

Interactive comment on “Variability in stream discharge and temperatures during ecologically sensitive time periods: a preliminary assessment of the implications for Atlantic salmon” by D. Tetzlaff et al.

Anonymous Referee #3

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MS-NR: hessd-2005-0023 D. Tetzlaff, C. Soulsby, A. Youngson, C. Gibbins, P. Bacon, I. Malcolm and S. Langan Variability in stream discharge and temperatures during ecologically sensitive time periods: a preliminary assessment of the implications for Atlantic salmon

GENERAL COMMENTS This manuscript seeks to improve understanding of the links between stream discharge, water temperature and two life stages of Atlantic salmon (resident juveniles and returning spawners). These hydroecological associations are poorly known; and this study represents a fairly unique opportunity to address this research gap due to the availability of high resolution and high quality paired hydrological-

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biological data sets, which are rare. Hence, the paper has the potential to provide a very useful contribution to the literature. The authors clearly recognise the complexities and limitations of such multivariate, interdisciplinary research both in the title (i.e. “preliminary assessment”) and in the Discussion, and so address many of the criticisms that are often unfairly levelled at such work. They also recognise the need to upscale these initial findings from the site to wider basin.

As currently orientated, the paper seems to be diverting attention away from the real utility of the work (see next paragraph) toward a critique of the resolution of data used in previous instream hydroecological studies. The authors focus attention on the use of 15 minute time-step data and claim the use of high resolution data offers greater insight than daily or monthly information; however, this assertion is not tested in the paper (see specific comments below). Oddly, it would appear that the paper often uses daily data itself, with only the velocities presented at 15 minute resolution. If the authors decide that the goal of the paper is to make a comparative analysis of time-scale of analysis, then clearly addition data mining is required. The practicalities (i.e. collection) and historical availability of 15 minute resolution data needs to be considered in relation to river management and EAFs.

The main innovation of the paper (in addition to the reporting upon a valuable data resource) is the use of critical displacement velocities (CDV) to provide a physically-biologically meaningful bridge and to simultaneously consider the influence of river discharge and temperature on fish. This aspect of the research is not well highlighted by the authors in the aim/objectives or elsewhere. CDV seem a very useful potential hydroecological tool but does not get adequate recognition. Some further contextualisation of CDV is need (in the Introduction) with respect to the limitations of alternative approaches to assessing hydraulic (as opposed to hydrological) habitat. There is no clear need for further analysis if the authors decide the manuscript’s focus is on CDV and providing a meaningful ‘missing link’ between hydrology-hydraulics-fish; but if data resolution is the focus then further analysis is unavoidable.

In terms of general expression and organisation, the paper needs refinement. The introduction requires streamlining and restructuring. Aspects of the Study Site and Data and Methods are overlapping and contents are misplaced between the two. In the Discussion, it is often difficult to differentiate between new findings of this study and previous work. The inclusion of a short conclusion would help reinforce the key points for the reader, which are somewhat lost in the current discussion. The manuscript requires editing in a number of places for accuracy and clarity of phrasing. The authors should also take the following specific points into consideration.

SPECIFIC COMMENTS Introduction 1. The Introduction is fairly lengthy. A number of themes are introduced but the chain of thought does not flow particularly well. The whole section could be streamlined to make key points clearer. 2. p. 694, para. 1: the basis is not well established for the assertion that that monthly or daily mean physical habitat data may not allow meaningful correlations with ecological data. Some acknowledgement also needs to be made that daily data are most likely the highest resolution available to river managers. The manuscript seems contradictory as the need for “short-term” data is exemplified by a paper (Schlosser, 1995) that uses daily data itself. 3. p. 694, para. 2: a few confusing contradictions sub-arctic climate vs. temperate rivers and “least disturbed rivers” vs. “many” hydropower production and have regulated flow regimes”. 4. p. 695, para. 2: This information should come before the preceding paragraph on the Scottish Highlands. 5. p. 695, para. 2: change of terminology from “hydrological” to “hydraulic” requirements without explanation. 6. p. 695, para. 2: it would be useful to know which aspects of the flow and thermal regime (and for what periods) have been shown in the literature to be most important for salmonids. 7. The authors seem to miss a key point (i.e. a unique aspect of this research), that is the availability of a long-term, high resolution paired ecological and hydrological time-series. Such resources are frequently lacking in hydroecological investigations. 8. p. 696, para. 1: The latter part of the paragraph is unclear and needs rephrased. For example, what is meant by a “biologically realistic way”? (see annotated manuscript)

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Study site 9. p. 696, para. 2: some confusion between data collection/ availability and review of previous studies in the Girnock Burn. When did data collection begin for discharge and water temperature (cf. fish monitoring since 1966)? Assessment of homogeneity of time-series? 10. p. 697, para. 3: the definition of periods should be in the methods section, as this is not related to the character of the study area, rather the analytical framework. It would be interesting to see these key ecological windows mapped onto a long-term annual hydrograph and thermograph.

