We thank the two distinguished referees and yourself for the time and energy spent reviewing our manuscript. The comments and critiques have greatly improved its presentation and readability. Most substantively, we have added a final subsection to the methods detailing how the simulation results were ultimately summarized for the results, including the Gini index and portfolio benefit. We have also attempted to shorten sentences throughout the manuscript. Responses to specific comments are in our response. Line numbers are based on the original submission unless otherwise noted.

**Reviewer #1**

OVERARCHING COMMENTS

Overall, I think this manuscript provides a cool use of theoretical modeling to investigate

portfolio effects in three California fisheries. The results contribute to our understanding of

tradeoffs in multispecies fisheries, and provide insight into the effects of limited permit access.

There are some points that should be moved to different sections, mainly discussion points that

are brought up in the Results section. My comments are chiefly stylistic. I suggest reviewers

evaluate the manuscript for comma usage and consistency of verb tenses. I also suggest the

authors strive to simplify the language. In many instances, sentence structures are complex to

the point of hindering understanding of some key points. I think the manuscript would be greatly

improved if edited with an eye for increasing ease of comprehension.

**Response**: We have attempted to shorten sentences throughout the manuscript.

ABSTRACT

The abstract successfully conveys the purpose and main findings of the study.

*Line Comments*:

P2. L29-30. I suggest being more specific about what declines you are referring to. Declines in

stock biomass? Declines in environmental conditions?

**Response**: This half of the sentence was deleted since we do not really explore long term productivity change in the modeling.

INTRODUCTION

The introduction does a good job briefly covering the salient points regarding fisheries portfolios

and how they can influence revenue variability. The final paragraph which addresses analysis

performed in this study uses language that is oddly vague (“..based roughly on the fisheries…”

“…target some combination of…”). It is making me wonder why, and I suggest the authors

either adjust the language or be explicit about why they are using vague language. Stylistically, I

think a lot of the sentences are very long (some of them are even run on sentences), and many

would benefit from being split into two smaller sentences.

*Line Comments:*

P3. L48. The authors might consider including definitions of limited access and catch share

programs (and other fisheries-specific terms throughout the ms), since Ecological Applications

is not a fisheries-specific journal.

**Response**: We removed the reference to catch share fisheries and define limited access in the sentence now “limited access programs that restrict the number of fishers permitted to harvest particular species”

P5. L82. The word though should be through, I believe.

**Response**: typo has been corrected

P5. L83. Example of a really long sentence (there are many throughout this section). If you don’t

want to split it, I suggest removing the comma between “efficiency” and “and”.

**Response**: Sentence has been split.

P6. L104. Why is the simulation model based roughly on the fisheries and not just based on the

fisheries?

**Response**: The word “roughly” has been removed. We instead describe it as a “stylized” model.

P6. L110. What is meant by “some combination”?

**Response**: We removed the permit portfolios from this paragraph, and now refer to participation decisions for the three different fisheries. Since we removed the reference to portfolios, later in the paragraph we are more specific about the goal of the access scenarios.

METHODS

The methods section accurately describes the methods used in the analysis. Like the

introduction, this section also has a lot of long sentences that would benefit from simplification,

or a re-evaluation of comma usage.

*Line comments:*

P6. L120. I suggest a comma after economic, because the authors seem to use the oxford

comma throughout the rest of the methods and it should be consistent.

**Response**: Oxford comma has been added

P7. L141. Remove extra space after Recruitment.

**Response**: extra space removed

P8. L148-149. In my opinion the phrase “in common with crab” is awkward. I suggest editing it

to be “Similar to crab,”.

**Response**: The phrasing has been changed

P14. L289-L293. This paragraph switches to present tense, while the rest of the manuscript is in

past tense.

**Response**: Tense has been changed

RESULTS

The results section has a tendency to veer into Discussion territory. I suggest the authors edit

the entire section to remove discussion of reasons why they observed the results they

observed. If you are saying “this is because…” in the Results, there is a good chance that

should belong in the Discussion section. This section also introduces the Gini Index for the first

time with no citation. I suggest including an explanation of the usage of this index in the

methods section, and providing documentation of what this index does in a citation. Also the

final section of the Results (Synchrony and access) relies on other sections to state the results. I

suggest just explicitly stating the results without relying on reference to previous sections.

