Cyfoeth Naturiol Cymru
Natural Resources Wales

Our ref: ORDML145 28th March 2018

Dear Tim,

This letter sets out NRW PS's feedback on TLSB's sensitivity and scenario testing protocol. NRW PS has considered your submission and consulted relevant technical experts. This response is our conclusion on the assessment of all the evidence presented and you are required to address all the points listed below. In addition, this letter provides NRW PS's position with regards to the approach to be used for EIA fish population impact thresholds and it also provides a response to two questions raised by TLSB in relation to the methodology for WFD assessment for fish.

**Sensitivity and scenario assessment**

In response to your submission of the "*Tidal Lagoon Swansea Bay Fish ADZ sensitivity testing and scenario testing protocol v1.0 February 2018*", which was received by NRW PS on 21/02/2018, I can provide the following comments, all of which must be addressed in the sensitivity testing to ensure that the outputs are fit for purpose. These comments also address the issue of retention time and your email dated 8th March 2018.

Para 1.1.2, Figure 1.1: This figure appropriately includes the Striker model within the overall approach for evaluating fish population impacts, but no further mention is made of this part of the assessment in the sensitivity analysis. The output values from the Striker model should be included in the sensitivity analysis.

Para 1.1.4 and Appendix A: In previous submissions, TLSB has evaluated various alternative model scenarios (Appendix A), but you have not conducted a systematic analysis of the sensitivity of the assessment model to different parameter values.

Para 2.1.5: the sensitivity tests must be conducted in line with the parameters and validation set out in the model validation and model parameters sections of this letter and in the attached spreadsheet. These reflect our current position on the modelling however this is subject to change pending review of the outputs of the sensitivity and scenario testing.

Para 2.1.6: The sensitivity test should include all parameters other than those that are known, such as the duration of the tidal cycle. This may include parameters for which a range has not been used, such as the population range and age structure of herring.

Tables 2.1 and 2.2: The amount of change that will be applied to the parameters is a little unclear. Table 2.1 refers variously to amendments of ±30%, up to ±30% and ±40%, and Table 2.2 suggests that changes of + and – 10%, 20% and 30% will be used. Consistent changes should be applied to all parameters to aid comparison of the effects of each input parameter on the outputs. The use of six different changes covering both positive and negative values suggested by Table 2.2, should provide a comprehensive picture of the nature of the relationship between each input parameter and the results; this would not be achieved with a single percentage change. These changes may however not be precautionary enough for some parameters where there is low confidence the data, and for these, sensitivity testing should be undertaken over a far greater range.

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Tables 2.1 and 2.2: further to the above, justification should be provided to explain the reasoning why the chosen range of changes have been selected for each parameter and the evidence to support this. Where a test is 'not applicable' to a certain species, reasoning should be provided to explain why it will not be tested.

Tables 2.1 and 2.2: These Tables only refer to changing the mean, but changes should also be applied to the range (i.e. the difference between minimum and maximum values or the S.D.) as this will also affect the impact assessment at the 95% and 99% levels.

Table 2.1 and 2.2: Sensitivity analysis should be provided for the chosen distributions within the Monte Carlo model. Input parameters with uniform distributions should be tested by applying the changes to both the minimum and maximum values; this is the same as changing the mid-point (equivalent to the mean) but keeping the difference between the minimum and maximum values the same. The range between the minimum and maximum values should also be tested, as a separate exercise.

Table 2.1 and Para 2.2.4: The choice of an anadromous species (Atlantic salmon), a catadromous species (European eel) and a marine species (herring) is reasonable, but the models for nearly all species are different. The full range of HRA/WFD species should be tested; salmon, sea trout, European eel, shad river and sea lamprey. In addition, testing should be carried out for any marine species where the predicted impact level at the 95$^{th}$%ile threshold is close to the significance boundary of 2% mortality at the population level; and more limited sensitivity tests should be run on the other models to confirm whether they respond to parameter changes in a similar way to the primary examples.

Table 2.1: Population range – migrant life stages: As noted in the footnote, the population range for these life stages is determined by the swimming speed over a certain number of tides. The effects of changing swimming speed will be investigated separately, but the effect of changing the number of tides used to estimate the population range should also be investigated. This applies to both salmon and eel.

Table 2.1: Duration of fish presence: The proposal is to change this parameter by ±40% for salmon, but it is not clear whether this is the only change planned or whether it is in addition to applying the same changes as for other parameters. All parameters should be changed by the standard amounts, although as noted above, additional changes will be required for some parameters.

Table 2.1: The number of tides for which silver eels are present should also be tested.

Table 2.1: Swimming speed: Changes should also be applied to smolts.

Table 2.1 Avoidance should be tested using the Cefas approach as set out in the attached model parameters and validation for sensitivity analysis spreadsheet. In addition, the model should be run to show the effect of no avoidance.

Table 2.1: Age structure: For eels, the 'duration of presence (years) as residents' should also be tested (NB: This is not the same as the parameter referred as 'duration of presence' above.)

