HINKLEY POINT C PERMIT VARIATION

EPR/HP3228XT/V004

Technical Brief: TB017

Review of adult run size estimates for Atlantic Salmon in the Severn Estuary, River Severn, River Wye and River Usk.

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2020 (DRAFT-05)

INTRODUCTION

Salmon utilise rivers for reproductive and nursery phases, and the marine environment for adult development and rapid growth (Mills 1991), migrating from the Atlantic Ocean to fresh water to spawn in areas of rivers with clean gravel. This type of life cycle (spawning in fresh water, feeding and growing at sea) is termed ‘anadromous’.

After hatching, the young fish develop in fresh water before migrating to the sea as smolts (mostly in their second year in the Severn) to mature, returning after 1-4 years to spawn. Salmon spawn in autumn or winter by excavating depressions in the river substrate. On completion of spawning, females drop downstream, while males may remain to spawn with further females.

As returning adults, neither males nor females feed in fresh water, and the migration and spawning process results in an approximate 40% loss in body weight. The subsequent mortality rate of adults post spawning is high. The proportion of salmon returning as previous spawners is remarkably similar between rivers and is between 3 and 6%.

Around 10-30% of salmon that have spawned return to sea (termed kelts). These are very weak fish before feeding restarts in the marine environment and therefore may be more susceptible to impingement, but as multiple spawners they only contribute a tiny proportion of the total eggs deposition.

Smolts migrate to the sea, usually between April and June. The amount of time spent in the sea prior to the spawning migration varies from one winter (grilse) to two to four (multi-sea-winter (MSW) salmon). When adults return to spawn in fresh water they home to their natal river, and possibly to that part of the catchment in which they originated, although straying between catchments does occur (approximately 3%). The significance of such specific homing to natal habitats is that this trait has led to the development of genetically distinct sub-populations, possibly even within individual catchments highly adapted to the specific conditions found there.

As part of the permit variation application (EPR/HP3228XT/V004) we need to assess the potential impact of losses from the Salmon populations due to the predicted entrapment and associated mortality from Hinkley Point C’s proposed cooling water system. To do this we need to estimate the size of the population the entrapment losses will occur from.

This document sets out the current evidence and data considered and the Environment Agency’s proposals within this permit variation assessment.

Stock Assessments

The Environment Agency and Natural Resources Wales carry out stock assessments for principal salmon rivers in England and Wales on an annual basis, where a principal salmon river is defined as having had an annual rod catch in excess of 50 per year when the National Rivers Authority (now Environment Agency) Salmon Strategy was released in 1996. Conservation Limits (CL) are set for these rivers, where the CL represents the stock size below which the number of juvenile fish produced in the next generation would be expected to be significantly reduced.

Rivers can fall into one of 4 categories:

Not at Risk (NaR)	> 95% probability that the stock assessment will meet the CL
Probably not at Risk (PNaR)	between 50% & 95% probability that the stock assessment will meet the CL
Probably at Risk (PaR)	between 5% & 50% probability that the stock assessment will meet the CL
At Risk (AR)	<5% probability that the stock assessment will meet the CL

The preliminary stock assessments for the rivers that are the most likely contributors to the Severn Estuary mixed stock are:

- River Severn Probably at risk (PaR)
- River Wye Probably at risk (PaR)
- River Usk Probably at risk (PaR)

The 2018 stock assessment identified the River Severn stock as being ‘Probably at Risk’ of failing its conservation limit. Although, classified as ‘Probably Not At Risk’ in previous years and showing an improving trend, the 2018 assessment included robust and consistent revisions to previous estimates and the River Severn stock is currently being treated as the weakest stock component in the Severn Estuary mixed-stock fishery when carrying out the HRA process for the licencing of the salmon net fisheries in the Severn Estuary..

