Environment Agency response to BEEMS Scientific Position Paper SPP107 Worst case glass eel entrainment assessment. (HPC-DEV024-XX-000-RET-100xxx Revision 02)

NNB GenCo (HPC) provided Cefas's BEEMS Scientific Position Paper SPP107 Worst case glass eel entrainment assessment (HPC-DEV024-XX-000-RET-100xxx Revision 02) for HPC in July 2020.

SPP107 did not form part of the Appellant's submission for the WDA (EPR/HP3228XT/V004), but this paper is now being produced as part of the appeal documentation.

SPP107 suggests that the Environment Agency (EA) estimates of glass eel (*Anguilla anguilla*) entrainment impact are overestimated due to a reliance upon glass eel trawl density data and presents an alternative assessment and a 'reasonableness test' examining the utility of the trawl density data.

SPP107 concludes that:

"*Based on the results of this assessment the following conclusions about eel mortality after HPC becomes operational have been derived:*

a) *The predicted impingement and entrainment losses after HPC becomes operational are negligible as a percentage of escapement biomass based upon precautionary assessments.*

b) *There will be no net losses of eels when HPC becomes operational. Due to the precautionary nature of the assessments, it is considered likely that there will be a reduction in net losses of eel as a percentage of escapement biomass after HPC becomes operational.*

c) *There will be no adverse effect on eels in the Severn and South West River Basin Districts from the operation of HPC."*

The EA has reviewed SPP107. A summary of the main points follows:

1) **The different input values for the initial entrainment impact estimate.**

   The initial estimated biomass of silver eel equivalents entrained as glass eel in SPP107 is broadly similar to EA estimates, although some of the input values are different. These differences, and the reasons for EA rejecting the Appellant's entrainment mortality input figures are explained.

2) Reasonableness Test approach

The EA consider the approach taken in the "reasonableness test" to examine the utility of the glass eel trawl density data is flawed. Using the trawl data to estimate the silver eel recruitment to the population from migration in the entire estuary introduces a high degree of uncertainty by extrapolating and interpolating data collected at very small and discrete spatial scales, to a far larger area. The approach has been considered for use in this current Appropriate Assessment by the EA, and elsewhere in similar work by EA, Cefas, Defra and other organisations but has been rejected in favour of different approaches. The subsequent entrainment estimate and conclusions drawn from the reasonableness test rely upon this population estimate but do not fully address the uncertainty it causes.

3) The basis for carrying out an updated eel entrainment assessment.

The Appellant states that "*The Environment Agency conducted an Appropriate Assessment in 2012 as part of the determination of the WDA permit for HPC. That appropriate assessment concluded that HPC would not have an adverse effect on the eel population of the Severn Estuary and Bristol Channel as a result of entrainment. Eels are not deterred by AFD systems and so the removal of the HPC AFD would have no effect on eel entrainment (nor impingement) losses*".

The EA agrees that AFDs are likely to be inefficient for yellow/silver eel and of no use in causing intake avoidance for glass eel, for which intake area, hydrodynamics and velocity will be the primary determinants of entrainment. EA do not claim that the proposed removal of AFD is the cause of a change in opinion on impact to eel in this current Appropriate Assessment (AA) - it has been driven by analysis of new, relevant and suitable scientific data in the current AA. EA are required to use the best scientific knowledge available as part of this assessment.

4) The basis for presenting a different conclusion on eel entrainment impact from the original 2012 AA.

The Appellant states "*The results of the 2012 survey were shared with the EA so that they could use them during the preparation of their Appropriate Assessment of HPC (Environment Agency 2012). The Appropriate Assessment concluded: "We would thus agree that such increases are not significant, and as these calculations are very conservative and are based on worst case scenario. We can therefore conclude that the abstraction at HPC alone will not have an adverse effect on the eel population of the Severn Estuary and Bristol Channel as a result of entrainment*"."

The Appellant then goes on to say: "*In the light of the previously presented evidence, the Environment Agency's conclusion in 2012 and the fact that the removal of the Acoustic Fish deterrent would have no effect on the abstraction*

of eel (impingement or entrainment), the eel entrainment calculation was not revisited in TR456".

However, the EA's position is that conclusions based on the current AA could not have been reached at the time of the 2012 AA, as EA were not in receipt of TR274 (received June 2014), which reported and synthesised the results of both the 2012 and the 2013 glass eel trawl surveys.

In addition, 3) above addresses the point about the need for a new assessment being unrelated to a change in risk to eel brought on by the proposed AFD removal.

