



## ***Interactive comment on “The effects of biomanipulation on the biogeochemistry, carbon isotopic composition and pelagic food web relations of a shallow turf lake” by B. M. Bontes et al.***

### **Anonymous Referee #1**

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General Comments: This manuscript is an exciting example of biological control on chemistry of ecosystems. In this case fish removal has led to dramatically altered productivity levels and fundamentally altered carbon cycling. Few examples exist where aquatic food web manipulation has altered carbon cycling and even fewer examples exist of chemically enhanced diffusion and its impact on carbon stable isotopes. Additionally this work takes advantage of techniques to measure stable isotopes of specific algal groups. Using these techniques the authors are able to illustrate the differences in primary producer signatures that can exist at the base of a food web. Moreover they then use this help elucidate which producers are ultimately being used by secondary consumers. This is the next important step in utilizing stable isotopes for food

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web analysis. However, this careful isotope analysis may have only revealed that most consumers are generalists in their food source. The biomanipulation produced some confounding results which have been typical of some biomanipulation experiments, but it also produced some striking results. Unexpectedly, numbers of large cladocerans did not increase. However, macrophytes, even rare species, returned to the site where fish were removed. But most notable was the increase in productivity in the fish removal site that caused supersaturation of O<sub>2</sub>, undersaturation of CO<sub>2</sub>, large increases in pH and concomitant chemically enhanced diffusion. Unfortunately there is no clear indication exactly what primary producers were causing the increased productivity. My first theory, upon a quick read through, was that increased macrophyte productivity would be the cause, but this hypothesis was not explored in depth by the authors. Finally I would have liked to see some data for these location before the treatments. If any exists I think it should be included; if not the manuscript will do without. I have other specific comments and technical issues, but all of these I feel can be dealt with sufficiently by the authors.

#### Specific Comments:

Introduction I think the introduction could benefit from some rearranging and rewriting. First a small point; I don't think turf lakes are very common to most readers so more explanation about them would be beneficial in the intro. The first two paragraphs deal with eutrophication and biomanipulation, which are a bit of old news. The big story here is the use of isotopes and the large changes in water chemistry due to the biomanipulation. Therefore I feel that the material on eutrophication and biomanipulation could be shortened a bit. In the final 2-3 paragraphs of the intro I think there could be some rearranging done. The section that describes Schindler's work might make more sense to be presented earlier. This way the intro would flow from DIC to algae to higher trophic levels. This flow would lead to better parallel with the presentation of results later on. The last sentence in the intro should not be the last sentence. It should end with, "The aim of the study" Are the three question in the intro answered specifically c) trophic

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interactions between seston species.

## Methods

Go into a bit more detail (1 sentence) about the trophic niche of bream and roach. Are the results for optical density ever presented? They might be useful? Otherwise this part of the methods should be omitted. You must make clear how the discrimination factor for algae was calculated (pg 1005 l. 2). It should be with respect to CO<sub>2</sub> and not DIC, but it is not clear which you used. In this same paragraph you mention the offset between fatty acids and total cell carbon for algae. Is there a similar offset applied to the zooplankton data? Are the data in the tables the raw data or the values after the offset has been applied? Other comments are technical (see below).

Results In the section describing pH, O<sub>2</sub> and CO<sub>2</sub> dynamics (pg 1007) you suggest that the growth of macrophytes might be the cause of the changes observed and even comment about observed increased in macrophyte biomass. Was the biomass measured quantitatively or is this a qualitative observation. In either casem, you never explore the role of macrophytes (vs. other producers) in more detail in the discussion. In the last sentence of the first paragraph of section 3.3 there seems to be some material that should either go into the discussion or further material should be added to give a proper explanation of the cause of the low DIC isotope values. Much of the last paragraph of the zooplankton isotope results is vague and hard to understand. This is probably because there a not many strong results, but the writing could be cleared up. The one result that I noted was that Asplancha was had consistently the lowest isotope signature across all treatments (surely not significant but potentially worthy of note).

Discussion The short paragraph on pg 1011 l. 14 seem out of place. It should be moved or removed. In the following paragraph there could be some clarification where the references are given for comparison of results. First of all the Hanson et al. (2004) reference might not be overly appropriate here. They suggest that food webs may have a large influence on CO<sub>2</sub> cycling however no physical biomanipulation exists in this