The River Wye has not achieved its salmon Conservation Limit for a number of years but until recently was showing positive signs of recovery. However, from the 2018 assessments it is now clear that the salmon run was poor and has consequently resulted in the stock failing to achieve its conservation limit. The stock is therefore still predicted to be “probably at risk”.

The 2018 assessment for the River Usk places the stock as ‘Probably at Risk’ and with a declining population trend. In 2017, the stock was categorised as ‘Probably Not At Risk’ with an improving trend. However, substantial recent deficits in juvenile salmon production since 2016 indicate that adult returns in 2019 and 2020 could be even worse than indicated by trends and a precautionary approach to adult management has been taken to protect future stock numbers.

Juvenile data

In England and Wales, the National Fisheries Classification Scheme (FCS2) is used to evaluate fish population status with population densities being graded from A to F based on the frequency distribution of juvenile density values in a national database of fish survey data (Joint Nature Conservation Committee, 2015). Data are presented separately for 0+ salmon (fry) and >0+ juveniles (parr) with a separate grade derived for each age class.

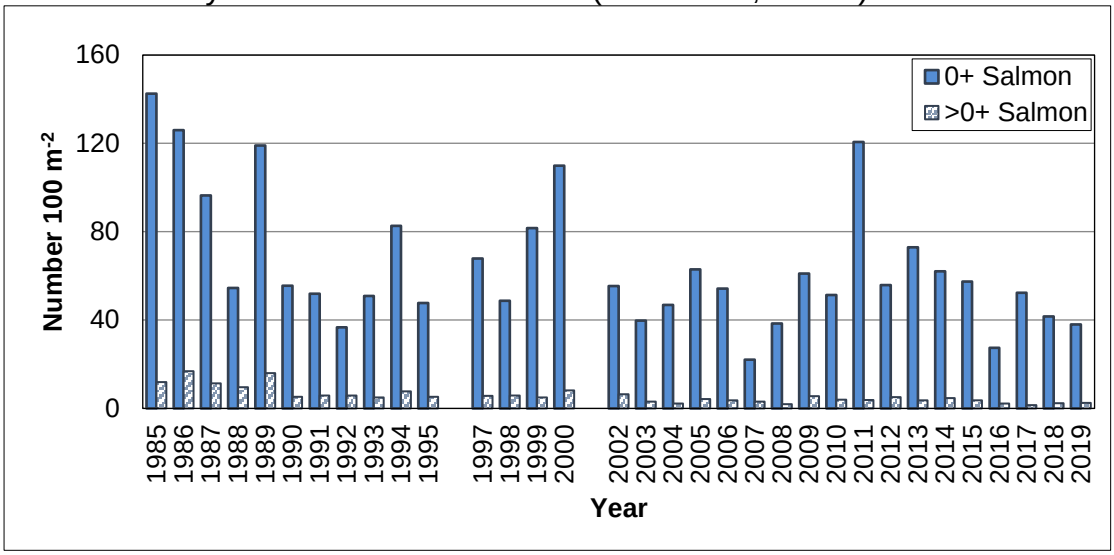
The latest Natural Resources Wales data for the River Wye show that, of the 24 sites sampled in 2019, juvenile salmon were found at 18 of these (NRW, 2019a). The sites at which no salmon were recorded included sites with known access problems for the species (NRW, 2019a). However, It is notable that there were no Excellent or Good sites for >0+ salmon on the River Wye in 2019 (**Table 4**).

Table 4. Numbers of electric fishing sites of NFSC classifications A to F, surveyed by NRW on the River Wye in 2019 (data from NRW, 2019a).