Lastly, the fact that the eel entrainment calculation was not revisited by the Appellant at the time of the permit variation application does not remove the need for the EA to do so as part of its AA, as required by the availability of new and relevant scientific evidence on the matter.

5) Additional points of issue

There are additional points of issue which we have highlighted for completeness.

Each of these points 1-5 is considered below, with supplementary information where required:

1) The different input values for the initial entrainment impact estimate.

Glass eel density	HPC cumecs	Eels/s entrained	Number entrained in 90 days (flood tide)	Entrainment mortality	Glass eel mortality	Silver eel equivalents t
5.56E-03	131.86	0.733	2,850,455	20%	570,091	11.17

Figure 1 - Appellant's revised HPC eel entrainment input figures from SPP107.

EA took a glass eel density of 0.00309/m^3 of water, based upon the mean density across all pooled HPC intake location surveys, rather than the 0.0056/m^3 "peak" density shown in Fig.1. Using the same HPC intake capacity (131.86 cumecs), resulted in 0.407 eel/s being the entrainment rate estimate. Applying the same factor (3,888,000 to represent the number of seconds during flood tide conditions over the assumed 90 day migration period), the estimated number of eels entrained was 1,584,155. EA used an overall entrainment mortality rate of 34.04% rather than the 20% used by the Appellant. This figure was derived from a combination of:

- the 28.3% realistic worst-case mortality from glass eel Entrainment Mimic Unit (EMU) work (BEEMS TR273) for the 92% of the intake flow specified by the

Appellant to flow through the drum screens to the cooling water circuit (EDF 2016);

- the 100% entrainment mortality assumed for the 8% flow through the band screens to the Essential Cooling Water system (SEC) and the Auxillary Cooling System (SEN). No specific glass eel mortality could be applied to this route, in which pressures were higher than glass eel survival have been tested for in BEEMS TR273. This approach was agreed between EA and the Appellant during discussions over CW1 (EDF email 27 March 2015).

Therefore: (28.3/100)*92 = 26.04%
(100/100)*8 = 8.00%
= 34.04% total.

Further justification of selecting this mortality estimate is provided in the European Eel Feature Impact Assessment Template (FIAT). The EA continues to support the use of the 34.04% entrainment mortality figure.

2) Reasonableness Test approach

While the EA have adopted the use of the glass eel trawl data to estimate the entrainment impact, it is important to state that only the data collected at the specific proposed location of the HPC intake heads was used for this purpose. According to TR247, these data were collected within a localised area at and around the proposed abstraction point (in a zone about 1.5km long and 0.75km wide).

In the EA's opinion these are the best scientific data available upon which to base the entrainment estimates, because they represent site-specific, surveyed densities of glass eel for a given volume of water that could be drawn in to the intake heads, at different times throughout the expected migration period and over two migration seasons (which seemed to feature different recruitment rates).

EA acknowledge the seasonal and annual variation within the data, and have therefore taken mean values of all of the pooled HPC trawl glass eel density data in order to reduce the effect of this variation in their calculations.

The EA also recognise that the glass eel trawl surveys were novel, the first to be conducted in an estuary of this size and contain inherent imprecision, as detailed in Walmsley *et al. (*2018). However, they do offer excellent coverage of the specific area of the proposed intakes (Fig.2).

Each of the four intake heads will be 35.4m long and approximately 10m wide, along the direction of the cross-estuary transect proposed in SPP107 – collectively 40m of transect length. 51 trawls were carried out in the immediate vicinity of the proposed HPC intake heads using a 1.18m-wide sampling net. Assuming that at each trawl, a previously-unsampled part of the transect was surveyed, then a transect width of approximately

60m would have been surveyed, giving high resolution data with good coverage of the intake head locations. Plots of the shoot and haul positions of these 51 pooled trawls in Fig 1 suggest this is a reasonable assessment.

