hour.

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 2021 and projected to 2026.

Fig. 6 Dee sea trout rod catch and catch per hour 1989-2022



5. River temperature and flow in 2022

Last year was notable for its dry and very warm summer.

The Met Office confirmed that 2022, as a whole, was the UK's warmest year on record, with the average annual temperature exceeding 10ºC for the first time ever. Not surprisingly, last year was also the warmest on record for all nations: England: 10.94ºC; Wales: 10.23ºC; Northern Ireland: 9.85ºC and Scotland 8.50ºC.

The weather statistics for 2022 were consistent with a pattern that has seen 15 of the UK's top 20 warmest years on record occurring this century - with the entire top 10 all within the past two decades.

Heatwaves in June 2022 also meant the UK experienced its fourth warmest summer on record. Temperatures broke the 40ºC mark for the first time, with an all-time high air temperature of 40.3ºC recorded at Coningsby in Lincolnshire on the 19th July. Closer to home, Wales recorded its highest ever temperature on 17th July: 37.1ºC at Hawarden in Flintshire.

In the Dee catchment, rainfall was scarce from mid-April to the end of September. At the time when air temperatures were reaching their peak in mid-July, a release of water was requested from Llyn Celyn via the Bala Sluices to help freshen the river in an attempt to avoid any fish kills that might arise during this exceptionally warm period. This water came from the Special Release Allocation set aside for such purposes and was a precautionary measure aimed particularly at improving conditions for migratory fish in the estuary. For example, similar warm weather conditions in 1995-96 resulted in

some mortalities of salmon and sea trout in the Dee estuary, although, in the years that followed, steps were taken to improve water quality – including investment in estuary sewage treatment works. No repeat of the 1995-96 situation has been observed since, including in 2022.

The release of water in mid-July last year provided an opportunity to examine its effect on river temperature and fish movement on the main Dee at Manley Hall.

The Manley Hall site is one of several in the Dee catchment providing river level and flow data at 15-minute intervals and will be familiar to many anglers for this reason; see:

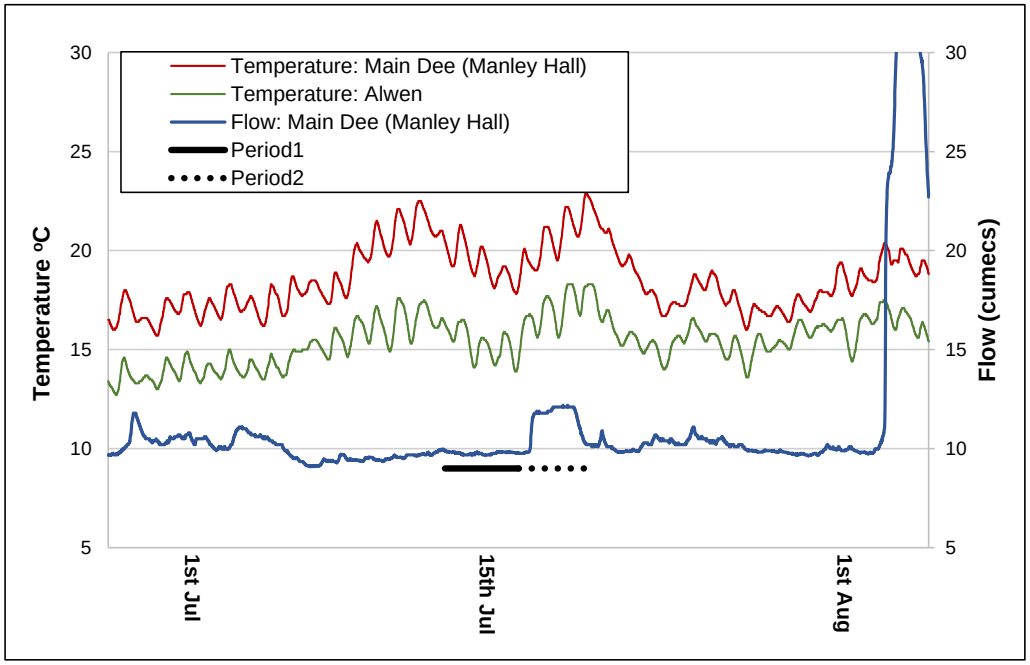
https://rivers-and-seas.naturalresources.wales/Station/4176/?lang=en&parameterType=1

River temperatures were also being logged at Manley Hall in 2022 (alongside other locations in the catchment where temperatures have been routinely recorded for fisheries purposes) – again at 15-minute intervals.

The resistivity fish counter was also operating at this site last year on a trial basis (the first time for some years) and provided 'real-time' counts of upstream migrating salmon and sea trout sized fish.

Fig 7 below shows the flow (in cubic metres per second or cumecs) and river temperature (centigrade or ^{o}C) recorded at Manley Hall in July-August 2022. A second set of river temperature data recorded at a site on the lower Alwen is also shown for comparison. The Bala release (2 cumecs – or a 20% increase on the ~10 cumecs prevailing at Manley Hall at the time) ran from the 16th to 18th July and can be seen in Fig 7 as the step-change in flow evident in 'Period 2'. This occurred close to the summer peak river temperature at Manley Hall of 22.9^{o}C on the 19th July.