			Number of sites	
Grade	**Descriptor**	**Interpretation**	**0+**	**>0+**
A	Excellent	In the top 20% for a fishery of this type	3	0
B	Good	In the top 40% for a fishery of this type	7	0
C	Fair	In the middle 20% for a fishery of this type	3	5
D	Fair	In the bottom 40% for a fishery of this type	4	8
E	Poor	In the bottom 20% for a fishery of this type	1	3
F	Fishless	No fish of this type present	6	8

Looking at long-term trends, the density of 0+ salmon in the River Wye was low in 2019, averaging 38 salmon 100 m^{-2} (1985-2019, Q1=47.3 salmon 100 m^{-2}, median = 55.4 salmon 100 m^{-2}, Q3 = 77.3 salmon 100 m^{-2}) (**Figure 1**). The density of >0+ parr was also low as compared to other years, at 2.6 salmon 100m^{-2} ((1985-2019, Q1=3.4 salmon 100 m^{-2}, median = 5.0 salmon 100 m^{-2}, Q3 = 6.2 salmon 100 m^{-2})

Figure 1. The average densities (number 100 m^{-2}) of salmon fry (0+) and parr (>0+) in the River Wye catchment 1985 – 2019 (from NRW, 2019a).



On the River Usk, the picture is similar. Of the 91 sites sampled by electric fishing in 2019, juvenile salmon were found at 52 of these – some sites are known to be inaccessible or to have poor habitat for salmon (NRW, 2019b). Very few sites were recorded as having 'Excellent' or 'Good' salmon densities, with 48% of sites having no 0+ and 73% having no >0+ salmon present (Table 5). Despite the low numbers of 'Excellent' and 'Good' sites, 2019 is still noted as being 'an improvement against the previous three-years' survey results' when juvenile numbers were significantly affected by two successive warm winters meaning little recruitment was successful (NRW, 2019b).

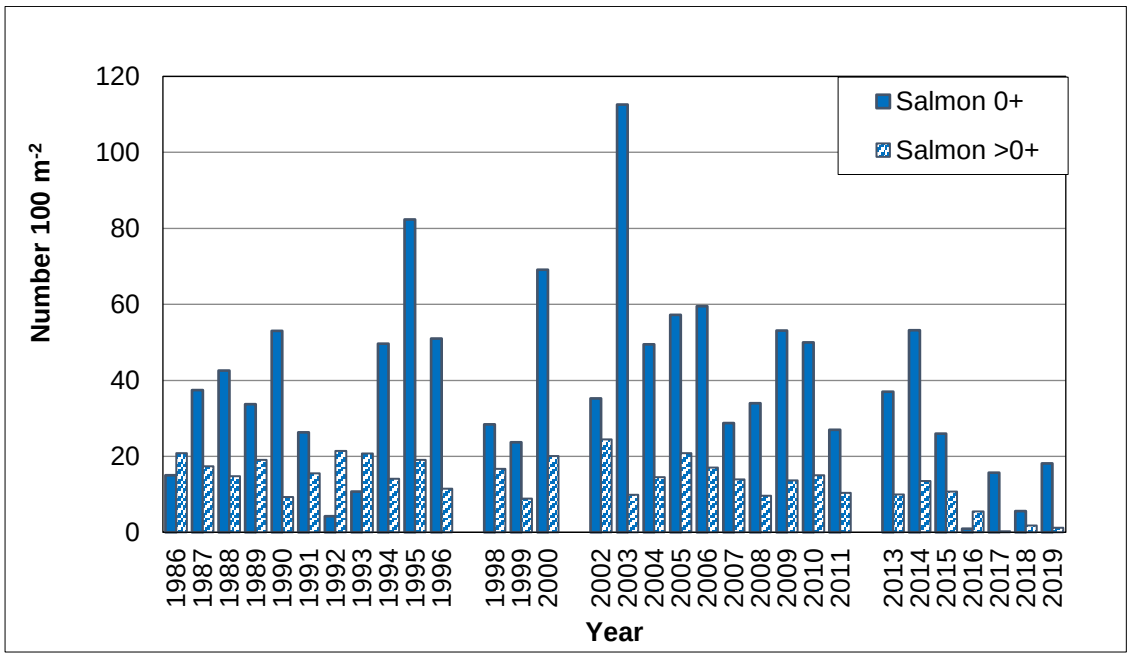
Table 5. Numbers of electric fishing sites of NFSC classifications A to F, surveyed by NRW on the River Usk in 2019 (data from NRW, 2019b).