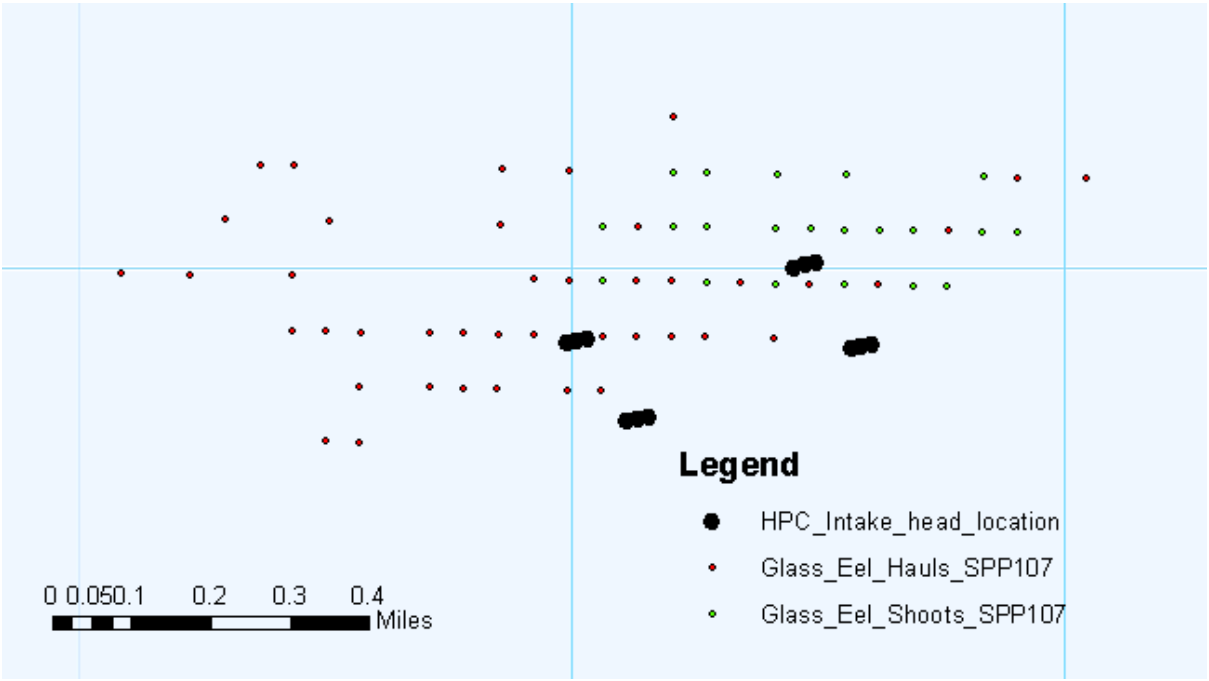

Figure 2 - Plots of the HPC-specific net shoot and haul points, relative to the proposed HPC intake locations (Source: TR247).

For the purpose of the reasonableness test, a selection of glass eel trawls are pooled in SPP107 to represent a 23km transect spanning the estuary. Approximately 250 trawls using a 1.18m-wide sampling net formed the basis for the density data for which the reasonableness test population estimate was made. Taking the same assumption that at each trawl, a previously-unsampled part of the transect was surveyed, then a transect width of approximately 300m would have been surveyed by these 250 trawls. With a total transect length of 23km, 300m represents 1.3% of the transect width for which a density estimate is available from the sampling. Fig. 3 suggests this also a reasonable assessment (bearing in mind the plots on the map represent a far larger area than the width of the net used).

This approach to forming population estimates upon which to base the AA was initially considered and deselected by EA as potentially factoring-up inherent imprecision and uncertainty in the localised density results. A similar approach had also recently been rejected by EA, Defra, Cefas and other organisations as part of Walker *et al*. (2020, in prep.) for the same reason.

The EA see these limitations as valid reasons to reject extrapolation and interpolation of the data across the full width, depth and flow rate of the estuary to construct full population estimates because it introduces unreasonable scientific doubt.

The Appellant subsequently uses the estimated silver eel recruitment to the population from migration in the entire estuary as a comparator to other estimates of “pristine” eel production and concludes that the basis for using the trawl data directly for either population estimation or entrainment impact is not reasonable and it results in an overestimation factor of at least 58. Based upon this, the initial entrainment impact assessment is reduced by a factor of 58 in the Appellant’s alternative assessment. For the reasons outlined above, EA reject this step, the alternative assessment and the conclusions which result from it.