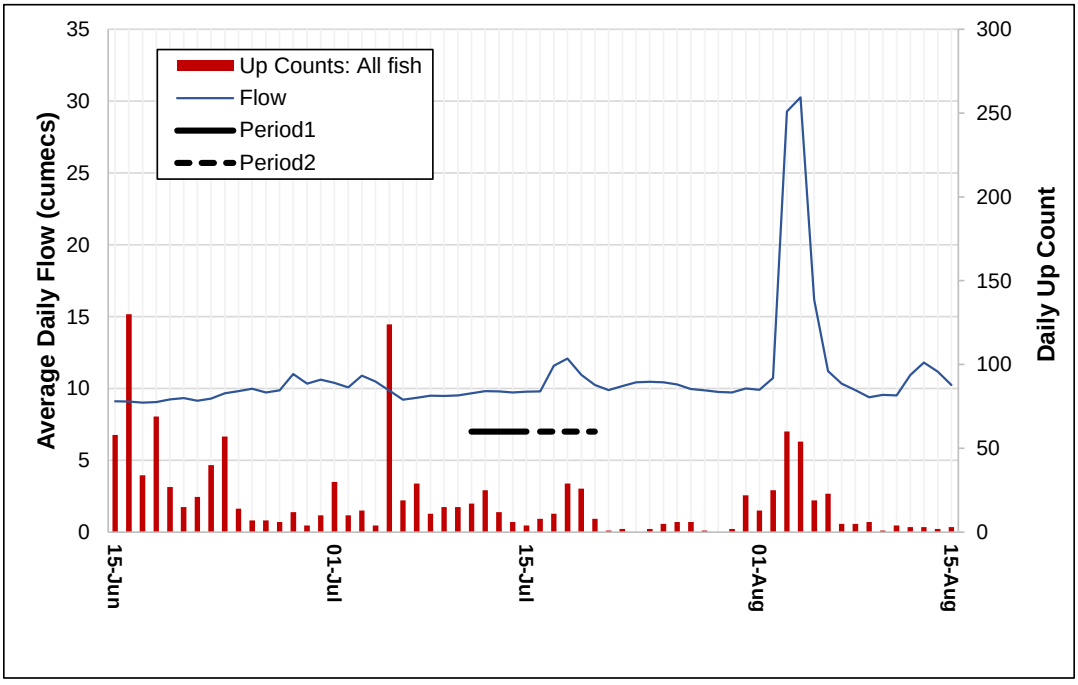
Fig. 7 River flow and temperature on the main Dee at Manley Hall; July-August 2022. River temperature readings for the Alwen are also shown.



To asses the effect of the Bala release on river temperatures at Manley Hall, temperature readings for the latter were compared with those collected simultaneously at three tributary sites in the Dee catchment: the Alwen (shown as an example in Fig 7); Ceidiog and Mynach. The average difference between the river temperature at Manley Hall and the three Dee tributary sites was calculated for periods just prior to (Period1) and during the release (Period2). In all cases, this comparison indicated that there had been a significant fall in the river temperature at Manley Hall during the release (Period2) relative to river temperatures at the other sites. On average this temperature fall was ~1^{o}C for all sites, but ranged from 0.4^{o}C if compared to the Alwen to 1.7^{o}C if compared to the Ceidiog.

Fig 8 (below) examines the flow at Manley Hall – including the Bala release – alongside the upstream fish count. This indicates that the release stimulated a small pulse in the up-count (Period2), but a comparison to average up-counts in the days immediately before the release (Period1 – when flows were low and stable) found no significant difference in the average count between these two periods. *[A second release reached Manley Hall around the 11th August and is also apparent in Fig 8. This didn't appear to stimulate fish movement to the same extent as the mid-July release but was preceded by a natural rainfall event and small spate about a week before which did appear to promote upstream migration at the counter.]*

Fig. 8 River flow and upstream counts of salmon/sea trout sized fish on the main Dee at Manley Hall; June-August 2022.