**Response**: We have included a description of the Gini index in the methods section. We added a citation for the R package we used to implement its calculation. The Gini index itself is a rather ubiquitous metric and is generally used without citation (i.e., there is an extensive Wikipedia article). While we understand that this reviewer prefers to include description of model mechanisms in the discussion section, we feel this is a stylistic decision up to the authors, and chose not to restructure the manuscript. We feel it would be awkward and require more overall text to refer back to and explain the mechanistic drivers behind specific results in the discussion section and prefer to focus the discussion section on broader findings and their relation to the literature. We have explained the statement “except as noted above” in the final sub-section.

*Line Comments:*

P17. L356-357. Which levels of aggregation? Which individuals?

**Response**: This sentence now reads “Synchrony increased variability of total revenue, but not variability of revenue of each species.” Individuals were removed from the sentence, as this was accidentally left over from previous drafts where individual revenue variability was included in the same paragraph. This added detail made it redundant with the following sentence, which we deleted.

DISCUSSION

The Discussion does a good job speaking to the broader implications of this study, and

providing explanations for the model output results. Similar to the introduction, I think this

section suffers from needlessly complex sentence structures that make it a difficult read. I

suggest reviewing the entire manuscript with a critical eye toward simplifying language and

sentence structures. I also think the discussion points that are currently in the Results section

should be moved to the Discussion.

*Line Comments*

P21. L462. “participation in crab..” is kind of an awkward phrase. I suggest changing it to

“participation in the crab fishery”.

**Response**: This phrasing has been changed

P22. L476. I’m not sure what the authors mean by “filter the environment”. Be more explicit.

**Response**: This sentence now reads: “…a population’s age structure influences how environmental variability is filtered through the population to ultimately influence variability of aggregate measures like biomass and productivity”

P22. L485-487. An example of a needlessly complex sentence. Commas are misused here, and

it’s not necessarily clear what the “it” pronoun is referring to in the second part of the sentence.

This sentence takes a few reads to get the point across, and is a prime example of one that

could be edited to get the point across in a more clear and concise way.

**Response**: This sentence has been revised.

P23. L494. Remove errant comma.

**Response**: Removed

TABLES AND FIGURES

Overall, I think the quality of the figures can be improved greatly. There are multiple figures that

have axis labels overlapping with tick mark labels, and others that have legends or plot labels

that overlap with the data displays.

**Response**: We looked very carefully and are not able to see any figures with axis labels overlapping with tick mark labels, nor do we see legends overlapping with data – it I possible that this happened when the files were converted to PDF. We agree that such plots would need to be greatly improved, but need more detailed information from the reviewer or editor to proceed.

*Table/Figure Specific Comments*

Table 2. Seems like the authors might be missing the second half of the table caption?

**Response**: We cannot recall what was supposed to go in the second half of the table caption, so the second half has been removed.

Table 4. Capitalize Gini Index in the caption and the table to be consistent with how it is

referenced in the manuscript text.

**Response**: Done

Figure 1. Increase font size of axis tick labels.

Figure 2. Increase font size of axis tick labels.

Figure 4. Increase font size of axis tick labels.

Figure 5. Increase font size of axis tick labels.

**Response**: Font size has been increased.

Figure 6. The caption needs to provide a better explanation of what the colored lines represent.

Which color corresponds to which recruitment strength? I would also suggest providing a legend

with this information.

**Response**: We have amended the caption to remove mention of different recruitment strengths, as this was a distraction. We tried to more clearly state the intended purpose of the colors. They are there merely to draw the reader’s eye to five specific paths catches might take through the year. The specific recruitment strengths and their order are not important, so we did not include a legend with that information.

Figure 7. The second sentence of this caption does not provide enough context for it to be

meaningful. I suggest either removing it, or providing greater explanation of what is meant.