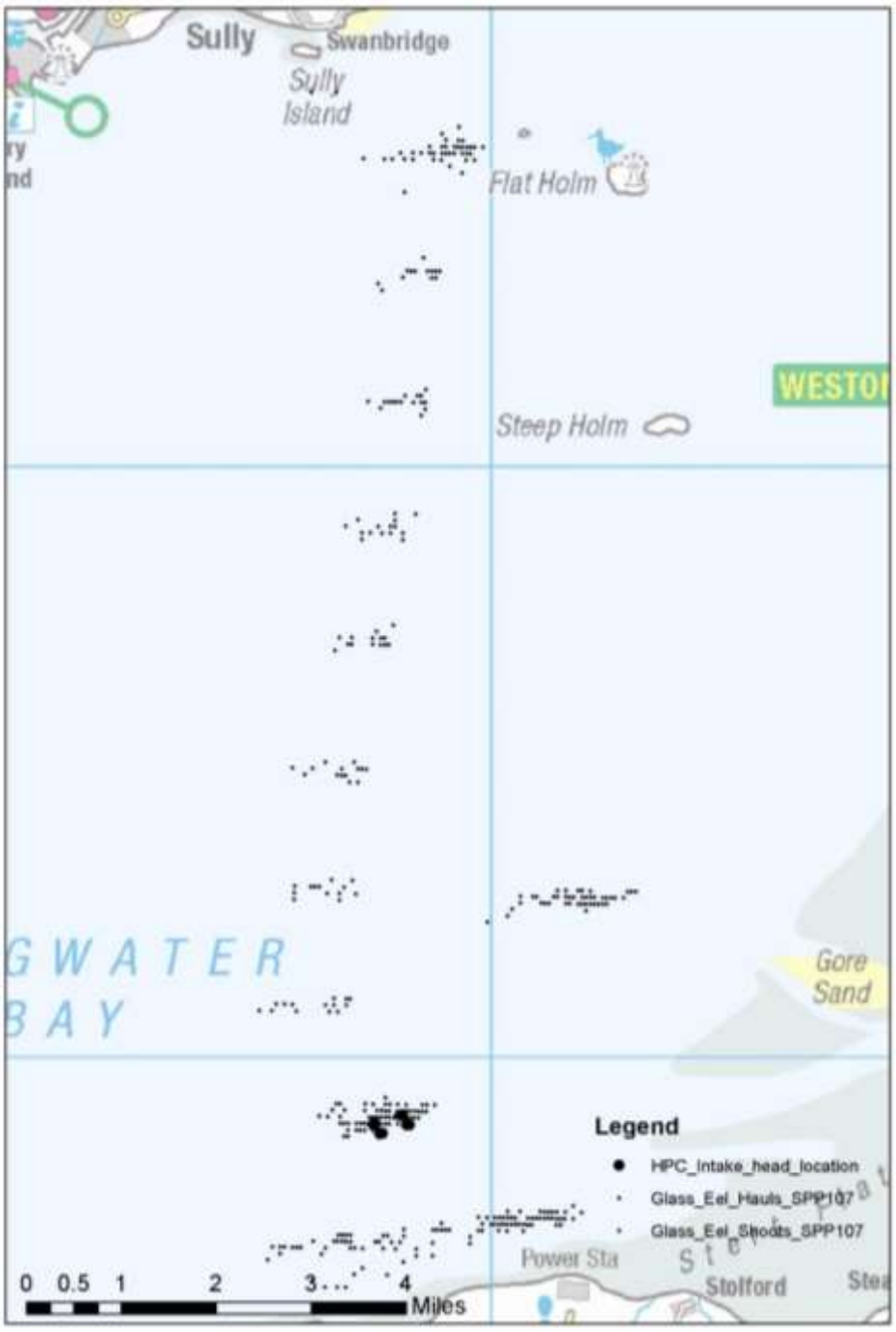

Figure 3 - Location of selected glass eel survey net shoot and haul locations used in the reasonableness test. (Source SPP107 and TR247)

3) The basis for carrying out an updated eel entrainment assessment.

No further information is provided here however the EA view on the lack of effectiveness of an AFD system for deflection of eels and the evidence supporting it is provided in greater detail in the EA Eel Regulations Assessment Report (AR002).

4) The basis for presenting a different conclusion on eel entrainment impact from the original 2012 AA.

No further information is provided.

5) Additional points of issue.

a) The Appellant considers that the reason for the silver eel recruitment estimate in their reasonableness test being so high is due to adoption from the EA's TB004 of the use of "invalid initial assumptions about the spatial and temporal variability of eel density in the estuary (namely that eels are uniformly distributed through the water column, their density does not vary annually or within season and make 100% use of the flood tide to migrate)". These three "assumptions" are explained in turn below:

i) Distribution of eel in the water column:

During the AA the eel density results at the three depths of the trawls were analysed for the data collected specifically at the HPC intake location. These showed that the 4-m depth trawls returned the highest density, with the 0-m depth ranked second and the 7-m depth third. These results all came from trawls carried out on the flood tide as none were reported on the ebb tide at the HPC site. These results differed from the reported pooled data for all sampling sites given in TR247 with highest densities being recorded in the top 0-1.4m depth. There is also evidence in TR247 that at sites where ebb tide samples were taken, eels were captured and sometimes in greater densities than at the same sites on flood-tide trawls. For example [N.B. it is likely that the trawl described below took place at HPB rather than HPC as described]:

"*For the last day of sampling, 4th March, the Cerulean left Penarth at around 1330h and headed south to repeat the tows of the proposed Hinkley 'C' intake site. Three tows were initially fished over the ebb tide at 0m, and this yielded a somewhat surprising 116 eels*".