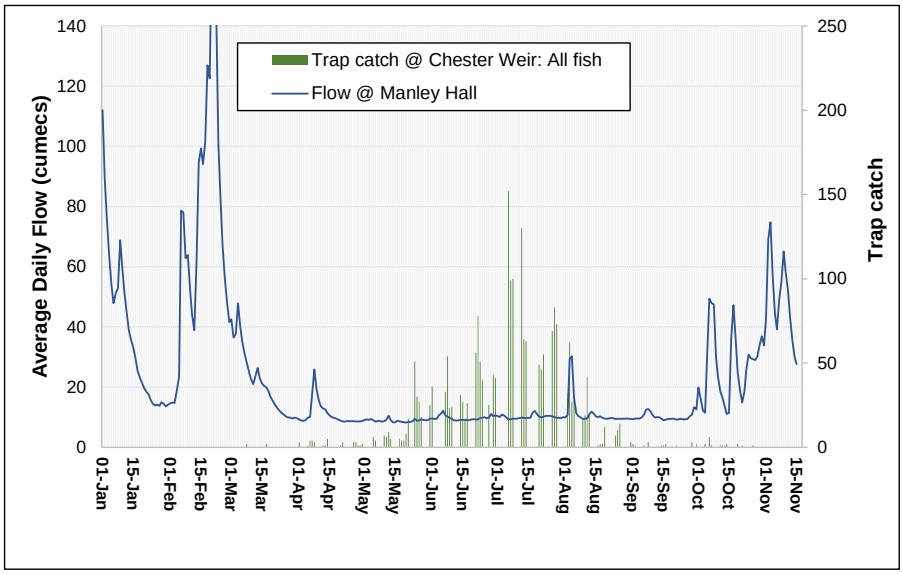


Up-counts and flow over the whole year (January to November) at Manley Hall are shown in Fig 9 along with the combined salmon and sea trout catch at Chester Weir. It is evident that at both these sites upstream migration

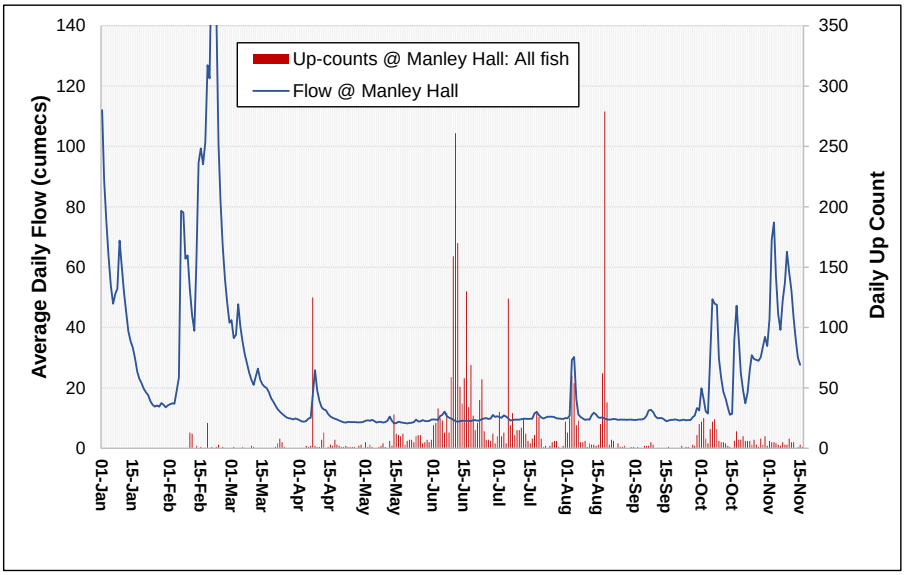
continued to some extent throughout the summer even at the lowest flows (and followed the usual seasonal pattern). However, unlike on most rivers, the flows on the Dee are augmented by the regulation system with enhanced flows maintained in the main river for abstraction close to Chester and, except in the most extreme drought conditions (the last time was 1996), maintenance of a minimum flow of 4.2 cumecs at Chester Weir – primarily to encourage passage of migratory fish through the estuary. In the case of the latter, the 2 cumec release in July 2022 would have increased the flow at Chester by around 50% on the 4.2 cumec minimum.

Fig. 9 Combined salmon and sea trout trap catch at Chester Weir with flow and upstream counts of salmon/sea trout sized fish at Manley Hall; January to November 2022.

a. Trap catch at Chester Weir:



b. Upstream counts at Manley Hall:



Temperatures which are lethal to salmon and trout have been defined in various ways and usually from laboratory studies. The ability of fish to survive high temperatures will depend on how acclimatised they are to such conditions (i.e. the temperatures they have recently been exposed to). Brief exposure to a peak temperature of nearly 23°C on the Dee at Manley Hall in July 2022 is unlikely to have been directly lethal. For example, for trout acclimatised to warm water conditions the 1000 minute (~17 hour) upper lethal temperature is about 26.7°C and the 7-day upper lethal limit about 24.7°C. For salmon, the equivalent lethal temperatures are around 3°C higher. Rivers and streams are also complex environments where fish may find areas of cooler water (e.g. deeper pools) to avoid more extreme temperatures.

That said, temperatures approaching 20°C or above tend to be outside the preferred range for trout and salmon and, even if not directly lethal, can have adverse effects e.g. on feeding and other behaviour. Similar adverse effects associated with high temperatures may include, for example, increased susceptibility to parasites or disease or exposure to low levels of dissolved oxygen or other deleterious changes in water quality. Water temperatures of around 25°C were reported on the River Wye last summer and linked to mortalities among adult salmon. On the Wye and Usk a voluntary scheme called for salmon angling to cease as river temperatures reached or exceeded 19°C in order to avoid catch-and-release mortalities. This was widely adopted in the warmest months of July and August. The 19°C threshold also triggered a similar voluntary halt to angling on the rivers Test, Itchen and Hampshire Avon in England.

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EU Funds: Investing in Wales

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Photo: Probable salmon ascending the right-bank weir at Manley Hall (the three stainless steel electrode strips of the resistivity fish counter are visible on the downstream face of the weir).