January 15, 2019

Trends in oyster populations in the northeastern Gulf of Mexico: An assessment of river discharge and fishing effects over time and space

Manuscript ID: UMCF-2019-0050

Dear Dr. Adkison,

Thank you for the opportunity to revise the manuscript UMCF-2019-0050. We have made extensive revisions throughout based on the Editorial teams comments. We have provided detailed responses to the reviewer and editor questions and comments in the attached document and we feel the manuscript is greatly improved. In the attached document we provide the original comment and then our response in *italics.*

We hope that you find these changes acceptable for publication.

Regards,

Wiliam E. Pine

Reviewer(s)' Comments to Author:

Editor comments

I noticed that the offset of counts for transect length was log-transformed. I may have missed some detail of the analysis, but I would expect that counts would be linearly related to transect length. Please check whether this log-transformation is appropriate given your analysis model.

*We have expanded this discussion in the paper and added additional references. The offset changes the model from modelling counts C, to modelling a rate C/L (where L is the transect length), as the response.  Since, these models have a log link, we have log(C/L) = beta0 + beta1 \* covariates, which can be rewritten, moving the length to the right hand side, log(C) = log(L) + beta0 + beta1 \* covariates. So because the model is using a log link, the values are on log scale. See line 144-167.*

Reviewer: 1

Comments to the Author

Summary: The authors pull together multiple sources of data to investigate patterns of oyster populations and environmental conditions in the Suwannee River region. The statistical methods used are appropriate for drawing inference from these diverse data sources and the data presented and conclusions are valuable to many stakeholders in the region and the field. Given the limited data available, this analysis fills an important gap in our understanding.

*Thank you, we appreciate your positive feedback on our study!*

General comments: The structure and writing of the paper are clear and easy to follow. The discussion is speculative and wanders from the available data and analyses presented here to discuss general issues affecting oysters that are beyond the scope of the paper. This context is important – but reorganization of the paper is needed to focus on the advancements pertinent to the analysis, and then generalize to interactions with other factors. The modeling and sampling methods should be described in more detail, particularly in reference to figure 3 and the modeled oyster populations, and the time period of oyster surveys. This essential detail seems to be missing from the manuscript. Statistical methods are complex, which may be necessary given the limited data, however this needs to be better justified.

*We have added a table in the supplementary materials defining the period (i.e., season and year) when each site and locality were surveyed.*

Specific comments:

Abstract:

Line 13: how are inshore intertidal bars becoming like offshore bars? Simply in that they are degraded or are there other structural, biological similarities that inform causes of declines?

*We have revised to clarify that the inshore bars are becoming degraded. Line 24-25*

Line 16: confusing arrangement suggests a linkage between increasing CV of discharge and oyster fishing effort. Consider revising.

*We have deleted this sentence from the abstract.*

Data collection line transects: what interval were transects sampled, and over what timeframe? I can’t find where the period for oyster surveys is defined. Also winter or summer period is only mentioned in the model methods without definition of how this relates to surveys or other data.

*We have added a table in the supplementary material that defines which periods each locality/site was surveyed. In addition, we define the time period (i.e., year and season).*

Line 99: minimum? Maybe just a typo or maybe needs to be updated

*We have removed the ? after minimum – this was just a typo.*

Line 110: How were these selected? Is there evidence that mean daily discharge or extreme events has a greater influence on oyster populations?

*We have added text to clarify that these variables were used as a proxy for salinity (line 123).*

Line 120: Were all counties pooled for the analysis? I’m curious if there were differences in fishing effort among locations or if the resolution is good enough to address this?

*Yes, we have clarified that landings data were combined for the counties. No, the data resolution is not adequate to reflect effort among locations. Line 138-140.*

Line 128: the term ‘period’ is confusing throughout the manuscript. I think this general model description is outlining a method applied to datasets with different sampling intervals and durations, but I found this confusing throughout the manuscript and in the figure captions. particularly in figure 3 with period on the x-axis. Are sampling periods evenly spaced such that the model fit indicates proportional change over time?

*Yes, sampling periods are evenly spaced they refer to summer or winter of each consecutive year. We have included a Table in the supplemental files defining each period.*

Line 130: Can you provide more justification for using counts and transect length as an offset versus calculating average density?