			Number of sites	
Grade	**Descriptor**	**Interpretation**	**0+**	**>0+**
A	Excellent	In the top 20% for a fishery of this type	2	0
B	Good	In the top 40% for a fishery of this type	5	1
C	Fair	In the middle 20% for a fishery of this type	13	7
D	Fair	In the bottom 40% for a fishery of this type	11	3
E	Poor	In the bottom 20% for a fishery of this type	7	8
F	Fishless	No fish of this type present	35	54

Salmon parr numbers around the Usk catchment are reported as 'remaining at record low levels' (**Figure 2**) (NRW, 2019b). The density of 0+ salmon in the River Usk was low in 2019, averaging 18.1 salmon 100 m^{-2} (1986-2019, Q1 = 21.4 salmon 100 m^{-2}, median = 34.0 salmon 100 m^{-2}, Q3 = 51.0 salmon 100 m^{-2}) (**Figure 2**). The density of >0+ parr was also low as compared to other years, at 1.2 salmon 100m^{-2} ((1986-2019, Q1 = 9.8 salmon 100 m^{-2}, median = 14.1 salmon 100 m^{-2}, Q3 = 19.0 salmon 100 m^{-2}). The report notes that:

> 'There is little prospect of a quick stock recovery, 2016 spawning failure is now impacting recruitment. The low returning adult numbers in 2019 (part of which is grilse from 2016 progeny) will likely ensure low recruitment into 2020, inadequate spawning fish numbers will mean poor 0+ recruitment in 2020. Adult run size is predicted to be equally poor in 2020 due to the impacts of the 2016 0+ year class, MSW salmon from 2016 progeny are due to return in 2020.'(NRW, 2019b).

Figure 2. The average densities (number 100 m^{-2}) of salmon fry (0+) and parr (>0+) in the River Usk catchment 1986 – 2019 (from NRW, 2019b).



Review of Application

In section 7.3.2.1 of TR456 Ed2 (BEEMS, 2019) the applicant describes the Environment Agency & Natural Resources Wales's annual assessment of the spawning escapement in the 64 principal salmon rivers of England and Wales, stating: *"The assessed rivers of relevance to Hinkley Point impingement include the Severn, Wye and Usk. The EA/NRW assessment also includes an estimation of the annual number of adult spawners per river and the time series for these three rivers goes back to 1997 (Table 25). The adult salmon population in the 3 rivers has been relatively stable over the 21-year period but with an apparently increasing trend in the later years of the time series (Figure 14)."*

It should be noted that, although the specific source of data is not clearly referenced these figures are likely to be provisional figures created jointly with Cefas for the annual ICES reports. It is standard practice for these figures to be revised once the rod catch return system is finally closed down each year, generally a few weeks after the production of the ICES report. It should also be noted that the columns for the Usk and the Wye are labelled the wrong way around in table 25 of TR456 Ed2 as below.

Table 25 Number of salmon spawners (adults) by river and by year)

Year	Severn	Usk	Wye	Total
1997	4,011	6,528	4,663	15,203
1998	2,096	5,574	5,631	13,301
1999	2,083	5,465	5,816	13,365
2000	2,700	4,237	7,952	14,888
2001	3,354	5,954	8,219	17,527
2002	2,013	2,562	6,636	11,211
2003	3,977	4,464	3,403	11,844
2004	3,705	6,462	7,491	17,658
2005	5,170	5,746	4,720	15,635
2006	4,069	4,407	7,209	15,684
2007	2,522	3,970	8,629	15,121
2008	3,479	5,784	8,051	17,314
2009	2,549	3,414	3,704	9,667
2010	2,551	2,519	3,772	8,843
2011	4,658	4,896	5,213	14,766
2012	3,269	7,799	8,450	19,518
2013	4,507	7,778	4,658	16,943
2014	2,863	4,247	3,696	10,807
2015	7,830	9,405	6,097	23,332
2016	5,665	13,001	8,676	27,343
2017	5,139	9,471	8,966	23,576
Mean				15,883
Standard deviation				4,673

Source: Environment Agency/Natural Resources Wales.

