

We want to thank this reviewer who has provided a detailed review of our manuscript and provided valuable comments and suggestions, which have significantly helped improve our manuscript.

We have done our best to account for these comments and have responded individually (red text) to each of them below.

The significant changes of the revised manuscript will include:

- *A simplification of the introduction and removal of repetitive information*
- *Rephrasing of the results/discussion section in line with the concluding remarks*
- *A more succinct explanation of the weakened conditions in the Southeast Indian Ocean likely contributing to the recruitment failure*

We hope that our response and modification to the manuscript will satisfy the reviewers and editor so that our manuscript will be recommended for publication.

Kind Regards

Jessica Kolbusz and co authors

Anonymous Referee #1

General comments

This paper investigates several oceanographic factors and one biological factor to try and explain the reasons for the breakdown of the positively correlated relationship between western rock lobster puerulus settlement and the strength of the Leeuwin Current off WA. The authors employ a multiple regression analysis to predict puerulus settlement, and also explore the influence of seasonal and inter-annual variations in the Leeuwin Current and Capes Current.

Given the high economic value placed on the western rock lobster fishery in WA, and given the past predictability of future catch by 3-4 years in advance has played a significant role in the sustainability of the fishery, this paper explores new drivers that would benefit scientists and managers in the fisheries and biological oceanography space.

Thank you for the supportive comment!

To arrive at these findings, the paper presents a lot of information, particularly around the oceanography, which I think could do with further refinement in order for the main takeaway messages to be clearer. These findings are presented more clearly in the concluding points of the paper, but not so much in the results/discussion section.

Agreed. We will revise the manuscript accordingly to better illustrate the conclusions within the results/discussion section.

There is a lot of information presented in this paper which makes it quite tricky to digest in some parts. In particular, the high number of predictor variables and oceanographic patterns explored for each station, on top of splitting the data temporally and spatially. It's potentially borderline too much for one paper, but I understand the complexity of oceanographic and biological patterns and the need to examine the extent of variables chosen in this paper.

Yes, thank you for understanding the complex problem we, too, were faced with. Hopefully, the conclusions will be more straightforward by revising the areas you and the other reviewer have brought to our attention.

In general, some sentences are quite long and could benefit from a grammar check and the addition of commas. I strongly recommend another round of editing on the document.

Clear, concise and grammatically correct sentences will help with the digestion of a vast amount of information.

Yes, agreed. A thorough grammar check has now occurred.

Specific comments

Abstract

Summarises the paper well

Thank you for the supportive comment!

Introduction

Overall, I think the information presented in the introduction is relevant but could be more streamlined, have a clearer flow and avoid repetition. The aim is also mentioned twice but with different wording, so I suggest to just provide it once in the last paragraph of the intro

Agreed – this has been modified in the revised manuscript.

Line 36: 'Puerulus settlement has subsequently recovered, but despite extensive research', can you give a quick indication of where the extensive research focused e.g., in the oceanographic space, biology space

As suggested below, with Line 96, this has been moved up to this location.

Figure 1: consider whether should be in the methods section, given the caption is also methods related.

An interesting comment. It has been moved to the 3.1 Puerulus settlement data section, but it is referred to throughout the Study Region section. It is subsequently now Figure 2.

Line 96: Could this sentence 'Prior to current study, research on the 2008/09 decline had included an examination of overfishing of the spawning stock (de Lestang et al., 2015) and whether conditions of survival were no longer met in the early pelagic life stages (S awstr om et al., 2014)' be moved up to plug the missing info mentioned in comment above Line 36?

Yes – this has been moved to line 36

Study region

Line 150: Sentence starting with 'An increasing' needs rewording, sounds confusing. Is 'replicated' the right word?

This has been changed as the information is also repetitive in line 129. This final sentence is now -

As the LC strength increases, as does its associated eddies and meanders.

Methods

Line 158: 'The fishery-wide standardized puerulus index, PI, is calculated based on the seasonal (May – April) mean puerulus settlement numbers from all 8 sites, then summed to obtain an annual index (Kolbusz et al., 2021)' repetition. Already mentioned in Intro.