**Response**: Second sentence removed.

**Reviewer #2**

In 'The effects of population synchrony, life history, and access constraints on benefits from fishing portfolios,' the authors present a simulation study of the effects of access constraints and population synchrony/asynchrony on mean and variability of revenue from fisheries among which fishers can switch (to differing degrees), thereby addressing the question of how access rights can increase/decrease known portfolio benefits of fishing multiple species given the constraints of population dynamics. It is an interesting and timely topic and fits within the scope of the journal, and the paper was generally well written and presented. There was, however, some important information missing from the Methods that would allow the Results to be more understandable and the importance of them interpretable in Discussion. Below I provide descriptions of these under 'Major comments', followed by a list of 'Minor comments' that both points out where major comments can be addressed in the text, as well as additional suggestions to improve the flow of the text.  
  
Major comments:  
1 - Methods in general: There is missing a description of how the model was actually run, and what a simulation entails. Crab and salmon may be straightforward modeling, but was groundfish run to equilibrium (using the stock recruitment relationship) and then weekly fishing begun? I suppose several years (how many?) of weekly fishing were run per simulation (otherwise, what is the point of having a stock-recruitment relationship built into groundfish?). However, Figure 6 suggests that only 1 year of weekly fishing is run, so it is unclear what a single simulation actually entails.

**Response**: We think this confusion is largely due to the misleading caption for figure 6. We have revised the caption to emphasize that each line represents a different year of the same simulation. The simulation length of 50 years was stated in several locations in the methods section, though we have added more test. As described in the parameterization section, groundfish were initiated at equilibrium age-structure at 40% of *B*0. We added a specification that this initial condition was calculated analytically.

2 - It would also be clearer if the output variables used were formally defined (means, CVs) so that it is more intuitive whether the variability analyzed throughout is actually across annual or weekly, or across vessels within a time period (annually/weekly), and when this measure of variability changes depending on the question. Similarly, there are many ‚distributions‘ analyzed in the figures, but it is unclear of what the distribution is – e.g., individual vessel means or CVs over years or weeks? Differences among "simulations"? Table 4 suggests an averaging "across simulations" within scenarios but it is not described how simulations differ within scenarios. Figure 3 also has a formal definition of an output indicator used that is never described in the paper ("Portfolio benefit").

**Response**: We have added a sub-section “summarizing simulation results” to the end of the methods section that attempts to cover these details. In addition, we changed the aggregation procedure for the portfolio benefit to be more consistent with other summary statistics in the manuscript, mainly for ease of comprehension. This had no qualitative change on the results.  
  
3 - One of the more interesting results applicable to policy, the effect of access rights on equality of fishery participants using the Gini Index as an indicator, is drawn on as a rather important finding in both the Abstract and Discussion. However, there it is never mentioned in Methods and is barely mentioned in Results. If this is going to be used in a major conclusion, then the mechanisms behind why this occurs should be explained better in Results / Discussion.

**Response**: We have added the Gini index to the new methods sub-section in response to major comment (2). We have also explained the mechanism behind the effect of access on the Gini index in the results, as recommended in one of the minor comments below.  
  
Minor comments:  
Abstract: After reading the paper, I‘m not sure where the conclusion "Thus, building a portfolio of diverse life histories can buffer against the impacts of extremely poor environmental conditions over short time scales, though not for long-term declines." stems from because long-term declines do not appear to be a component of the simulations (or if they are, then the time-scale of simulations needs to be better described and this topic should come up in Discussion).

**Response**: We removed the latter part of this sentence since we do not really explore long term productivity change in the modeling as the reviewer notes..  
  
Line 189: Suggest inserting (Ns,y,w) after "a given week", then moving lines 179 – 181 below this, so that Ns,y,w is defined before using it in equation 3.

**Response**: Done

Line 56: What about predator-prey relationships?

**Response**: predator-prey relationships have been added as an example driving both synchronous (bottom-up dominated) and asynchronous (top-down dominated) dynamics, with appropriate citations added.

Line 69: "However" is awkward here – I don‘t see how the ability to divert effort into another fishery is changed (latter sentence) whether the fishing seasons overlap or not (previous sentence).

**Response**: However has been removed, and the two sentences have been revised.

Line 111: It would be good to have a one-liner indicating why sablefish is used to calculate the groundfish fishery. (Consider moving line 307 here).

