We thank Reviewer 3 for their thoughtful comments and suggestions and would also like to wish them a speedy recovery.

Note that all revised figures referred to throughout the response can be found at the end of this document.

Dear Authors,

Thank you for your patience awaiting the reviews of your manuscript. The third referee suffered an arm injury and was unable to write up a full review report but did send me via direct email a number of general comments and suggestions.

The first two review reports both identify some major limitations of the work presented here. Of key concern are the lack of novelty of the findings and inconsistencies be-tween the objectives, simulation scenarios, and conclusions. These concerns are shared by the third referee, whose comments I can paraphrase here as: /- Conclusions are stretched, and the impact of beach width on dune erosion is already well-known. Itis also obvious that dune erosion is less when an artificial dune is placed in front; the% reductions found are purely a consequence of the arbitrary geometry of the artificial dune.

This concern has been shared among the reviewers and we understand that further work was needed to clarify the conclusions and analysis presented in this paper. Reviewer 1, in particular, shared this concern and stemming from their comments we have restructured the paper to better demonstrate the relative roles of dune aspect ratio and beach morphology in determining how dunes erode under storms of varying intensities and duration. To explain how we have revised the manuscript, we present an excerpt from our response to Reviewer 1 below, which outlines the changes which have been implemented:

We have reframed our presentation, restructuring the results section and reorganizing the discussion section to highlight that: 1) We isolate the effects of dune aspect ratio on dune erosion through analysis of our toes-aligned simulations (in which beach width is held constant). These scenarios allow us to also examine the effects of storm duration and storm surge level on dune erosion as a function of dune aspect ratio. 2) We then isolate the effects of beach width on dune erosion by subtracting the effect of dune aspect ratio on dune erosion as determined from the analogous toes-aligned simulations, and 3) Our fenced aligned simulations then provide additional insights into how dune erosion is influenced by emplacement of sand fences as a function of storm duration and surge level. We have also proposed to change our title from "The influence of dune aspect ratio, beach width and storm characteristics on dune erosion for managed and unmanaged beaches." "The relative influence of dune aspect ratio and beach width on dune erosion as a function of storm duration and surge level." For more details, please see page one of this response for the complete summary of changes in this regard.

/- Systematic exploration of dune erosion is a good idea, but the set of scenarios is not optimal and there is little interrogation of the details of the erosion process itself.

To further analyze the erosion processes occurring in our simulations we have performed additional analyses investigating changes in dune toe position, beach width, and wave energy impacting the dune. Results from these analyses have been incorporated into our revised manuscript and can also be found in our response to reviewer 2.

/- There is thus more to be found in analysis of the simulations, perhaps also regarding the parametrisations in Xbeach. Figure 7 shows some interesting features that are not fully discussed.

This comment was also shared by Reviewer 2 and we repeat our response here:

Here the reviewer also suggests useful papers that have indicated different XBeach parameter values, which may be more appropriate than the values we used with the simulations presented in the original manuscript. We re-ran the simulations with the new parameterization, described below and, which qualitatively confirm our original results but with some quantitative differences. The default values for wetslp and dryslp in XBeach are 0.3 and 1.0 respectively. The wetslp value we used is equivalent to that used by Palmsten and Splinter (2016) but with a dryslp of 4.0 instead of the default 1.0. To improve the model results and simulate better erosion physics with XBeach we re-ran the simulations using an improved setup with parameter values updated from those published by Splinter and Palmsten (2012) and Palmsten and Splinter (2016) The following values have either been changed from a previous non-default value or have been set from their default value:

- Changed *eps* from 0.05 to 0.1
- Changed *facSK* from 0.30 to 0.15
- Changed *dryslp* from 1.0 to 4.0
- Set *hswitch* to 0.10
- Set *hmin* to 0.01

We have added the following statement to the methods section detailing the changes we made to the parameterization and some of XBeach's limitations as detailed by the reviewer (revised manuscript lines 180-187):