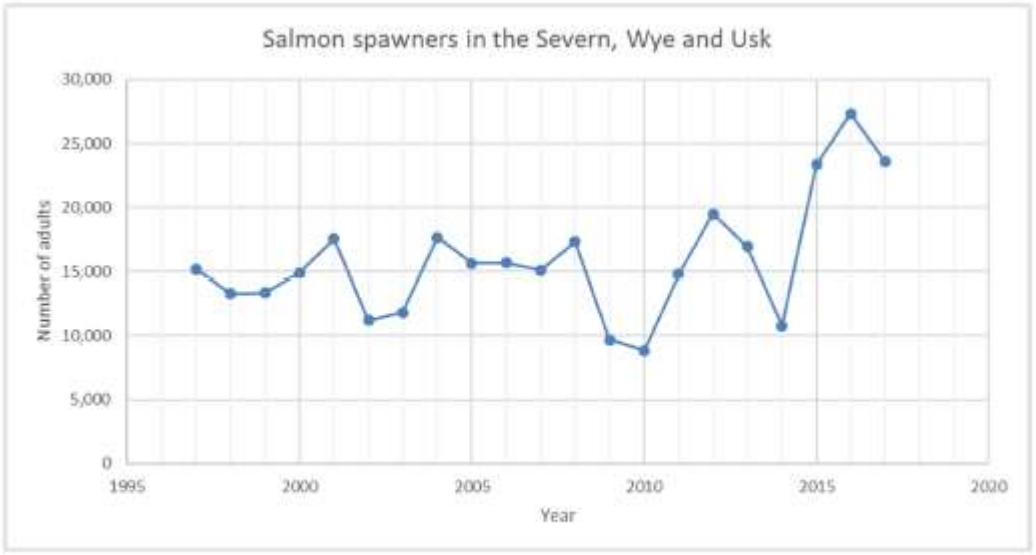


Figure 14 Adult Salmon trend from 1997 -2017

From this data (table 25, TR456 Ed2) the applicant calculates the mean number of adults within the population over this 21 year period as 15,883 with a standard deviation of 4,673. The applicant then uses this mean as the best estimate of SSB and two standard deviations below as a worst case SSB estimate (6,537).

These are then considered against the recorded adult salmon impinged in the 37-year RIMP programme (1981 – 2017). In comparing only adults impinged over the course of the RIMP programme, the applicant is assuming that the mean SSB level for 1997 to 2017 is representative of the whole 37-year period and that any juveniles impinged at HPB (and hence HPC) pose no benefit to the population.

Proposals

In its assessment, the Environment Agency will consider projected impingement losses at HPC in relation to the populations of Salmon Action Plan rivers.

This approach entails calculating the adult run sizes based on angling catch returns (and other sources of data where appropriate) for each of the rivers. The catch returns are scaled up for each of the rivers by applying a 10% increase (correction factor) to account for the unreported fish to give the most accurate run estimate. An exploitation rate is then applied, based on the index river it is most similar to (rivers where exploitation is measured using fish counters and rod catch data), giving the run size estimate for that particular river.

Where appropriate, additional data or assumptions are used. Salmon net catch data are included to work out an estimate for the Severn Estuary. A value for 'estuary losses' is also applied. This represents fish that make it as far as the estuary but then never enter rivers (natural mortality). This is an additional 10% on top of the sum of the estimates for all rivers.