Pick one or the other. Suggest keep in methods.

Removed from the Introduction.

Line 236: Can you clarify this sentence 'Models containing variable combinations with correlations > 0.4 were excluded, to eliminate potential problems with collinearity and overfitting (Graham 2003)'? Are you referring to predictor variable combinations? If so, isn't the cut off 0.4 correlation between two predictor variable quite low? Typically it is set at 0.7 or 0.8 before you would start to exclude correlating predictor variables. But I can see further down you mention >0.8 . So perhaps just needs clarifying a bit more.

Yes – we must not have changed the value in the text – this was kept at 0.7. The 0.8 further down is regarding before completing the GAM analysis. This has been moved to the second paragraph of this section and rephrased to be more explicit.

Table 1: 'Predictor **variables** and metrics'
Changed

Line 267: expand on what you mean by 'hiatus' and during what years?

By 'hiatus' we mean an extended period of low activity in the SE Indian Ocean, namely the LC. This is evident between 2001 and 2007 (Pattiaratchi & Sij 2020). We agree this needs to be expanded on within the methods and aims. The exploration of long-term oceanographic conditions are explored due to processes in the ocean not having instantaneous changes. This is also relevant to your point re Line 457 and 'memory' in the system. This needs to be better explained by us. It will be in the following revision.

Pattiaratchi, C. and Siji, P.: Variability in ocean currents around Australia: State and trends of Australia's oceans report, Hobart, 1.4.1-1.4.6 pp., 2020.

Results/discussion

Line 274: you say 'time-series patterns of the **spatial and temporal variability of the physical environment** experienced by *P. cygnus* larvae between 2000 and 2017', but then start of section 4.1 talking about variability in puerulus settlement. So summary wording around this section (from line 274) needs to be revised to reflect content accurately.

Results and discussion are combined into three sections (1) time-series exploration of *P. cygnus* settlement between 2000 and 2017 and associated oceanographic conditions experienced by the larvae (when data was available); (2) exploring correlations of the oceanographic conditions with settlement data through multiple regression analysis, and (3) inter-annual and seasonal oceanographic variability.

Line 275: '(2) exploring correlation of oceanographic conditions with multiple regression analysis'. Is that the right wording? Would 'correlations between predictor variables and puerulus settlement' be more accurate?

Yes, this has been changed.

Line 309: these sentences sounds contradictory: 'The CC strength was highly variable between latitudes. Over the initial months of the current forming (Figure 7a) it is, on average, strongest at 30° S. The CC displayed a roughly a similar pattern across all latitudes with less variability in current at 27° S where it is weakest (Figure 7).'

Agreed, this has been changed.

Line 324: is it meant to say 'decreased at 31S and 27S?' Not 29S?

Yes, now changed, thank you.

Line 412: suggest putting sentence 'From our analysis we have not defined directionality and size of the LC eddies, but it is an important consideration that would require further modelling, outside the scope of the current study' in method section as I was expecting you to mention anticyclonic or cyclonic eddies somewhere. It is an important consideration, and one I would have expected to see in the modelling/analysis given the detail of the other predictor variables used, and the potential impacts of the eddy types on body condition of larvae.

Thank you for this comment. We have moved this sentence to where KE and EKE are defined.

“For our analysis we have not defined directionality and size of eddies, but it is an important consideration pertinent to larvae energy stores that would require further modelling outside the scope of the current study.”

The paragraph starting at line 407 has been rephrased with this sentence removed.

Line 457: what do you mean by ‘due to memory in the system adjusting’?

By ‘memory in the system adjusting’, we mean the climate inertia of the system. So the system would have some resistance or lag to changes such as KE and the extended cool water period. We have rephrased this to explain our findings better.

Line 466: is ‘communicated’ the right choice of word?

This has been changed to ‘transferred.’

Line 487: ‘A shift in mean LC and CC conditions’ – clarify what conditions, speed, direction?

