

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 #2

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General Comments

Tetzlaff et al. use hourly and sub-hourly data to attempt to characterize intra and inter- annual variability in hydraulic variables and temperature in Girnock Burn and relate this to ecologically sensitive time periods of Atlantic salmon. The context of the manuscript is that we need to better understand the relationship between organisms and flow regimes in rivers to derive ecologically acceptable flow regimes (EFAs) to successfully implement and meet criteria set forth in the Habitat Directive and EU Water Framework Directive. As the title suggests this is a truly preliminary assessment. A major premise in the ms is that data collected at very fine resolution (hourly and sub-

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hourly) will provide better insights than cruder data based on daily, weekly or monthly means. However, the authors fail to make use of the wonderful opportunity to test this, which is essentially what I expected from the ms. Although it is always implied that the fine-scale data is superior to other coarser data, this is never explicitly tested and leads me to wonder about what relationships would and would not be detected using the two data types. Perhaps as the authors revise the ms, they could re-analyze their data at a traditional coarser scale (using some sampling approach to create a subset of coarser data from their data set) and then undertake a comparison of relationships found and missed with each data type. Given the effort and expense involved with fine-scale data collection I also wonder how many scientists would be in a position to complete such a fine-scale analysis i.e. how realistic is this fine-scale data approach in the real world of limited funding and personnel shortages. Probably many fewer than the number of rivers being altered. However, by focusing on a comparison with coarser data (which is probably being collected on many more rivers) this ms could truly add to our understanding of what we may be missing and show when and where our sampling efforts should be concentrated.

Specific comments

In general the manuscript includes much jargon and imprecise writing which needs to be addressed. The first part of the introduction needs to be connected in a meaningful way to the specific objectives the authors actually undertake. Much of the first part of the introduction deals with ecosystem functioning or productivity, but these are not specifically related to the objectives of characterizing hydrological and thermal regimes over 10 yrs and the relationships between variability in discharges, temperatures and fish behaviour (potential for juvenile fish to forage; and migration of sexually mature adults to spawning areas). I was also surprised by the lack of agreement between the objectives and the 'fine-scale' data actually used. For example one of the objectives was "to characterize hydrological and thermal conditions over the 10 hydrological years using high resolution data (hourly and sub-hourly)" p695 - yet on p 698-699 the authors

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state that hourly resolution temperature data gaps were filled from monthly time scale linear relationships, and then they calculated degree days by summing mean daily temperatures. I fail to be convinced that these data are any different than those collected by most researchers or weather stations. In addition, the authors are aware that their gauging station temperatures (shaded) are not reflective of temperatures in other parts of the catchment which are unshaded (p 702) and experienced by the migrating salmon and salmon fry. This leads one to question the validity of the CDV comparisons and raises the thorny issue of the influence of within-catchment variability to swamping any potential of finding meaningful relationships. Along with the temperature variability, one must also consider the flow variability. The authors assume that the average flow determined at the gauging station is reflective of conditions throughout the catchment. Although they acknowledge in both the methods and discussion that this is unlikely, their entire analysis rests on the assumption. Again, given the within catchment variability, one wonders if data collected at a coarser scale would lead to the same conclusions as achieved with the 'fine-scale data. However, this remains to be discovered. The authors have the data at hand and are poised to address this in a future revision.

Technical corrections

692 L25 'drivers' of what? Be explicit 693 L2 'major effects' - what are these? L3 'ecosystem processes' - such as? L4 'key driver' of what? L10 'ecological functioning' - what do you mean? L27 'ecologically meaningful' - explain L28/29 'ecosystem functioning or productivity' explain 694 L4 'This is probably not the case' - explain why daily or monthly means - and the manner in which they are collected are not sufficient using data and or references. This is central to your use of fine-scale data and needs to be fully rationalized L7 'longer' than what? L8/9 'biological responses' explain which ones you mean (feeding/reproduction/ behaviour/ movement?) L12 'ecological functioning' - explain L19 'ecological sensitive periods' - of what? All biota, fish, invertebrates? 695 L2 'Many Scottish rivers are used for hydro power...' this seems contradictory to p694 L20 'The Scottish highlands contain some of the least disturbed rivers in Eu-