"We used the XBeach (Roelvink et al., 2009) model to simulate the effects of the synthetic storms described in Section 2.2 on the profiles described in Section 2.1. We ran XBeach (version 1.23.5465) in 1D-hydrostatic mode with the break parameter set to roelvink_daly and the gamma parameter set to 0.52 to better capture the effect of swash processes on the reflective beach profiles (Roelvink et al., 2018) we also adjusted parameters related to wave breaking and dry sediment transport in order to more realistically simulate dune erosion processes given the tendency of XBeach to overestimate erosion with default settings (Palmsten and Holman, 2011, 2012; Palmsten and Splinter, 2016; Splinter and Palmsten, 2012). XBeach erodes the profile by comparing the slopes to the dryslp (if a cell is dry) parameter or wetslp (if a cell is wet) to determine how much erosion should occur to maintain these values. Palmsten and Holman (2011, 2012) show that wet sand can sustain much steeper scarps than dry sand. By using a particularly high value for the dry slope (dryslp = 4), we allow the dunes to maintain much steeper, and more realistic, scarps during the storms (Palmsten and Splinter, 2016). This realism allow us to better understand how the dune is eroding under collision when it is actively

scarping during the storm by comparing dune toe migration to dune volume loss. A full listing of non-default parameters can be found in Table 2."

The 'managed dune' set-up is rather limited, it should include modifications of the dune toe such as marram planting, sand ramps, and sand fencing, interventions that aim to widen an existing/eroded dune again.

The managed setup is meant only to represent the effect of a dune system that has an established fenced dune. The impetus for this project arose from an exploration on the morphologic evolution of fenced versus natural dune systems in the Outer Banks (Itzkin et al., 2020). While we do not simulate other management interventions that also effectively widen the dune, our results can reasonably apply to the interventions mentioned by Reviewer 3 given that they would result in a decrease in the dune aspect ratio while maintaining the pre-intervention dune elevation. We have addressed this issue in the paper by including the following (revised manuscript lines 399-405):

"While we do not explicitly simulate other interventions that would widen the dune (e.g., dune grass planting, sand ramps), these management strategies effectively widen the dune without adding elevation, thus leading to a lower dune aspect ratio than the pre-management condition. In this case, the results presented for sand fences likely apply to these situations as well. In all cases, if dune management actions are not paired with beach nourishment (i.e., Itzkin et al., 2020) then the wider dune will likely come at the cost of a slightly narrower beach. The amount of erosion during storms will likely decrease because of the lower aspect ratio (Figure 7), but the potential decrease in erosion will likely be offset by the erosion arising from the narrower beach (Figure 10)."

The following figures can be found in the revised version of the manuscript referred to in the responses to the reviewers. Note that figure numbers refer to their placement in the manuscript.