Due to the use of the RIMP data to derive an annual mean impingement estimate for salmon at HPC, and not a year-specific data set (such as the CIMP), a comparable population estimate, ideally over the same time range, needs to be calculated.

Although there are some historic data from rod catches for the full time range of the RIMP data (1981-2018). The Environment and Natural Recourses Wales hold and have reported the rod catch data for the three principle rivers needing assessing in light of this permit variation application (Severn, Wye & Usk) since 1997.

The EA therefore propose to calculate a comparable annual mean run size for each of the principal rivers from these rod catch data, following the standard method described above, for the period 1997-2017. These principle river estimates are then summed and raised (as above) to produce an estimate of the Severn Estuary run size as a comparable annual mean (**Table *1***).

The estimates for the River Wye and River Usk remain the same as presented by the applicant (besides correctly labelling which river the data corresponds to) as NRW have confirmed the provisional data has not subsequently been updated. The River Severn estimates have subsequently been updated by the EA, due to a revision of the fecundity values used within the egg deposition model. This revision applies to the River Severn data alone.

Due to variability within these yearly estimates, a range of uncertainty will also be placed around the annual mean estimates. As there is no clear statistically accurate distribution present within this set of data, the minimum and maximum values for each of the rivers, and the minimum and maximum values for the raised estuarine estimate will be used to define these uncertainty ranges (***Table 2***). These ranges will

then be used within the uncertainty analysis process as outlined in TB013 - Uncertainty Analysis (EA, 2020).

Table 1. Run size estimates for the Principle Salmon Rivers, together with catch data from the net and putcher fishery, estimated natural mortality in the estuary and run size estimate for the Severn Estuary (see text for description of methods of calculation).

	Severn	**Wye**	**Usk**	Net & Putcher	Estuary Losses	**Severn Estuary**
1997	3,089	6,528	4,663	2,262	1,654	18,196
1998	1,832	5,574	5,631	1,857	1,489	16,383
1999	1,832	5,465	5,816	1,986	1,510	16,608
2000	3,237	4,237	7,952	984	1,641	18,051
2001	2,703	5,954	8,219	1,029	1,790	19,695
2002	1,931	2,562	6,636	1,196	1,232	13,557
2003	3,297	4,464	3,403	1,546	1,271	13,981
2004	3,158	6,462	7,491	777	1,789	19,677
2005	4,257	5,746	4,720	945	1,567	17,235
2006	3,524	4,407	7,209	870	1,601	17,611
2007	2,772	3,970	8,629	682	1,605	17,658
2008	2,911	5,784	8,051	875	1,762	19,383
2009	2,099	3,414	3,704	889	1,011	11,116
2010	2,317	2,519	3,772	245	885	9,738
2011	3,574	4,896	5,213	177	1,386	15,246
2012	2,465	7,799	8,450	217	1,893	20,824
2013	3,277	7,778	4,658	131	1,584	17,428
2014	2,089	4,247	3,696	177	1,021	11,230
2015	5,698	9,405	6,097	144	2,134	23,478
2016	3,959	13,001	8,676	168	2,580	28,385
2017	3,777	9,471	8,966	27	2,224	24,465
Mean	**3,038**	**5,890**	**6,269**			**17,616**
Minimum	**1,832**	**2,519**	**3,403**			**9,738**
Maximum	**5,698**	**13,001**	**8,966**			**28,385**

Table 2. Conclusion results of adult salmon population estimates.

Population	Used in Applicant's assessment	Used in Environment Agency's assessment	
		Predicted Value (mean)	Uncertainty Range (minimum - maximum
Severn Estuary	15,883	17,616	9,738 – 28,385
River Wye	N/A	5,890	2,519 – 13,001
River Usk	N/A	6,269	3,403 – 8,966
River Severn	N/A	3,038	1,832 – 5,698

References

BEEMS (2019) Revised Predictions of Impingement Effects at Hinkley Point C – 2018. Technical Report TR456 Edition 2 Revision 10. Cefas.

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