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rope..' - clarify L8 'correspondingly important' - to what? L8-20 constant switch between salmon, salmonids - be consistent. Salmonids include trout and salmon include many species including Pacific, Coho, King, Pink etc. If you mean Atlantic salmon, say so. 696 L16 'smaller' than what? L17 'extensive data sets' describe more fully L17 'abiotic conditions' - give parameters L20 'high variability' on what scale? (hourly, daily, seasonally, yearly) 697 L15-16 '...period 1 in this paper) bounds the time during which the majority of ready to spawn salmon....actual spawning occurs during... L26 '...in the context of likely ecological implications' what do you mean - clarify 698 L20 '...presence of low velocity refugia at high flow.. see above comment- what is the implication of this to your whole study? 'derive a mean velocity time series for each hydrologic year' this is the same approach used by others with coarser data - yet you argue for sub-hourly data - comparison should be of your data to coarser data - see comments above regarding overall direction of ms L23 'total error' what is meant by this? 699 L12 'prolonged periods' explain 10 min, 1 hr etc. L14 'correspondingly constrained' to what? L17 How do CDVs from flume experiments translate into real world behavior - elaborate L 18/19 'higher' than what? L27 'using linear trend series filling' explain or provide a reference 700 L11 omit 'routinely', 'on a' and 'basis' L14/15 move to results. Is Figure 3 necessary? You give data in Figure 9 as well. L21 Delete first sentence L22 drop s on discharges; add 'flow duration' before 'curves' and '(Figure 4)' after 'curves' 701 L3-4 what critical information does the % exceedance of average flow contribute to the ms? L4-5 Incomplete sentence and conveys no useful information as a topic sentence. Re-word. L5/6 'more concisely' than what? L7 'most marked change' of what? L8 'Flattest period of flow accumulation' what is this and why is it important? Explain in methods or reserve for discussion L13 'the highest maximum discharge is uncertain but close to...' why is it uncertain if flow was measured at 15 min intervals? Explain fully. L10-18 Is all of this necessary info given little of it is of relevance to latter parts of the ms? L25 'more markedly..' than what? 702 L2 replace 'in common with' with 'Similar to...' L5 '...even more variable' than what? L6-7 Why is this % exceedance significant? explain in methods L13 Are you considering 18C as the growth optimum

for salmon in your study stream? If so, state it clearly. L14 'lower temperature limit' which are you referring to? L20-21 Re-word into a topic sentence that conveys useful information L21 'clear differences were observed' statistical/biological/by eye? explain and be explicit 703 L1 4.3 Effects (of what?) on foraging behaviour of juvenile salmon L8 'each age class'- do you mean year class since you are only reporting on 1+ fish? L9/10/11 '...higher...greater...higher' than what? L11 How do you assess CDV stability? From an organismal point, at what value of day-to-day CDV variability does it become unstable? what is your evidence for this? 703 L13 - again how do you determine biologically meaningful CDVs with regard to 'greater intra-annual than interannual variability' Sure there may be variability, but it may not be biologically relevant. Provide evidence at what point it does become so. L14 'however, clear differences were evident' how were these clear differences determined? by eye/statistically/biologically - and what do the differences mean. 704 L2/3/4 'higher...hogher(spelling?)...lower' than what? L5/6 'greater...higher' than what? L7 4.4 Effects (of what?) on returning spawners. L8/9 Replace with an informative topic sentence L9-12 Weak. Say "the number of returning females spawners was not ($P=??$) directly related to discharge'. etc. L12-14 'However, focusing on ecologically sensitive time periods and providing a more biologically relevant temporal resolution for analysis improved regression results substantially' This is a methods statement and needs to be re-worked in the appropriate section to avoid the reader's knee jerk reaction "we didn't get the results we wanted so we re-analyzed the data until we got what we wanted" it elicits now. L15 why plot coefficient of variation? this is a ratio and difficult to interpret; give rationale in methods. L16-19 repeat of L14-17 from p700, delete. L20 'weaker correlations' between male #'s and what? L21 Regression plots - these need equations of lines and p-values to indicate if regression slope is significantly different from zero. Because you indicate that 95/96 had undue influence and should have been identified as an outlier by your regression analysis, you may want to remove them and re-analyze the data to check their influence in forming the relationships. But don't remove them from the plots. L24/25 Re-word into an informative topic sentence Figure 10 is very small and I'm not sure what info is

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conveyed in it that isn't already given in other parts of the ms. If there are significant relationships - you should do a regression or correlation analysis to highlight them. 705 L3 'more evenly' than what? 706 L1-3 If there is local genetic adaptation as suggested by references cited, then what is the broad applicability of your study? Does it mean the results are only applicable to Girnock Burn? Discuss. L8 'highlighted quite marked' What do you mean by this? See discussion or lack thereof of biologically relevant CDVs above. What variation in CDV would cause a decline in growth? How do you justify the statement? If you relate CDV biologically, you should be able to address how much variability in growth is explained by inability to feed L10-12 Run-on sentence L15 'lower and less variable' than what? L16/17 'marked effects on recruitment' which way? + or - be explicit and provide useful info to reader L22 'lower temperatures' than what? L28-29 'This was also strongly influenced by fine scale variation in discharge conditions' - you really have no basis for this statement - show a regression or correlation if this is the case but don't rely on reader to surmise some relationship from figure 10. L29 'more evenly distributed' than what? 707 L2-3 move to results section L4 'biological imperatives' explain what is meant. L14 'larger...shorter' than what? L24-26 'This study has shown that for an ecological analysis, data with a high temporal resolution has a number of advantages over averaged data...' You have no basis for this statement because you never explicitly undertook this test. It is the analysis I expected and suggest above. 708 L5/6 'very different' from what? 719 Table 4. You need to provide some related statistics - such a p-values so the reader can judge if the correlations are significant. Also provide number of samples. 722 Figure 2 Explain Q's fully in figure caption. 725 Figure 6 Explain significance of 18 and 7.8C line in figure caption.

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