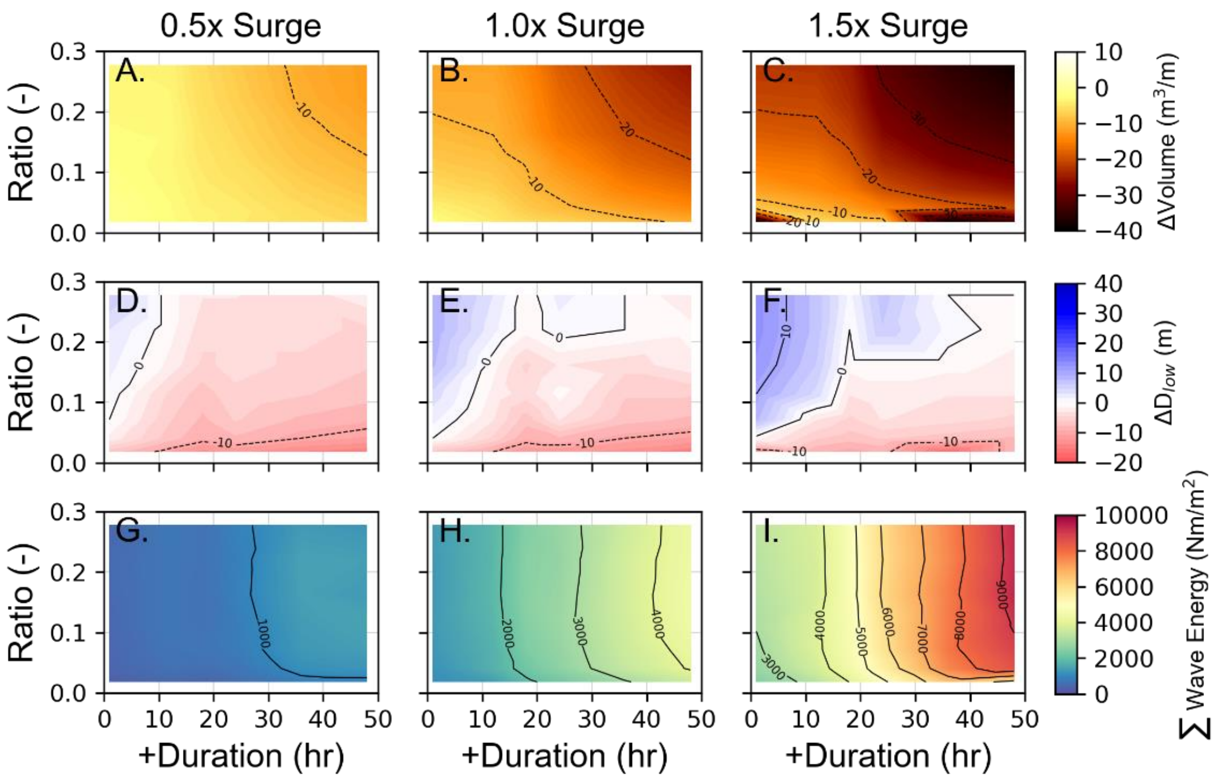

Figure 7: Dune aspect ratio versus storm duration for simulations with toes-aligned (controls for beach width/slope and initial dune volume). Each column represents a different storm surge level (increasing left to right). The top row (A, B, C) shows the change in dune volume, the middle row (D, E, F) shows the change in dune toe position (negative values indicate landward erosion), and the bottom row (G, H, I) shows the cumulative wave energy impacting the dune.

