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Biogeosciences Discussions

Interactive comment on "Sources and cycling of nitrogen in a New England river discerned from nitrate isotope ratios" *by* Veronica R. Rollinson et al.

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Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-390, 2020. Anonymous Referee #2 Received and published: 23 December 2020 The authors present a comprehensive study about the nitrogen sources and cycling in a well-studied river and estuary system in New England, USA. They used a complex one-year data set, including all nitrogen components such as DIN (ammonium, nitrite and nitrate), DON and PN, additional the stable isotopes (15N and 18O) of nitrate including 17N for deposition analysis. The data set contains weekly data from two station, seasonal transects in the river at 15 station, one high resolution short transect, and

data from two WWTP near the mouth of the river. Additional, ammonium and nitrate concentrations and stable isotope of nitrate in atmospheric deposition were provided. The main findings are that nitrate sources mainly stemming from the groundwater and from shallower groundwater and surface flow during higher river discharge C1 during the cold month. WWTP and industrial zone runoffs had a portion of approx. 20 %. The stable isotope analysis suggest the river-in nitrogen cycling is not that important in relation to the sources. One suggestion is that by nutrient spiraling occurring were reverse processes are not visible in concentrations or isotope signals. In comparisons to former studies in the river estuary system, there is an increase of nitrogen loads to the adjacent Little Narragansett Bay, which causes eutrophication. The manuscript is well written and presented a robust data set and the interpretation and discussion based on that and is not excessive, although, the text is somehow to long and can be shorted, especially in the discussion. The study present a good contribution to the discussion about the role of rivers and estuaries nutrients transport from the land to the ocean.

Nevertheless, I have some comments and questions on some issues in the manuscript.

L 11ff: The abstract is a bit too long and should focus more on the main finding. It seems like a list of what were done and what were discussed. Be more specific. We agree with the reviewer's assessment. We modified the title of our study to make it more descriptive and pointed, and we trimmed down and re-arranged and modified the abstract to emphasize the more salient points of the study.

L 84: The 18O values of nitrate produced by nitrification (_1. . .) is misleading, because later on you discuss it is bit different way, that is depending on the 18value of the water and so 1‰ higher. (see L 595 ff) We modified this text to specify that the ïĄď18O of NO3- produced by nitrification aligns closely with that of ambient water.

L 133: Maybe, just because I0m not a native speaker and not from USA. What exactly are turf farms? Do they produce grass, which can put later in the garden or it is something to produce peat. This could explain the high concentration of tannin in the

water. Turf farms are a characteristically North American enterprise, producing mats of mono-specific grass for suburban homes, which then require an obscene amount of herbicides, pesticides, water and fertilizers to maintain. They are not used for peat production. The elevated tannins in the river presumably derive from the forest soils and litter.

Figure 1, L144: I needed a bit to understand the description and the map, please present the sampling sites and map in a clearly arranged way. We extended the figure caption to be more explanatory.

L 150 Explain shorty why you are not measure in the same period and be aware that deposition data are just represent a period of higher precipitation We are aware that our precipitation samples only cover the fall season. The samples were opportunistic, given to us by an undergraduate student studying mercury deposition. Hence, the data do not span the whole of our study. While the attribution of the % atmospheric nitrate may have been more nuanced seasonally given a broader span of measurements, differences would likely be within the error of attribution ($\pm$ 1‰ and, more importantly, would in no way change the inferences drawn from our data – that the fraction of uncycled atmospheric nitrate in the river was negligible.

L 180. Do you also measure 15N NH4 isotopes? Could be interesting to see what C2 happened to the deposited nitrogen in whole. . . We did not measure the ammonium N isotope ratios in rainwater, as this was outside the scope of our study, and would have required an altogether different (and very exacting) analytical technique (see Zhang et al. 2007).

Figure 2: the figure is relatively small. I0m surprised that the summer nitrate concentration were higher in summer than in winter. The figure is not at its final size (we think). The dynamic we observed here has been observed in other mid-latitude streams and rivers (e.g., Mulholland et al. 1997).

Figure 4: In “a” and “b” your present the fluxes from the WWTP. The discharge from the

WWTP was much more smaller that the discharge of river itself, so that the presentation is a bit misleading, especially because later on the discussion of the source count the WWTP later on (L770 ff) We disagree with the reviewer’s assessment. Figure 4, upon close inspection, reveals that the N flux from the WWTF is negligible during high discharge, but relatively important in summer during low river discharge. What was remarkable to us is that the facility maintains a constant N flux throughout the year, in spite of seasonal differences in constituents (Figure 5).

Figure 6: Explain why the station 6 is separated (Tributary) We have added this explanation in text. Station 6 is in a tributary feeding the main study river rather than in the river proper. Before L366. The depositions results are not presented in the results section, but later in the discussion. The deposition results are now alluded to in the Results at Line 274.

L400: Reference for the tannins are missing. How high is the refractory and labile part of the DON? Good question. We added a reference. Tannins are considered recalcitrant, and we added a reference which validates this assertion.

L403: The unexpected nitrate concentration in summer should be compared to other rivers like you already done with the results from Fulweiler&Nixon. We feel that this would add to an already long manuscript that we have struggled to shorten. Readers interested in regional differences can delve of their own initiative from the cited reference (Narragansett Bay Estuary Program, 2017). Importantly, the more elevated concentration in summer is not an entirely novel dynamic, as it is germane to other systems (e.g., Mulholland et al. 1997).

L 526: What happened with the NH4 in the atmospheric deposition? While that is not a focus of the study, NH4+ in aerobic soils and streams can be assimilated by plants and algae or nitrified to nitrate, which can be denitrified in hypoxic and anoxic soils (e.g., hydrated soils). That there typically is little to no uncycled atmospheric nitrate in mid-latitudes rivers (e.g., Sebestyen et al. 2019; Mengis et al. 2001) suggests that

reactive N deposited at the land surface is quickly cycled.

L661: Use these turf farms a high amount of fertilizers? Typically, yes.

L 685: Who or what is responsible. Agriculture? Too much fertilizers? Turf farms? We hoped to have constraints on specific areas of N loading from the study. All that we can conclude is that a disproportionate fraction of the polluting N occurs up-river in the agricultural part of the watershed ($\sim$30%; Line 663 of total), and down-river (anywhere from 20 to 50% is our best estimate; Line 675). Up-river, we hypothesize that turf farms contribute significantly to N loading, but there is also a point source (Kenyon Industries) that looks to be important, as detailed in the discussion.

L 703: What is the main source for the increase of nitrate in the groundwater? I would expect higher use of fertilizer? We don't know. It could be the proliferation of turf farms, increased fertilizer use by farms and households, and/or increased loading by Kenyon Industries.

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