These results did not clearly conform a simple explanation of selective tidal stream transport (STST) theory, where the eels would be expected at or very close to the surface on the flood tide and at or very close the bed on the ebb.

Broadly, the EA would expect glass eel in the estuary to exhibit STST behaviour but the evidence appears nuanced, and certainly as glass eel make vertical migrations through the water column across the tide range, they would be exposed to the risk of entrainment from the intakes for an unknown period of time.

In the absence of clear evidence to the contrary, the EA position is to assume that eel density is constant in the water column, but to limit the potential for overestimation by using a mean of the eel density data taken across all trawls and all depths at the HPC intake location, as the basis for the entrainment estimates.

ii) Taking account of annual or seasonal variation in eel density:

The Appellant highlights in SPP107 that glass eel density results varied considerably throughout the migration season and also between the two sampled seasons.

The EA agree with this point, both for the pooled data across all sites and the HPC intake-specific data. However EA can see no clear basis for reasonably choosing either a higher or lower glass eel density from the HPC intake location data by selecting or deselecting parts of the migration season, or choosing data from one migration year over the other. The EA position is to acknowledge these variations but minimise potential for overestimation or underestimation by using a mean density value of the HPC-specific data for the entire range of the period sampled for both migration seasons, as the basis for the entrainment estimates.

iii) Assuming glass eel make 100% use of the flood tide to migrate:

As outlined in 5)a)i) there is evidence that glass eel are present in the water column on both the flood tide and the ebb tide and therefore the available data for the Severn Estuary give limited support of a binary “flood tide = surface, ebb tide = bed” position. However, EA felt it appropriate to limit the time (relative to the tidal cycle) when glass eel would be most at risk from the intakes, in recognition of the behavioural principles of STST, which are well-evidenced in the Literature. On this basis a 50% reduction in any 24-hr period to reflect the flood tide conditions is felt to be neither over- nor under-precautionary.

b) SPP107 concludes it is “likely that there will be a reduction in net losses of eel as a percentage of escapement biomass after HPC becomes operational. This relies upon the assumed “*additional mitigation of the closure of Hinkley Point B (HPB) before HPC becomes operational.”* EA are not able to consider the closure of HPB as mitigation for the purposes of this AA.

Conclusion

The EA has reviewed SPP107 as part of the Appeal process. There are relatively small differences between the initial estimated biomass of silver eel equivalents entrained as glass eel between the Appellant and EA's methodology which have been explained and evidenced in this paper. The EA will continue to support the methodology it has used in the current AA.

The SPP107 reasonableness test used selected glass eel trawl data to estimate silver eel escapement biomass relevant to the Severn Estuary. When compared against reported population metrics it was up to 58 times greater than a reported "pristine" estimate which is far above the likely current local population size. This finding is used as cause to reduce the Appellant's alternative assessment by a factor of 58.

The Appellant considers that the reason for their silver eel recruitment estimate being so high is due to adoption from the EA's TB004 of the use of "invalid initial assumptions about the spatial and temporal variability of eel density in the estuary (namely that eels are uniformly distributed through the water column, their density does not vary annually or within season and make 100% use of the flood tide to migrate)".

The EA have addressed each of these assumptions in turn, in the light of needing to make an AA based on reasonable precaution. The EA conclude instead that the most likely reason for the reasonableness test producing an unrealistic estimate of silver eel recruitment in the Severn Estuary is because it relies upon factoring-up eel density data that already contains inherent imprecision and was sampled from less than 2% of the width of the Estuary in order to represent the unsurveyed 98% of the Estuary.

In contrast, the EA concludes that the use of the mean eel trawl data taken at the precise location of the proposed intake heads with almost complete coverage and high spatial resolution represents the best available scientific evidence upon which to base their AA, and that it has also carried out and presented an uncertainty analysis to complement the assessment; the results of which have been presented in the AA.

References:

Appropriate Assessment for the Hinkley Point C Permit Variation EPR/HP3228XT/V004. Environment Agency 2020.

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BEEMS Technical Report TR273. Entrainment Mimic Unit (EMU) Experimental Programme Report: European glass eel (*Anguilla anguilla*), June 2013. Cefas, Lowestoft.

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