*We have included additional explanation and references to Zuur (2009 and 2013). Using effort as an offset changes the model from modeling counts, to modeling a rate (count/area) as the response variable. Because each of our transects was a fixed width, the area only changed as a function of transect length. Since these models have a log link, the equation is most simply written as log(count/transect length) =* *beta 0 + beta 1 \* covariates which can be re-written as log(count) = log (transect length) + beta 0 + beta 1 \* covariates. Additional advantages of using the actual counts vs. converting the counts and area to densities is that the fitted values and confidence internals do not contain negative values (Zuur et al. 2009). See line 144-167.*

Line 170: what do ‘these covariates’ refer to? River discharge and fisheries landings? confusing sentence structure

*We have dropped this sentence as it was no longer needed given further revisions.*

Line 177: are these statistically significant trends? Mean daily discharge and total annual discharge are the same pattern just with transformed data (i.e. divided by 365) – could simplify discussion and reduce the number of figures to select one and focus on that.

*We chose to use mean daily discharge throughout the paper and have removed total annual discharge.*

Line182-189: Move to methods as justification for using Suwannee River data for all locations.

*We have made this change.*

Line 245 (and references therein): Kimbro 2017 and Pusack 2017 appear to be the same paper? Double check references.

*Yes, Kimbro 2017 and Pusack 2017 are the same paper – the correct citation is Kimbro 2017. We have fixed this in the manuscript and references.*

Line 247-259: I appreciate the candid discuss of limitations – what do you think contributed to the strong modeled relationship between oyster count and discharge? It is important to understand why this relationship was observed before extrapolating to whether the relationship is globally relevant.

*We do not understand from a mechanistic perspective what drives this relationship.*

Line 292: This discussion of factors leading to decline of oysters could benefit from more details from the study. In the methods you mention counting live and dead oysters, but this data does not appear to be used in the analysis. Were there concomitant changes in dead oysters that could support or refute hypotheses about putative causes of decline (like habitat)?

*We have not made extensive use of the dead oyster count data, because we are unsure how long the dead shells persist on the oyster bars. We have observed that the dead shells are more likely to wash away in storms than live shells, so we do not know how informative these shell counts are. We simply do not know what other factors led to the decline and feel that discussion beyond what is provided is highly speculative.*

Line 316-317: I agree, the use of the fisheries data to explain oyster count when little to none or variable effort occurs in intertidal reefs is tenuous. However, it is of interest to explore whether or not synchrony exists in populations occurring in different habitats that could suggest environmental vs harvest factors driving population changes. The current structure of the analysis doesn’t allow for a quantitative comparison, yet some discussion of the needs of this type of analysis seems appropriate.

*We have added text (Lines 341-347) expanding on this point.*

Figures:

All figs: I recommend redesigning figures for legibility in the final version. Font size is too small, background grids, when present, are distracting.

*Figures have been revised.*

What is period?

*This is addressed by adding the supplemental table*

Fig1: Really nice figure!

*Thank you.*

Fig3: Model seems to poorly predict observations. Many observations outside of the 95% confidence interval – give the relatively low number of surveys this seems like an issue. In Fig. 2 the negative binomial predictions look to accurately model oyster density – can you provide detail why the model might be less accurate in the site-location combinations?

*Based on reviewer comments, we switched from using the GLMM to the more widely used MASS package and the likelihood function described in Venables and Ripley (2002). We originally used the GLMM package because we were exploring the use of random effects and the computational speed of the GLMM package was greater than other packages. However, in revision the use of the likelihood formulation in the MASS package resulted in better model fit to the data. We have revised the results and figures based on this improved fit.*

Reviewer: 2

Comments to the Author

I recommend that the article be accepted at this time with minor revisions. The authors investigated the relationships of river discharge and fishing effects over space and time for populations in the US Gulf of Mexico. Overall, this work contributes to further unraveling the complexities behind oyster population flux and decline with implications for conservation management and future research. My suggestions to improve the manuscript are as follows.

General Comments:

1) Be mindful of defining acronyms at first use. There are many instances of undefined acronyms in the text.

*We went back through the manuscript to make sure all acronyms were defined the first time that they were used.*

2) Go back and check for missing spaces between periods, I note that the authors are using two spaces after the end of a sentence.

*We have standardized throughout.*

3) Overall, trim the use of significant digits to an appropriate level of precision, such as two to three, e.g., Table 4 estimates and standard errors and p-values throughout the manuscript (e.g. L215 p=9.25e-16 would be sufficient as p<0.01).