**Response**: We added “which contributes the largest share of revenue to the non-whiting groundfish fishery). As the reviewer noted, a more detailed rationale was in the methods.

Line 221: Doesn‘t using week 53 essentially offset your stock-recruit relationship by 1 more year? That is Bg,y-k,53 = Bg,y-k+1,1? Perhaps it would be clearer to ireplace "to account for catches from the final week." with something like " to include all weeks of fishing mortality but exclude next year‘s recruitment in the calculation of Bg,y-k."

**Response**: Yes, this is a correct interpretation. We have used the reviewer’s recommended language.

Line 233: It seems like there is an equation or missing relating when/how fixed costs are actually removed to calculate profit (only variable costs are considered in lines 263. – 268. If they are only used in the supplementary material, state that. Variable costs are also not very well defined – are they related to effort? If so, they would increase with week (especially for crab) as the fishing season progresses, is that correct?

**Response**: The purpose of the paragraph on line 233 is to give a conceptual overview, and equations are provided further down. We added a sentence that a vessel’s variable costs do not change within a simulation, but are only incurred when the vessel fishes. Fixed costs are intentionally not removed from \*marginal\* profits for the upcoming week. We have included calculations of annual profit in the new methods subsection, and this does include fixed costs. We added figures to the supplement showing patterns in profit. The patterns for mean profit track those of mean revenue and patterns for profit \*SD\* track those of revenue \*SD\* (the latter of which is also now in the supplement). We did not report profit in the main manuscript because we could not calculate a CV as profit is not non-negative. Profit SD, like revenue SD, was heavily influenced by scale and thus difficult to interpret. Our rationale for including revenue rather than profit in the main figures and a reference to the supplement figures is in a new first paragraph in the results.

Line 291 or 300: Define what a "specialist" vs. "generalist" is here.

**Response**: Defined at line 291.

Lines 338 – 343: With a q scaled to be the catchability of a single vessel, and the total number of vessels participating in a given fishery differing among scenarios, isn‘t there the potential that the groundfish will either become overfished or underfished depending on the scenario (since the groundfish, have a stock-recruitment relationship built in)? Is this realistic, or would it be more realistic that fishing continues until a management goal is reached? In general, when do fishers stop fishing? It seems like for crab and salmon that this would either be when the fishery is no longer profitable or the end of the season, whichever comes first, but it is not clear for the groundfish. Is there management included?

**Response**: There is no groundfish management other than permit restrictions, which we have clarified in the referenced text. The supplement previously had a figure showing that biomass stayed roughly constant over the 50-year simulation under medium access. We have added panels showing that biomass slightly declined in the easy access scenario and slightly increased in the hard access scenario and referenced it in this paragraph. We did not think these changes were dramatic enough to warrant the added complexity of modeling a TAC. If groundfish decline sufficiently, it would eventually become unprofitable to fish, and people would stop. These ideas have been appended to the referenced paragraph. We think exploring how a TAC influences the central role the groundfish fishery occupies for revenue stability could be an excellent direction for future research.

Line 345: All combinations of endpoint values?

**Response**: phrasing has been changed

Equations 14 and 15 should be checked for formatting errors.

**Response**: We do not notice any major formatting errors. We did find a better way to specify argmax in Word’s equation editor.

Line 362: Suggest removing "However" and moving sentence to after "(Figure 1, bottom row)".

**Response**: This suggestion did not flow very well, but we rearranged the paragraph in the same spirit as the suggestion.

Line 366 – 372: Order of thoughts here is confusing. Try re-ordering sentences 1 – 4 to be 2,1,4,3.

**Response**: Similar to above, we did not take this exact suggestion, but the entire paragraph has been restructured.

Line 373 – 374: "for the same reasons there were no changes in variability of total revenue at the species level" I don't know what that is, so don‘t make the reader guess – spell it out specifically. Because it was defined a priori not to change in your scenarios? This should also be explained in the previous paragraph as well.

**Response**: We have spelled this idea out in this paragraph. The reviewer’s interpretation is correct, that it was defined a priori not to change. This was already explained in the previous paragraph (“we held the CV of each individual population constant.”).