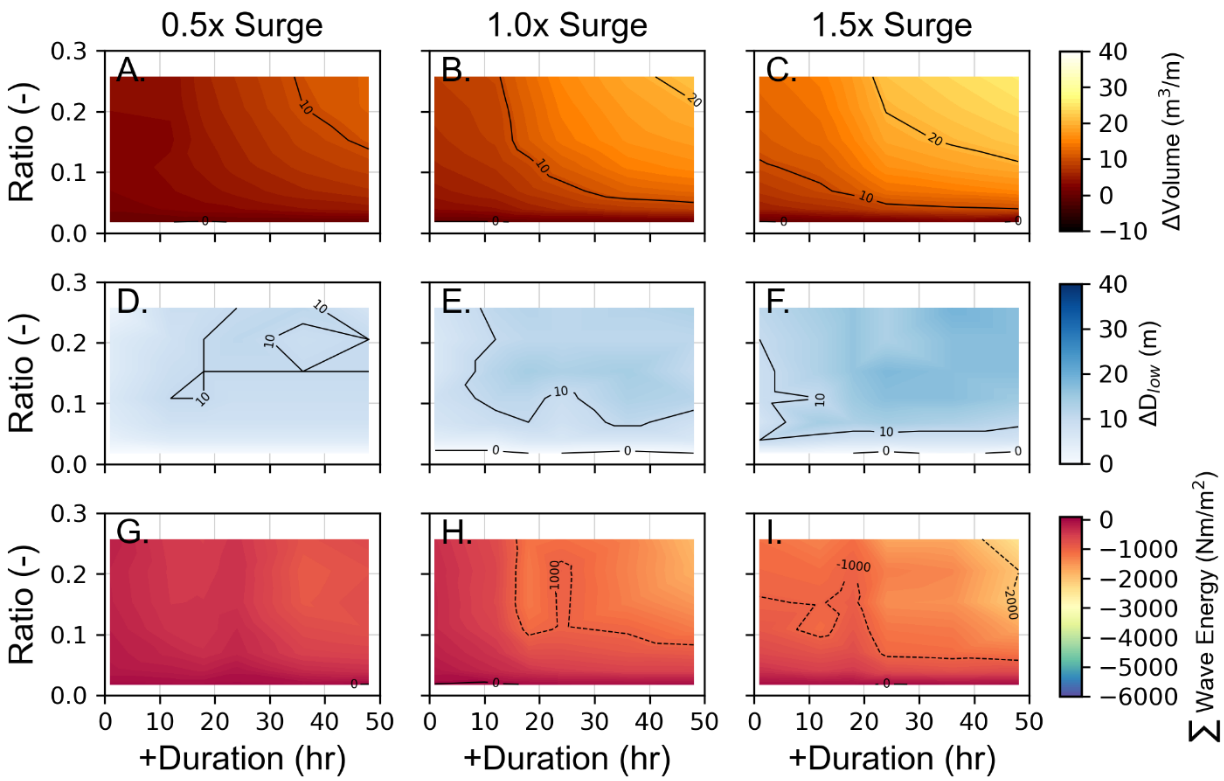

Figure 8: Dune aspect ratio versus storm duration for simulations with crests-aligned. The values from the equivalent simulations with the dune toes aligned have been subtracted from the crests-aligned simulations to highlight the influence from the varying beach widths in the crests-aligned simulations. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes aligned simulation (where beach width is controlled for) such that the top row (A, B, C) shows the amount of volume loss prevented by the wider beach in these simulations, the middle row (D, E, F) shows the additional dune toe progradation induced by the wider beach width, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the wider (and thus lower sloping) beach.