Table 2.1: Similarly, the age structure of herring should be tested. Cefas has advised that one option for doing this would be to use the current age structure to derive the total annual instantaneous rate of mortality (Z) between consecutive year classes [i.e. Z = -ln(N(age i+1)/N(age i)]. Z can then be increased/decreased in a similar way as other parameters.

Table 2.1: Sex ratio and Fecundity: Changing the proportion female for both 1SW and MSW salmon at the same time should not affect the impact assessment; the test needs to involve a change in the fecundity of 1SW fish relative to MSW fish.

Table 2.1: Similarly, changing the fecundity of all age groups of herring together should not affect the impact assessment; the relationship between age and fecundity needs to be modified.

Table 2.1: The sensitivity of the eel model to changes in selective tidal stream transport (STST) and diurnal behaviour should also be investigated.

Table 2.1: Sensitivity testing should be undertaken for fish length.

Table 2.1: as set out in comment 11.4 of the parameters spreadsheet, the sensitivity analysis should test the population range of sandeels. The scenarios tested should reflect the potentially large changes to sandeels using Swansea Bay as habitat.

Table 2.1: as set out in comment 7.4 of the parameters spreadsheet, the sensitivity analysis should test the impacts of larger/smaller life stages for eels.

Table 2.2 (and paras 2.2.2 and 2.3.2): the effects of changes should be compared on the 95$^{th}$%ile impact values for trout, herring, sandeel, cod, whiting, bass, plaice and sole, and the 99$^{th}$%ile for allis shad, twaite shad, river lamprey, sea lamprey and Atlantic salmon.

Para 2.2.1 and Appendix B: The proposed assessment of the reliability of the evidence used to derive the parameter values and ranges is potentially helpful. However, the reliability of a parameter value may be affected by the three factors, ‘data source’, ‘location’ and ‘species/lifestage studies’ independently, and a high score for one (or more) factor will not necessarily compensate for a low score in another. In addition, the need for data to be derived from the same site will depend upon the parameter. As a result, the addition of the three scores to provide a ‘high’, ‘medium’ or ‘low’ certainty level may be misleading.

Para 2.2.3: Figures may be helpful where they clarify the relationship between a specific parameter and the overall impact assessment (e.g. is the relationship linear?). Figures (e.g. bar graphs) should also be provided showing the increase/decrease in the impact assessment when each parameter is changed by the same amount; this will show the relative sensitivity of the model to different parameters.

Figure 2.2: Charts will need to have the axis range that encompass the data spread. It would be clearer to show the ‘alternative value’ centred around 0% rather than 100% as this relates directly to the proposed changes. All results should be presented in both graphic and tabular form.

Para 2.2.5: indicates the importance of swimming speed values and how not evidenced values might draw the model to unrealistic scenarios. It is important to keep in mind that the results of the sensitivity testing proposed here are to understand the model behaviour to changes in the parameters only. Hence it should not matter whether the sensitivity testing process uses not accurate values. It may then be good to indicate on the process table (2.1) the realistic range of the parameter.

Para 2.2.5: The MCA uses fish cruising speed and not the maximum sustained swimming speed (MSSS). It is not therefore appropriate to consider “a range for the cruising speed to the MSSS”.

Para 2.3.2: Limited information has been provided on the proposed in-combination changes that will be tested and so it is not possible to comment on them in detail. Some in-combination testing is likely to be informative, but it will need to be conducted on an exploratory basis. Population range is also likely to be a key parameter and so should be included in combination tests.

Table 3.1 and Para 3.2.2: Retention Time: Little information has been provided in the protocol on the proposed additional scenario testing and in a follow up email dated 13/03/2018 TLSB stated that '*we do not consider it would be appropriate or meaningful to try to add retention to the model'*. NRW PS has been advised by consultees that testing of replacing cut off dates with retention times for salmon, sea trout and silver eels is important, and as such, NRW PS instruct that this should form part of the sensitivity analysis. Previous scenario testing retention time by TLSB has used complex patterns of retention making it impossible to determine the effect of increasing retention time on the impact. It is important to keep the assessment simple. Cefas has previously advised TLSB (Alex Scorey – email dated 3/03/2017) of a method for incorporating retention time in the ADZ-MCA models. Given that TLSB has not provided a methodology for this in the sensitivity and scenario testing proposal, NRW PS direct that this should be undertaken in line with Cefas's method (see attached). NRW PS has spoken with Cefas about this method and they have checked the equations in their proposed methodology and have advised the following:

i. the '10' in the second formula should be 't', so the formula should read:

   p(retained) = (1-p(exit per tide))^t

ii. the equations do not indicate the full method for including retention in the 'ADZ-[stage]' worksheets of the ADZ -MCA models. The above equation calculates the proportion of fish entering the lagoon on each tide that will be 'retained'. Further adjustments have to be made to calculate the number of fish killed as they leave the lagoon. Clearly the proportion of fish entering the lagoon on each tide that will leave before the retention time limit is reached will be 1-p(retained). This value should be used in place of the 'No. alive in lagoon between tides' (Col I) to calculate the number that will exit through the turbines and the number of these that will be killed.