*We have reduced all numbers to two significant digits throughout.*

Abstract:

1) L7 - Do you mean generalized linear mixed effects models? I agree that you are using mixed effects models, yet in the manuscript they are referred to simply as GLM. It is fine to just call these GLM, just decide and stick with that. It would actually be more interesting if the mixed effects are called out specifically in the Data Analysis Methods.

*As discussed above, based on these comments we re-evaluated our use of the GLMM package given we did not use a random effect in our final model. We re-analyzed all data using the more common MASS package and this resulted in improved model fit. This led to us updating all results and figures to reflect this improvement in fit.*

2) L16 - Sentence starting with "Overall" is confusing, here, yet this linkage is clear in the manuscript text.

*We have deleted this sentence.*

Intro:

1) Overall, the concept of oyster reefs being intertidal or subtidal AND either inshore, nearshore, or offshore is confusing as presented. Some readers may not know this about oysters.

Perhaps add a sentence stating this explicitly and then lead into the literature examples (L50-53) and that this study focused on intertidal only in all three spatial provinces.

*We have added text to clarify the terms intertidal and subtidal as well as inshore, nearshore, and offshore descriptions.*

Methods:

1) L94 - add a space between sentences.

*Done.*

2) L97 - Define acronym.

*We have defined the acronym.*

3) L99 - Strange occurrence of "?".

*We have removed the ? from this sentence.*

4) L97,99,101 - Decide if using e.g., # m or #-m.

*We have used # m throughout.*

5) L110 - Yes, CV is the coefficient of variation, yet should still define the acronym.

*We have defined this acronym.*

6) L118 and L125 - Hold off on using GLM here, and if you do define the acronym. Rather, flow would be improved to replace use of GLM here with "analysis" and describe in Data Analysis subsection that you used GLM or (GLMM).

*We changed these sentences to just say ‘analysis’ instead of ‘GLM analysis’.*

7) L127 - call these generalized linear mixed effects models, as in abstract, and define your mixed effects.

*We actually used generalized linear models not mixed models, which is why the mixed effects are not defined. We have fixed this throughout the manuscript.*

8) L128 - extra space between 2008 and to.

*We have removed the extra space.*

9) L132 - needs a comma between ". . .function)", and which.

*We have added this comma.*

10) L135 - define acronym and provide a reference for AIC (Akaike . . .).

*We have defined this acronym and added a reference.*

Results:

1) L203 - model equation has an extra space and needs a parenthesis.

*We have fixed the formatting of this equation and added the extra parenthesis.*

2) Starting with L207 - Trim the significant digits used to report the p-values.

*These changes have been made throughout*

3) L212 - extra space in model equation.

*We have removed the extra space.*

Discussion:

1) L270 - Isn't there a link between discharge and habitat formation by sedimentation? I see that you get to this in the discussion (L340-341), could you introduce that briefly here? I think this is pretty important to the story.

*The role of sedimentation is also unclear. The Wright et al. paper is the only work we are aware of on this topic in Suwannee Sound and in the Big Bend region. Other regions where sedimentation has been assessed including coastal Louisiana are very different because oysters there do not form the same type of clumping reefs as they do in the Big Bend, nor do intertidal oyster bars exist with the same prevalence.*

2) L308 - Check use of "subtidal" and "sub-tidal" and choose.

*We have used subtidal throughout.*

3) L317 - add space between sentences.

*We have added a space between sentences.*

4) L326-327 - Sentence is unclear, although I know what you are trying to say, I think. Re-write, i.e., are inshore areas becoming more like nearshore and offshore areas in terms of density? Say this directly, and place nearshore before offshore in order.

*This sentence has been revised.*

5) L328 - Would use of satellite imagery assist with identifying location of new reefs?

*We have added text and references to address this.*

6) L360 - Extra parenthesis.

*We have removed the extra parenthesis.*

References:

Review and cross reference, I did not.

Tables and Figures:

1) In general, if acronyms are included in the table fields, define those in the captions.

*This has been done throughout.*

2) Table 1 - Define GLM acronym in caption. Define AIC in caption, and increase the spacing between fields AIC and Delta AIC.

*This has been done throughout.*

3) Table 2 - There are waaaaay too many significant digits used here, and it looks sloppy. Reduce to two or three significant digits. Define Std. error.

*This has been revised and updated.*

4) Table 4 - Same as Table 2.

*This has been revised and updated.*

5) Increase Figure resolution to 300 dpi for publication.

*This has been updated throughout.*

Good work, thank you for your contribution

*Thank you for the kind words.*