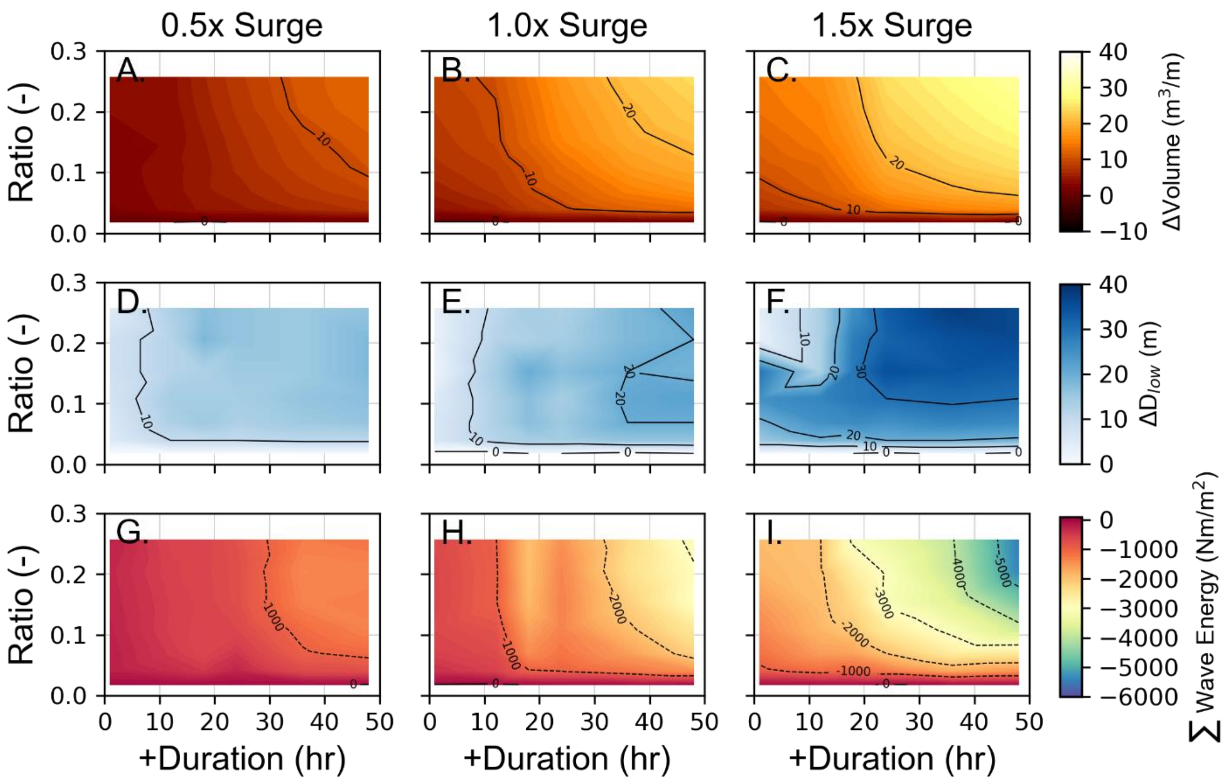

Figure 9: Dune aspect ratio versus storm duration for simulations with heels-aligned. The values from the equivalent simulations with the dune toes-aligned have been subtracted from the heels-aligned simulations in order to highlight the influence from the varying beach widths in the heels-aligned simulations. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes-aligned simulation (where beach width is controlled for) such that the top row (A, B, C) shows the amount of volume loss prevented by the wider beach in these simulations, the middle row (D, E, F) shows the increase in dune toe progradation induced by the wider beach width, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the wider (and thus lower sloping) beach.

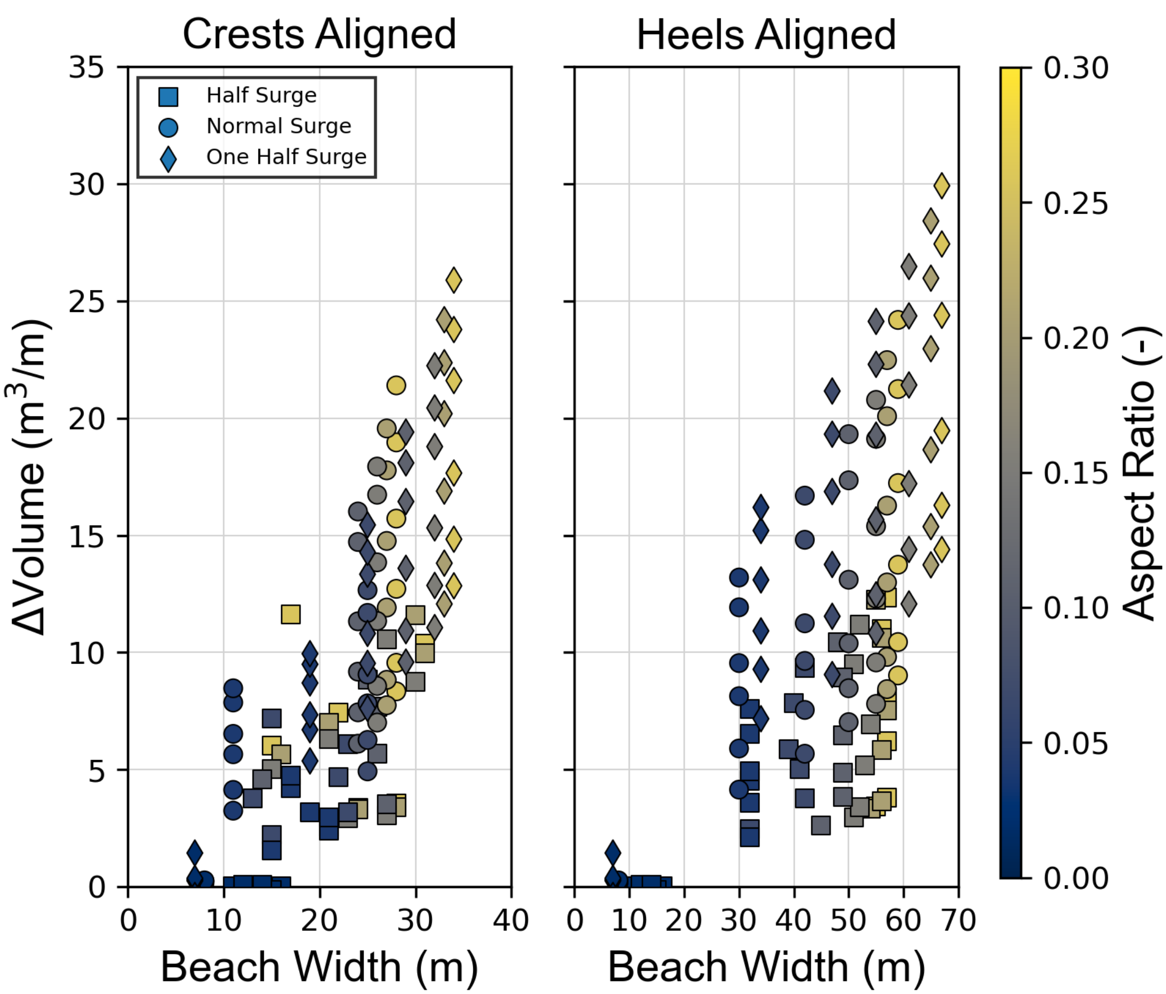

Figure 10. Volume loss from the crests-aligned and heels-aligned simulations minus volume loss from the equivalent toes-aligned scenarios versus the initial beach width for the crests- and heels-aligned simulations. The color corresponds to the dune aspect ratio and the shape corresponds to the surge level.