Line 374 – 375: "Synchrony also..." remove ‚also‘ and consider replacing with "in contrast" and/or beginning a new paragraph. It sounds like a new important result.

**Response**: Paragraph has been restructured. We maintained use of “also” rather than “in contrast” because we are emphasizing that the result is similar: for both specialists and the crab-groundfish portfolio, synchrony does not influence variability.

Lines 376 – 380: Not good practice to begin sentence with ‚This‘ without specifically saying what it refers to. Could consider deleting the first sentence here "This is because...‘ or moving to Discussion.

**Response**: The sentence beginning “this” has been deleted.

Lines 385 – 386: replace "even" with "medium"? The figures also have "ven" rather than "medium"

**Response**: The “ven” seems to be a formatting error that occurred during file conversions (or a typo by the reviewer). “Even” has been replaced with “medium” in the text, figures, and tables.

Lines 394 – 395: "Increasing permit..." This sentence repeats information given later – consider deleting it or moving it to be a concluding sentence (line 402, after "(Table 4).", then begin a new paragraph).

**Response**: We wanted to include all of the major points of the paragraph in the topic sentence (both average revenue and inequality). We have deleted the following sentence and moved the figure reference to the first sentence, to reduce the feeling of redundancy.

Line 402: Would be nice to hear more explanation for why the Gini index decreases with greater access - is it simply because of an increasing sample size (greater participants under greater access) and a change in bias with sample size?

**Response**: The main mechanism for this is access to the crab fishery, since it generates much more revenue than the other two fisheries. We have added two sentences explaining this.

Line 403: Consider replacing "population" with "species" (to be consistent with previous usage)

**Response**: Changed  
  
Discussion  
Line 460 - 462: But costs due to increasing effort to obtain crabs at lower densities later in the season could offset the benefit of obtaining higher prices later in the fishery. The effects of considering costs would be a generally good point to touch on in the Discussion section because your analysis focuses only revenues. Why doesn't it focus on profit, since you already have profit parameterized anyway?

**Response**: As stated above, we added figures to the supplement showing patterns in profit. The patterns for mean profit track those of mean revenue, with one exception which is now detailed on lines 435 and 444-446 in the revised manuscript. For total profits summed across the fleet total profits are maximized at the intermediate medium access because of the mechanism proposed by the reviewer. Patterns for profit \*SD\* track those of revenue \*SD\* (the latter of which is also now in the supplement). We did not report profit in the main manuscript because we could not calculate a CV as profit can be negative. Profit SD, like revenue SD, was heavily influenced by scale and thus difficult to interpret. We added this rationale to the start of the results. The mechanism the reviewer proposed does occur for individual profits from a given fishing portfolio as discussed on lines 460-462. (Like revenue, profits from a given portfolio declined monotonically with increasing access.)

Line 503: It would be nice to finish off the thought train in this paragraph on how multi-objective optimization would be useful to analyze the trade-offs highlighted by your study, or how your study can be used to inform currently used multi-objective optimizations or multi-criteria decision-making frameworks.

**Response**: We have added a final sentence to this paragraph describing how this might be done and cited a recently published article that serves as an example.

Line 522: Here would also be a good place to discuss how constraints of management were or were not included in the study, and what their effects could be. For example, your system represents 2 effort controlled fisheries in simulation and reality (I think), and the groundfish (I believe) is effort-controlled in your study also, but TAC-controlled in reality. How does this affect expectations?

**Response**: We have discussed possible implications of TAC management at the end of this paragraph.  
  
Table 1. "Indices" not "Indexes"

**Response**: Fixed

Table 2. incomplete caption

**Response**: We cannot recall what was supposed to go in the second half of the table caption, so the second half has been removed.

Table 3. Has a lot of repeated information – seems like it could be more efficiently stated in a single sentence.

**Response**: Agreed. However, when we tried to write this in a single sentence, it was a very confusing sentence!

Figures- see earlier comments ("even" is written instead of "medium", indicators being plotted are confusing because definitions are lacking in the Methods)

**Response**: “Even” replaced with “medium.” Attempted to better explain indicators in the new methods subsection.