Table 3.1: Population range of sea trout: This scenario testing has been requested to investigate the effects of the density of fish being greater towards the shore or around the draw zone. Amendments of much more than 30% should therefore be considered.

Table 3.1: a scenario should be run to test the inclusion of a cut-off date or retention time for adult shad.

**Model validation**
The sensitivity and scenario testing must be undertaken in line with all of the comments provided by NRW PS in column D of the model validation tab of the attached 'Model parameters and validation for sensitivity analysis March 2018'.

**Model parameters**
The model parameters that should be used for the sensitivity testing are set out in the model parameters tab of the attached excel document titled 'Model parameters and validation for sensitivity analysis March 2018'. Please ensure that all the parameters given in column D are used for the sensitivity analysis. Please note that these are provided for the purpose of the sensitivity analysis and are not necessarily NRW PS's final position on model parameters.

In addition to the comments in this spreadsheet we have the following comments to make:

i. Cut off dates for river and sea lamprey should be amended as the dated are too late into the spawning season to allow fish to pass out of the lagoon and complete their migration into the rivers. Based on spawning periods provided in Maitland PS (2003) 'Ecology of the River, Brook and Sea Lamprey' spawning of river lamprey occurs in March and April, but the model has used a cut-off date of Mid- April. Similarly, sea lamprey spawn in late May or June, but the model uses a cut-off date of Mid-June. As the model outcome may be sensitive to the cut-off date, and based on the reported spawning periods in the literature being earlier, we advise that the cut-off date for river lamprey is moved to mid-March, and the cut-off date for sea lamprey moved to 1st June.
ii. Attraction – any tendency for fish to be more concentrated towards the shore or around the development could result in the ADZ model underestimating the impact. This will need to be taken into account, along with other factors not included in the model, when evaluating the final results.

**EIA magnitude thresholds**

NRW PS has considered your proposed alterations to the criteria to be used for evaluating the magnitude of the estimated impacts of Swansea Bay Tidal Lagoon on VERs, which is set out in Table 4.1 of the *Alternative Fish Impact Assessment – Addendum 1, Monte Carlo Analysis of Alternative Draw Zone Models, June 2017*.

NRW PS are of the view that the method proposed by TLSB in the June 2017 submission of applying the significance threshold to each life stage independently to derive population thresholds, is not appropriate, and there is no biological rationale for the way they have been developed. As such, the values within Table 9.5 of the Environmental Statement should be used and should be taken to be annual % impact to the population due to turbine strike.

**WFD methodology**

NRW TE has provided the following responses in answer to your questions:

1. **Please could NRW(TE) specifically list the 'other contributing factors' which should be considered when defining the overall impact level and the method proposed?**

*"NRW TE note that several sources of potential impact of the proposed development on fish have not been incorporated into the MCA. Some of these remain qualitatively considered, but are not included in the overall impact assessments submitted. These factors include a range of critical fish behavioural responses including, but not limited to:*

- *coastal orientation of diadromous fish during their homing migrations;*
- *the potential impacts of fish attraction to the structures;*
- *fish aggregations at the structure;*
- *fish shoaling behaviours;*
- *predation by fish, birds and mammals known elsewhere to be strongly attracted to feeding opportunities at such structures.*

*Each of these are well known features at coastal structures elsewhere. NRW TE have previously provided comments on these during the Marine Licence application consultation process".*

2. **Given that there is no agreed method for assessing the potential effects of the project on migratory fish in individual river and transitional WFD water bodies, TLSB presented a method based on the FCS2 and the TFCI tools (used by NRW and the EA to classify river and transitional water bodies for the fish quality element) that would demonstrate that the level of predicted impacts would not cause a risk of deterioration in status of an individual water body or prevent the objective of achieving good status or potential in terms of the fish quality element. To further support this, the effects of the project were also qualitatively examined in relation to the normative definitions to further evidence conclusions. TLSB request full details of the methodology that NRW advise should be used for an assessment of the specific effects of the project solely against the normative definitions within an individual water body as none has been provided to date during discussions.**

*"NRW TE do not consider the approach utilising "an approximation of the FCS2 tool" to be a scientifically robust approach to the assessment of impacts to fish. In summary, this is because:*

- *It does not represent a year-on-year impact and therefore doesn't consider the cumulative impact over time of a project.*
- *It does not to consider the relative contributions each species both diadromous and resident makes to the EQR, both in terms of the current classification and at the calculated level of loss.*

*As previously set out, in the absence of an approved methodology for the assessment of potential effects to fish in river and transitional WFD water bodies, NRW TE advise that the approach to be taken should be to apply expert judgement to each water body, utilising the normative definitions. Furthermore, NRW TE take this opportunity to remind the Applicant that we are yet to agree impact levels upon which the assessment will be based. Additionally, NRW TE remind the Applicant that certainty regarding the project's compliance with the Directive is required at the marine licence consent stage; hence, where deterioration 'may' be caused, derogations under Article 4.7 of the WFD are required at this stage".*

If you require any clarifications regarding the above instructions, please contact us at your earliest convenience.

Yours faithfully

**Eleanor Ellick**
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