

R1

The manuscript by Cook et al. is very interesting and addresses the causes of cyanobacteria blooms in a temperate lagoon system. The study is well done and uses dated sediment cores with the analysis of proxies related to eutrophication and algal production. The sediment data are combined with historical archives on settlement and development of the basin. The authors describe the environmental history of the basin and the impact of humans. The manuscript will make an important contribution and supports previous related work on the occurrence of cyanobacteria in low salinity coastal marine ecosystems.

I have no large concerns regarding the significance of the contribution or the scientific quality, however, the paper needs some organization of the discussion to add structure, but more important to increase its readability and impact. The manuscript needs topical headings instead of one large discussion section. Perhaps the sections could be at the start of discussion (Impact of settlement), top of page 18841 (Eutrophication and cyanobacteria blooms), and then page 18842 line 1 regarding 3 key factors – this section is the key to the discussion. With this revision the manuscript will become a valuable contribution to the literature.

We thank the reviewer for their very positive comments. We agree the discussion needs to be broken up, and will re-write this with sub headings as well as reorganising as suggested by reviewer 2.

Specific comments

Sediment dating – It is not clear how the CIC model was “modified” (page 18834, line 21). Why not use a CRS model? It seems like it might be more appropriate given the changes in sedimentation rates. I don’t think the dates will change significantly enough to change the interpretation, but it will be more correct.

We believe this is a matter of semantics. The model has been modified from its original formulation, but is as described by Appleby 2001. To avoid confusion, we will simply refer to it as a CIC model in the revised manuscript.

However, my other concern with sedimentation rates are changes in sediment mixing through time. The most serious potential change in sedimentation rates could occur with the appearance of large sediment mixing polychaetes with increases in salinity, or the contrary e.g. the loss of organisms with oxygen depletion.

We agree, this cant be ruled out, particularly below the depth of 210Pb activity. We do however believe that large scale mixing of the core can be ruled out, leaving our broad interpretation of the 3 zones unchanged. Firstly, zone LK-1, which is prior to the opening of the artificial entrance consistently has the highest count of *Cyclotella* and lowest concentration of Thalassic diatoms. Second many of the proxies measured at high resolution showed abrupt changes throughout the core. If there was significant sediment mixing, such abrupt changes would be smeared out. We will add this argument to the revised discussion.

Pigments – Were samples shielded from light during the freeze-drying process or handling prior to pigment analysis? Studies have clearly shown the importance of protection from light (L&O Methods, 2005, 3:477–487).

We are aware of the extreme sensitivity of pigments to light and great care was taken to avoid this during the sampling and all extraction steps. Upon sampling, the cores were placed in black plastic bags, and upon slicing this were gradually peeled back and

rapidly placed bags wrapped in aluminium foil. Similarly, during the extraction and analysis steps, pigments were shielded from light. We will add these details to the revised manuscript.

Section 3.2 – How were the three broad zones determined? What program (C2, R) or what procedure was used to delineate the zones?

The zones were delineated by eye based on a combination of the abrupt changes in the geochemistry and the DCA axes. These periods also corresponded well with pre-european, the period of early settlement and modern times as covered in the discussion. This selection will be made clear in the modified manuscript

Page 18841, line 5. “calibrate” – not sure that is what you mean. Please rewrite.

We agree, validate is a better term.

"Cyanobacterial" is used several times. I think the more correct form is simply "cyanobacteria"

Will be changed as suggested

R2

General Comments: This is a good and thorough study which looks at a variety of biomarkers in sediment cores, located in Lake King, to investigate the occurrence of cyanobacteria from the past to the present and compare it to historical archives. The structure and organization of the paper is hard to follow, in particular the discussion which jumps from different time periods without fully explaining and supporting their idea until later. Suggestions for better organizing the discussion are found below. This is an interesting study with many supporting biomarkers. However I found the conclusion to be unoriginal. With some reorganization of the discussion and a more thought out conclusion this can be a great paper.

We thank the reviewer for their positive and thoughtful review

Specific Comments:

Abstract: Not clear why this study was conducted or why it is important. I suggest putting in a sentence similar to 18831 line 18.

