

**AUTHOR RESPONSE.**

Ref.: Ms. Bg-2014-324\_R2.

Title: *Riparian and in-stream controls on nutrient concentrations and fluxes in a headwater forested stream.*

Authors: Bernal, S., Lupon, A., Ribot, M., Sabater, F., Martí, Eugènia.

Dear Tom Battin and Anonymous Referee#3,

Thanks for your positive answer and kind words. We are delighted to submit to *Biogeosciences* an improved version of the manuscript including your final suggestions. Please, find below our detailed responses to your comments (*in italics*). If your query implied substantial changes, we have indicated the location of the changes made [i.e. lines in the final doc file].

Please do not hesitate to contact us if you consider that further changes are needed. We look forward hearing from you soon.

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### **Author Response to Referee #3**

*I greatly appreciate the authors' attention to my previous review and the great effort they have made in revising the manuscript. The inclusion of the whole-reach analyses is a particularly strong enhancement. One further suggestion (for authors' discretion) would be to work in Table R3, which appears in the authors' response, but not in the text. I have quite a few, mostly editorial, comments, but basically the paper is in good shape. I suspect this paper will be highly influential.*

The pleasure has been ours. Thanks again for your excellent review. We have worked on Table R3 as suggested by you by recalculating input vs output fluxes for each sampling date (in Table R3 the input-output balance was based on the average values for the whole period of study). When doing the same exercise but by sampling date, differences between input and output values are zero (of course).

Regarding whether including this Table in the manuscript, we have contradictory feelings. At first, we thought it may be a good idea to include it in the Supplementary (adding chloride and providing mean  $\pm$  SE, p.e.). However, after a second thought we are not entirely sure whether providing these data would be helpful to the reader because the relative contribution of inputs from different sources to the stream can be slightly (or even moderately different) depending on whether they are calculated for each sampling date and then averaged (or "medianed", as presented in Table 4) or otherwise, calculated from mean fluxes (that is what many readers would tend to do if we provide Table R3). Then, we are afraid that this could ultimately be a contra rather than a pro.

#### ***Line-referenced comments:***

*25-26: There is not enough background to make the sentence intelligible. The reader cannot be expected to understand that the 6, 18, and 20% refer to the average (median) of the absolute value of effects measured on a given date on a stream segment that is typically 200 m long. I suggest the following:*

*In stream net nutrient uptake ( $F_{sw}$ ) was highly variable across contiguous segments and over time, but its temporal variation was not related to the vegetative period of the riparian forest. Within segments and dates,  $F_{sw}$ , whether negative or positive, accounted for a median of 6, 18, and 20% of the inputs of  $NO_3$ ,  $NH_4^+$ , and SRP, respectively.*

**Answer:** Thanks. We have followed your suggestion (lines 29-31)

56: "major influence" should be "larger influence". **Answer:** OK (line 57)

60: write "capable of decreasing" **Answer:** OK (line 70)

79: write "processes of these two" **Answer:** OK

107: write “We chose” **Answer:** OK

109: write “pronounced” **Answer:** OK

129: write “fell within the long-term” **Answer:** OK

130: write “summer 2010” **Answer:** OK

145: write “fold” not “folds”. “Folds” is not standard English, but appears many times in the manuscript. Usually, “fold” is correct. “Times” may sometimes work as a substitute. **Answer:** OK. We use now “fold” throughout the text.

175: “with a YSI” **Answer:** OK

176: “avoided” **Answer:** OK

214: “leaf-out”, “leaf-litter” **Answer:** OK

280: “FSW being” **Answer:** OK

287: consider using “tributary” instead of “effluent” which generally means wastewater from a pipe. **Answer:** OK

324: Does  $F_{in}$  exclude in-stream sources ( $F_{sw} < 0$ )? I would think so, but Table 4 shows relative contributions from all four sources that, including  $F_{sw}$ , add up to less than 100%. See comment re: line 857.

**Answer:** Yes.  $F_{in}$  is the sum of upstream, tributaries and net riparian groundwater inputs. It does not include  $F_{sw}$  because this was the variable we wanted to infer. The reason why values in Table 4 do not sum up to 100% is because they are not mean values. See our answer to your specific comment in this regard at the end of this letter.

331: I find the expression  $F_{gw} > 0 / F_{in}$  confusing because it violates standard rules of mathematical precedence, which would call for dividing 0 by  $F$  before comparing to  $F_{gw}$ . The correct presentation would be  $(F_{gw} > 0) / F_{in}$ .