This sentence has been deleted since it is waffle and explained within the paragraph.

Technical corrections

Line 33: reword sentence to say ‘During the 2008 and 2009 settlement seasons (May - April) there was an unexpected **settlement failure**, given the strong Leeuwin Current over those years.’ In some cases throughout the document, you break up the sentence in a way that it doesn’t flow. Such as the above example.

Agreed – changed. This has been changed to “During the 2008 and 2009 settlement seasons (May - April), there was an unexpected recruitment failure.”

Line 52: missing bracket. Plus sentence needs clarification e.g.: ‘The onshore transport and movement of **puerulus** across the continental shelf occurs mainly during August – January (late austral winter-summer), **where settlement occurs** in shallow areas of generally less than 5 metres depth’

Changed

The onshore transport and movement of puerulus across the continental shelf peaks between September and February each year. Therefore, the circulation patterns of the south-east Indian Ocean influence spatially varied cross-shelf transport of the puerulus (Caputi, 2008; Feng et al. 2011). Puerulus settlement usually occurs in shallow areas of reef and seagrass habitats.

Line 61: ‘since **the** majority’

Added

Line 96: put month range for ‘second half of the season’ as did for first half of season

Changed

Line 105: ‘effects are at play For example’ missing full stop

Added

Line 135: join string of references ‘Wijeratne et al., 2018) (Smith et al. 1991...’

Joined

Line 148: ‘Eddies in LC are’ – ‘from the’ or ‘in the’

In LC is removed

Line 159: switch between 8 sites and eight sites – consistency. Spell out if between 1-10.

Changed to ‘eight’ throughout

Line 220. Missing full stop at end of sentence

Added

Line 270: why is '(Fremantle Mean Sea Level; Southern Oscillation Index)' needed in brackets when already defined in same sentence?

This was an issue with the referencing – it has been changed.

Line 320: add °S after 33 as well

Added

Line 324: Another example of a sentence that needs better grammar: 'In particular at 27°S on average offshore transport was possibly due to more mixing and a wider continental shelf and increased mixing around Shark Bay and with the contribution of the Ningaloo Current likely playing a role (Woo and Pattiaratchi, 2008).'

Rephrased.

In particular, at 27°S average offshore transport was possibly due to more mixing and a wider continental shelf. This is due to the topography of Shark Bay and the contribution of the Ningaloo Current likely playing a role (Woo and Pattiaratchi, 2008).

Line 362: Another example of a sentence that needs better grammar: 'However, the South Indian Counter Current flows eastward within the defined southern 'box' of KE, one would expect if this had such an influence that it would be true for all sites and not only within the early portion of the season (Wijeratne et al., 2018).'

We have expanded this with further clarity.

However, the southern and central flows of the South Indian Counter Current (sSICC, cSICC) flow eastward respectfully within the South and North KE 'boxes' (Menezes et al. 2014). These current jets connect with the LC and may cause the temporal and spatial differences in KE and subsequent influences on puerulus settlement.

Menezes, V. V., Phillips, H. E., Schiller, A., Bindoff, N. L., Domingues, C. M., & Vianna, M. L. (2014). South Indian Countercurrent and associated fronts. *Journal of Geophysical Research: Oceans*, 119, 6763–6791. <https://doi.org/doi:10.1002/2014JC010076>

Line 369: 'for survival. **This** may explain'

Changed

Line 382: 'but these trends becomes' – become

Changed

Line 395: positive not position

Rephrased

Line 405: most not model

Changed

Line 419: (early or late, Figures **10, 9a** and b)

Fixed

Line: 422: fix 'failure of 2008 and 201109'

Fixed

Line 453: 'fluctuated **in** a similar'

Changed

Line 510: Grammar: 'An increased LC while puerulus are crossing the shelf may transport them southward and either settling closer to Cape Mentelle or wash them too far offshore to return'

Rephrased

While puerulus are crossing the shelf, an increased LC may transport them past Cape Mentelle, away from suitable habitats.

Line 514: however this **is** beyond the scope

Changed