We agree, the importance of the study will be added to the revised manuscript

18831 Lines 11- 13: Not very convinced that “Gippsland Lakes provide an ideal case study” expand on explanation more.

Upon reflection this sentence is superfluous and will be deleted

18831 Lines 21-24: Great importance sentence.

18832 Line 24: Why did you choose this particular spot to sample? Is it representative of the whole Gippsland Lakes?

We stated on line 19 pg 18833, that previous studies have shown blooms are centred on this area. We will now state explicitly at the start of this sentence that ‘the study site was chosen...’

18833 Line 1 18835 Line 20: LKN1 core was exposed to light and heat, which would have degraded pigment biomarkers. Then I see that you only used LKN2 for pigment analysis. How did you get pigment data for the earlier years?

LKN 1 was also subsampled for pigments and carefully shielded from light. We agree this is unclear at present. The revised manuscript will clarify this.

18838 Lines 15-16: Pheophytin-a is only mentioned once here. Refer back to this biomarker in the discussion. Explain what this biomarker is used for.

We agree this has not been discussed enough. Pheophytin a is typically a marker for total productivity and we will revise the discussion to incorporate the fact the pheophytin peaks were observed prior to European settlement and the post war period, indicating peaks in nutrient input/recycling.

Results: I suggest organizing the methods and materials in the same order you explain the results for the different proxies.

We agree, this will be re-ordered as suggested

Discussion: I suggest rearranging the discussion following the same order as the results with the three different sections (i.e LK1-3) where each section you include the “factor controlling the incidence of cyanobacteria bloom” (18841 line 1 through 18842 line18). I believe it would be easier to follow.

We agree, and will modify the discussion, along these lines

18840 Lines 18-21. This sentence makes it seem as if the reference is for a study done in Gippsland Lakes. Rewrite to: “. . .within Gippsland Lakes and this is comparable with previous studies done in the Baltic Sea (i.e. Bianchi et al., 2000 and Funkey et al., 2014).

Will be amended as suggested

18842 Line 7 11: Firstly and Secondly should be First and Second C8797

Will be amended as suggested

8842 Line 26-28: Can you provide a reference for this?

We believe the reviewer is referring tip g 8843, and the requested reference is for the quantity of water diverted.

This is based on the following consultancy report which will be referenced in the revised MS

Moroka (2010). ‘Understanding the Environmental Water Requirements of the Gippsland Lakes Systems. Stage 2: Input to the Gippsland region Sustainable

Water Strategy.’ Report to East and West Gippsland Catchment Management Authorities, Traralgon. (Moroka: Melbourne.)

18843 Lines 1-3: Can you provide a reference for the 1939 wildfires?

Australian Broadcasting Corporation. 2016 [cited 2016 Jan 15]; Available from: <http://www.abc.net.au/blackfriday/story/default.htm>.

18844 Line 10: change to- World War II
Will be amended

18844 Line 10: Where is the “increased nitrogen inputs” coming from?

As documented in the previous paragraph, hydrological modelling has estimated that nitrogen loads have increased by a factor of 1.8, and this most likely originates from agriculture.

18844: Lines 13-17: I’m not convinced this is the right conclusion for this paper. From your explanation in 18842 Line 3-18 cyanobacteria blooms have occurred in Gippsland Lakes even when there was low nitrogen and phosphorus inputs. Definitely reducing N and P will help alleviate the gravity of the spring and cyanobacteria blooms.

Our argument is that there were large cyanobacteria blooms prior to European settlement and increased nutrient loads due to recycling of phosphorus in anoxic bottom waters. This being the case, there was sufficient phosphorus within the system in pre-European times to drive algal blooms. During this period the phosphorus release was driven by strong stratification and lack of hydrodynamic flushing leading to bottom water anoxia. The opening of the entrance increased ventilation (increased flushing and decreased stratification) reducing anoxia. In the absence of any hydrodynamic changes in the past 50 years, we argue that it is increased nitrogen loads that have lead to the re-emergence of anoxia and associated phosphorus release and the re-emergence of blooms.

We concede this has not been argued as clearly as it should have been and we will re-word this argument in the revised manuscript.

Figure 1: Add coordinates of sampling site.

Will be amended

Figures 2-4: The graphs are well done and clear. The captions however need to be expanded to describe all parameters and units.

Will be amended

Figure 34: What are LK1-3?

The three zones will now be indicated in the caption