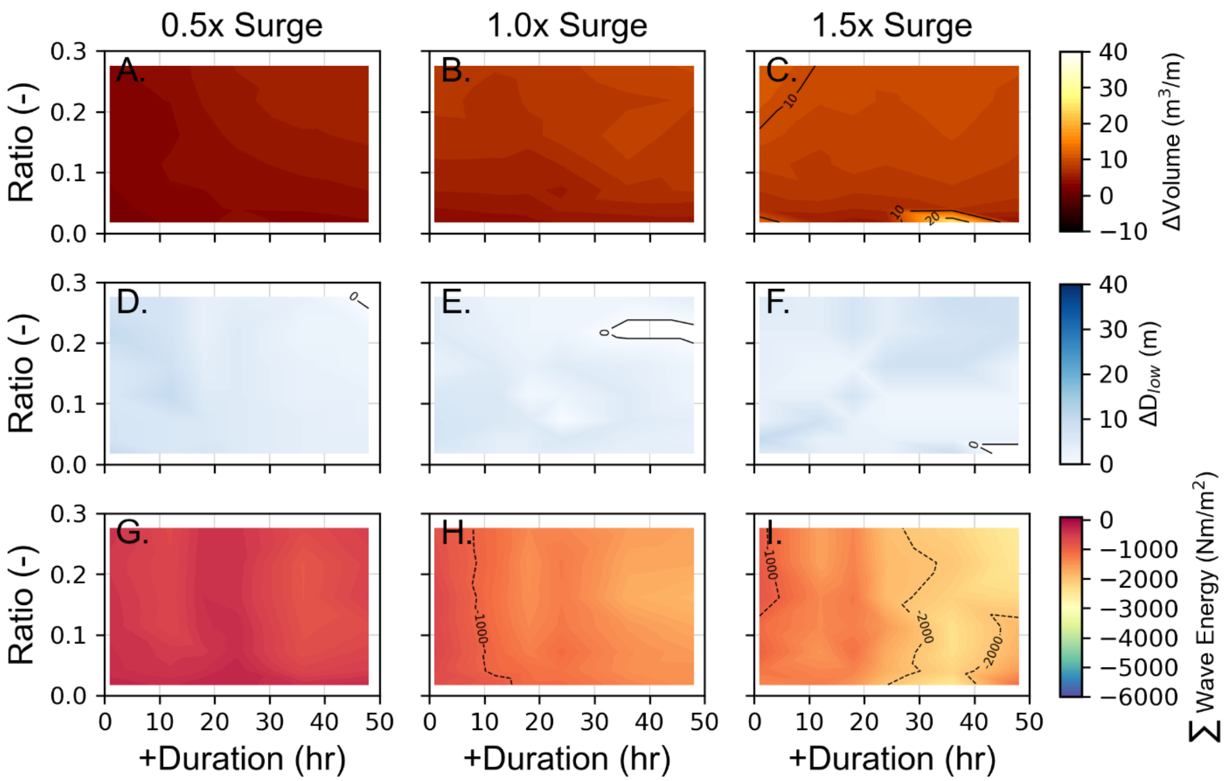

Figure 11: Dune aspect ratio versus storm duration for simulations with sand fences. The values from the equivalent simulations with the dune toes aligned have been subtracted from the fenced simulations in order to highlight the influence from the presence of the fenced dune seaward of the natural dune. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes-aligned simulation (where beach width is controlled for and there isn't a fenced dune) such that the top row (A, B, C) shows the amount of volume loss prevented by the fenced dune in these simulations, the middle row (D, E, F) shows the increase in dune toe progradation induced by the fenced dune, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the fenced dune.