**Answer:** Thank you for noticing. We do now refer to  $(F_{gw} > 0) / F_{in}$  throughout the text and captions.

413: Meaning is unclear. Do you mean “between-nutrient differences in FSW were not statistically significant” ? **Answer:** Yes, thanks for your suggestion.

417: “sinks” should be “sink”. **Answer:** OK

437-438: Doesn’t Figure 7a also show a net retention in December of 2011?

**Answer:** Yes, right. “and December 2011” was been added in line 438.

439: “consistently” should be “generally,” since as you note in line 441, it is not consistent. **Answer:** Right. Thanks.

525. “not only be explained” should read “not be explained entirely by”. **Answer:** OK. Thanks (line 526)

556-558. Awkward non-standard English. “than” should be “as”. Suggest. “It is worth noting that longitudinal trends in stream nutrient concentrations showed no simple relationship to in-stream processes. Other sources of variation of stream water chemistry were counterbalancing the influence of in-stream processes on stream nutrient fluxes” **Answer:** Thanks for your suggestion (lines 557-560)

**565-567: Good! I agree. Answer:** Thanks

569: “despite this may not result in” should be “even in the absence of” **Answer:** Thanks.

571: Here you say nitrification could explain the nitrate increase in the last 700 m, but doesn't line 525 say that nitrification is insufficient to explain the increase?

**Answer:** Right, this could bring to confusion. After considering a suite of competing hypotheses, we arrived to the conclusion that in-stream mineralization of N-rich leaf litter was the most likely explanation for the increase in stream  $\text{NO}_3$  at the valley-bottom. Our data did not support that such increase could result from either (i) in-stream nitrification of  $\text{NH}_4$  entering from riparian groundwater, (ii) human activities, or (iii) in-stream photoautotrophic activity. Therefore, this sentence now reads:

“For  $\text{NO}_3^-$ , our data suggest that the marked increase in concentration along the last 700 m could be a consequence of in-stream mineralization of N-rich leaf-litter stocks”

(lines 570-572)

575: write “ $(F_{\text{SW}} > 0)/F_{\text{in}} = 10\%$ ”, i.e., add parentheses.

**Answer:** Thanks. We do now refer to  $(F_{\text{gw}} > 0)/F_{\text{in}}$ .

575: I understand that the point is that in-stream processes may not explain the trend, but this leaves the reader hanging as to what might explain the trend. Might the decrease have been from lower concentrations of groundwater and tributary inputs? I see that you suggest this for SRP on line 581.

**Answer:** Yes. Following your advice the following sentence has been added:

“Therefore, the declining pattern was likely a combination of both in-stream nutrient processing and hydrological mixing with riparian groundwater and tributary inputs”

(lines 576-578)

Table 4:

850: Specify whether this Table is based on whole-reach budgets. **Answer:** Thanks. Done (line 857)

851: should read “[ $(F_{gw} > 0)/F_{in}$ ]” **Answer:** Thanks. Done.

852: add a bar and parentheses to get “[ $|(F_{sw} < 0)/F_{in}|$ ]” **Answer:** Thanks. Done.

854: should read “ $p < 0.01$ ”. **Answer:** Thanks. Done.

857: The median contributions don't add to 100%. Is this simply because they are medians and not means? If so, it might be helpful to note this. If not, then why don't they add up? This is the more puzzling because the first three are the components of  $F_{in}$  (as defined on line 324) and so by themselves should roughly total to 100%.

**Answer:** Thanks for noticing. Yes, you are correct, contributions sum up to 100% when using means rather than medians (Table R1). We have added the following sentence in the caption of Table 4: “Note that relative contributions from different sources do not up to 100% because they are medians rather than means.

**Table R1.** Mean and S.E. of the relative contribution of inputs from upstream ( $F_{top}/F_{in}$ ), net riparian groundwater ( $(F_{gw} > 0)/F_{in}$ ), tributaries ( $F_{ej}/F_{in}$ ), and in-stream release ( $|(F_{sw} < 0)/F_{in}|$ ) to stream solute fluxes at the whole-reach scale.  $n = 10$  for the 4 solutes.

Relative contribution (%)	Cl <sup>-</sup>	N-NO <sub>3</sub> <sup>-</sup>	N-NH <sub>4</sub> <sup>+</sup>	SRP
Upstream	15 ± 2	26 ± 3	10 ± 2	12 ± 2
Riparian Groundwater	26 ± 5	25 ± 7	59 ± 5	23 ± 6
Tributaries	58 ± 4	24 ± 3	24 ± 3	40 ± 6
In-stream Release	1 ± 0.5	25 ± 8	7 ± 5	25 ± 8