Data and methods Hydrological and hydraulic data: 11. Given the wealth of long-term daily data, there seems to be much scope for using these data in addition to 15-minute data over last 10 years. The better performance of these higher resolution data (cf. daily data) in predicting ecological response needs to be established. Is there scope for some nested analysis? 12. Why is it necessary to derive hydraulically-meaningful data from discharge measurements? The need to identify the ‘missing link’ between discharge volumes and hydraulic habitat was not identified in the Introduction. It is unclear how velocity data will be used in the paper. Without the explanation of CDV (in following section), the estimation of velocities appears to be just a rescaling of discharge that is confounded by necessary assumptions. There is a clear need for an overarching explanation of the methodological approach, including how the elements fit together at the outset of Section 3. 13. A definition (timeframe) of the hydrological year is not provided; this is important for an international readership. Stream temperature 14. Hourly temperature data vs. 15 minute discharge - what is the time-scale for combined analyses? 15. The methodology for water temperature gap filling is unclear (perhaps incorrectly expressed?). It seems highly unlikely that monthly relationships were used to fill daily data. What is the resolution of air temperature data for Aboyne? 16. Why is a degree day approach used over actual hourly observations? This approach seems to contradict paper’s goal to explore the utility of high resolution data for hydroecological analysis. Biological data 17. p. 699, para. 3: what was the nature of the best fit lines? 18. Despite the critique of daily data for hydroecological analysis and the decision to only analyse the last 10 years due to lack of 15-minute resolution data,

it becomes apparent later in this section that CDVs are calculated daily. This appears contrary to the manuscript's stated goal.

Results

19. A time series of discharge may be more useful than flow duration curves in identifying inter- and intra- annual flow variability (perhaps data could be aggregated-up given flash response of basin?).

20. Figure 5 shows cumulative discharge plots not flow duration curves as suggested in the text.

21. How were discharge statistics in Table 1 "selected"? (cf. host of variables identified by Richter et al., 1997; Olden and Poff 2003 etc.)

22. Is inter-annual variability "marked", if mean annual stream temperatures range by only 1.3°C across 10 years (cf. error of 0.6°C)?

23. The potential problems of using site-specific temperatures (shaded location at Littlemill) to upscale to the wider basin are clearly and honestly identified; but perhaps this issue should be flagged earlier in the manuscript.

24. Why use 15 minute velocity data and daily CDVs?

25. p. 703, para. 2: evident contradiction as low inter-annual variability in CDV is explained by limited year-to-year variability on stream temperature, which has been described as "marked" in the previous section (see point 22).

26. p. 704, para. 2: it is unclear what is meant by a "more biologically relevant temporal resolution".

Discussion

27. p. 706, para.2: "finer scale variation in discharge" is unclear. Were 15 minute or daily data employed? If the former, do higher resolution data pick-up the occurrence of flow pulses any better than daily flows (although instantaneous values will be recorded, the pattern of events over the year would be similar)?

28. p. 707, para. 1: What explains the threshold of 0.3m³s⁻¹ to fish entry - geomorphological impediment, biological response etc.?

29. p 707, para. 2: the "importance of regular discharge variability for ecological integrity" appears to be taken out of context.

30. p. 707, para 3: it is difficult to agree with this point in the absence of comparative analysis between average (daily and beyond) and 15 minute data.

Figures

31. Figure 2: shading of bars cannot be differentiated on grey-scale.

32. Figure 3: why does the caption state "(autumn)"?

33. Figure 5: why are unit for discharge mm

(cf. rest of paper m3s-1)?

Tables 34. Table 2: it would be better to omit summary statistics from the table when the % missing data is very high. For example, it seems somewhat misleading to give summary data when 81% of data are missing for Period 3, 1998-9.

TECHNICAL CORRECTIONS Please see annotated manuscript returned to the HESS Editorial Office.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 691, 2005.

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