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modeling paper, only a small attempt to represent hypothetical changes in a food web. The remaining references contain actual examples of manipulations, and although they “reported a similar reduction in CO<sub>2</sub> upon biomanipulation” the actual manipulation was usually quite different (removal of piscivorous fish vs. planktivorous fish in the present study). A clarification should be made here. In the next paragraph dealing with the DIC isotopes a bit more explanation may be needed. You explain why under heterotrophic conditions DIC signatures might become more negative, however there is not much explanation why they should be different during autotrophic conditions. Two explanations, preferential uptake of <sup>12</sup>C by autotrophs and influx of atmospheric CO<sub>2</sub> could be given. You may talk about these briefly in the intro, but it may be worth revisiting them. Later in this paragraph you mention that high biomass of macroalgae caused the low pCO<sub>2</sub>. Do macrophytes have any role, or can you rule out that macroalgae were the most important contributor? On pg 1013 you go into some detail about the discrimination of inorganic carbon during photosynthetic uptake. I’m curious as to how  $\epsilon$  varied over the course of your experiment, especially in -FW. Does  $\epsilon$  decrease as CO<sub>2</sub> concentration declines, as is often predicted in many of the references given? You state that mean  $\epsilon$ s for diatoms and green algae were rather constant, but examining Table 4, it appears that  $\epsilon$  for diatoms ranges from ~29 to ~14, which seems a significant variation. This should be dealt with in a manner other than just the mean values, given the amount of discussion on the topic. Also in this paragraph is the relationship  $\epsilon = 21 - f \times 20$ . There is very little explanation of this relationship, its derivation or reference to its source. The final paragraph on pg 1014 refers more to monitoring results of the biomanipulation than to isotope results and should probably be moved elsewhere. Finally in the summary, I don’t think you should suggest that the anomalous behavior of  $\delta$  DIC, increase in O<sub>2</sub> and decrease in CO<sub>2</sub> should be considered a general phenomenon observed in biomanipulated lakes. It is most likely just a phenomenon of high productivity, which can be caused by multiple factors; biomanipulation being just one of them.

Technical Comments/Corrections:

- p. 1000 I. 7 Flow cytometry is two words (other locations of this as well)
- p. 1002 I. 1 Replace Nowadays with Presently and make this sentence into two sentences. I. 12 replace fish was with fish were I. 18 replace the sentence with, “It must be noted that besides fish manipulation, the wooden dams may have also reduced wind and current exposure in the experimental enclosures.” Or something similar. I. 21 remove “Furthermore” and add “also” after “was” I. 24 remove “From hereon”
- p. 1003 I. 17 replace established with measured. Also remove Therefore from next sentence. I. 13 replace “was” with “were” I. 16 change these sentences to, “Concentrations and  $\delta^{13}\text{C}$  values of DIC were measured every other week by injecting 1.5mL of lake water into 8mL airtight bottles that had been previously flushed with helium. To convert all DIC to  $\text{CO}_2$ , the samples were acidified with 0.2 mL  $\text{H}_3\text{PO}_4$  (2M), and after 24 h, 0.4mL of the gaseous headspace was manually injected into a  $\bar{\epsilon}$ ”
- p. 1004 I. 3 This sentence needs clarification. Were fatty acids isotopes of zooplankton measured or just whole zooplankton? Remove the word representatives.
- p. 1006 I. 7 Chla should be Chl. a replace this in other locations as well. I. 9 replace “was” with “were”
- p. 1007 I. 1 replace Accumulative with Cumulative. I. 19. Be more specific, “In the same period”
- p. 1008 I. 9 The sentence, “Furthermore, average seasonal $\bar{\epsilon}$ ” does not make sense. Was del DIC and del  $\text{CO}_2$  averaged together? I see no reason why this should be done.
- p. 1009 I. 21 Insert a comma after fish also the last two sentence of section 3.2 are a bit long and need rewriting.
- p. 1011 I. 17 remove comma after isotope. Actually this sentence needs to be redone. Maybe the word isotope should also be removed? This entire paragraph will benefit from an attempt to rewrite it

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p. 1012 l. 2 change “system in a” to “system to a” l. 11 Insert “negative” between “large” and “fractionation” l. 18 This sentence is incomprehensible. l. 28 I don’t understand why figure 4 is referenced here A few sentences in this paragraph need some work. Here is a suggestion: “The high biomass of macroalgae and macrophytes in -FW during xx to xx led to low pCO<sub>2</sub>, high pH and the potential for chemically enhanced diffusion to take place (a reference such as Wanninkhof and Knox 1996, or others, might be useful here). During chemically enhanced diffusion the reaction of CO<sub>2</sub> with high concentration of OH<sup>-</sup> dominates the in the reaction to H<sub>2</sub>CO<sub>3</sub>. This reaction with OH has a large negative fractionation opposite the fractionation observed during the reaction of CO<sub>2</sub> with H<sub>2</sub>O (~+8). In Peter Lake and other lakes found in literature sources, Bade et al. (2004) found similar trends in δeDIC at high pH.

p. 1016 l. 11 replace “unravel the food web” with something like “determine proportionally what primary producers were fueling the primary consumers.”

Table 1 text. These aren’t all environmental variables. Perhaps better to say “Characteristics of the three treatments;”

Table 2 text. “Cladocera include the species Bosmina and Daphnia and rotifers species from the genus Keratella, Filinia, Polyarthra and Trichocerca.” This sentence is confusing. I think it should be two sentences. “Cladocera include the species Bosmina and Daphnia. Rotifers include species from the genus Keratella, Filinia, Polyarthra and Trichocerca.” The original reads as though the four rotifer species were included in the Cladocera group. If my suggestion is incorrect, I don’t understand why the rotifers would be grouped with the cladocerans.

Tables 4,5 and 6. Indicate whether these are raw fatty acid values or whether the +9 offset was included.

Fig 2. Perhaps don’t use a log scale with the chl data as it tends to hide the difference in concentration between treatments and over time that you are trying to accentuate in the text. Also in the text of this figure remove “vs.” with “and”. Vs implies that one is

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on the x and the other on the y axis. Finally remove “the primary C-source for algal growth;”

Fig 3. There are no labels to guide the reader as to which bars corresponds to which treatment.

Fig 3a is never referenced in the text.

Fig. 4 text has some redundancy that could be eliminated.

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