We thank the editor for his comments and Reviewer 1 for a very thorough reading and review of our revision. Their comments are much appreciated and have assisted us in improving the paper further. We also appreciate the important comment from Reviewer 2. We have revised our results to indicate that we are confirming the role of beach width in dune erosion. And, we have further clarified and demonstrated the role that fenced dunes play in mitigating dune erosion. Our responses to comments are listed below. Changes to the text are shown in italics.

The new version of the manuscript submitted by Itzkin et al. shows a clear effort to accommodate the concerns raised by the reviewers in relation to the previous version, I appreciate this effort and I see that the authors have addressed some of those concerns in a very elegant and convincing manner. In this regard, I congratulate the authors for this improved version of their manuscript where they have been able to reorganize the same data in order to present and explain the observations from the modelling in a way that can be more easily transferable and comparable.

Despite the improvements made on the manuscript, I maintain some of my concerns, namely regarding the major contribution of this work, and new concerns related to the way some of the data is presented in this new version. I maintain my view that demonstrating that a wider beach protects more the dune should not be the major output or fact to demonstrate within a work, as I insist, that is the basis of mitigation practices involving beach nourishment. So, I insist that it should not be shown as a novelty fact, as we have all learned from before. I see that the authors prefer to maintain their point of view and insist that this fact has not been demonstrated before, then I ask the authors what principles the engineers have used so far in order to plan these measures as the dimension of the berm is a key element?

It is not easy to understand why the authors insist also in looking at the ratio to understand different erosion patterns and as the way they present it, mechanism. From their data, and previous knowledge that they also have, the only major factor that seem to influence the mechanism or pattern of dune erosion is the stoss slope. As they mention, very high dunes with scarps (similar to the high ratio in the toe-fixed profiles) could have the tendency to collapse, and then add a different mechanism into the dune dismantling when compared to the low ratio dunes. Other than this, I cannot see how the shape of the dune influences the erosion mechanism as the authors express.

The width of the beach determines the amount of volume eroded from the dune, but the author affirm that the width of the dune is also an important factor, I would rephrase this as what the latter determines is longevity of the dune to survive successive erosive events, as the dune will erode in the same manner but the wider the dune, the longer it will last under erosive processes.

To address concerns from both the reviewer and the editor regarding the abstract of our manuscript, we have updated the abstract to better describe the changes to manuscript from the previous round of revisions. We have further revised it to explain that our results “confirm” that the beach width is the dominant control on dune erosion and that the width of the dune will determine how long the dune can persist under erosional conditions.

One more very important point that raised doubts regarding the approach, is the way the dune changes in the dune are evaluated for the case of the crest- and heel-aligned profiles. The authors have opted for presenting the volume change of the latter relative to the

change for the toe-aligned in order to isolate the effect of the ratio and focus on the beach width. As a result, the variation in volume will be always positive because of the wider beach that the latter profiles present relative to the toe ones. I find this way of presenting the data all but intuitive, I believe that the authors can find a way to show the results in a manner that does not raise doubts as what one reads from the graphs is that the larger storm accumulated larger volumes of sand as the beach width or dune ratio increases. It is obvious that with a greater beach the volume of erosion from the dune will be always smaller than if you buffer zone is reduced, then the comparison among the volumes will be always positive (figures 9 and 10) but has a very different meaning from the results in figure 8. Then I suggest changing the name of the axis and thus of this estimate, as it is a delta volume but a relative one or in other words, the volume preserved in the dune because of the increase in the beach width. And the same applies to the dune toe.

The positive values are a consequence of subtracting a large negative value (volume loss from the toes-aligned simulations) from a smaller negative value (volume loss from either the crests or heels aligned simulations). We explained this in lines 259-264:

To isolate the effect of beach width, we subtract the amount of dune erosion (i.e., volume, toe position change, and wave energy) that occurred in the toe-aligned simulations (which control for beach width) from the amount of erosion in the crest-and heel-aligned simulations. This calculation yields a positive number for volume change and dune toe migration, representing erosion that is prevented by the increase in beach width, and a negative value for wave energy representing additional wave dissipation provided by the beach for both the crest-and heel-aligned simulations.

To clarify this, we have revised the above statement as follows:

To isolate the effect of beach width, we subtract the amount of dune erosion (i.e., volume, toe position change, and wave energy) that occurred in the toe-aligned simulations (which control for beach width) from the amount of erosion in the crest-and heel-aligned simulations. This calculation yields a positive number for volume change and dune toe migration, representing *the volume of sediment preserved in the dune as a consequence of increasing the beach width*, and a negative value for wave energy representing additional wave dissipation provided by the beach for both the crest-and heel-aligned simulations.

Below I will transfer some more specific comments from the reading of the manuscript that I hope can help the authors to further improve the manuscript.
From the abstract:
I believe the authors have not updated the abstract to incorporate the slightly different outcomes that they got within this new version. In this line, I would suggest the authors to adapt this new version to what is inside the manuscript, namely the authors state:
"We find that low aspect ratio (low and wide) dunes lose less volume than high aspect ratio (tall and narrow) dunes during longer storms, especially if they are fronted by a narrow beach."
This sentence was fitting the previous version but need adaptation as from my understanding the beach width is the major factor and then minor factor the ratio. Also,

for the particular case of the toe aligned and low surge case, the different in volume change is not so dramatically different as the authors try to express.

Original sentence: We find that low aspect ratio (low and wide) dunes lose less volume than high aspect ratio (tall and narrow) dunes during longer storms, especially if they are fronted by a narrow beach.

Revised sentence: We find that low aspect ratio (low and wide) dunes lose less volume than high aspect ratio (tall and narrow) dunes during longer *and more intense* storms *when the beach width is controlled for*.

For the toes aligned simulations with low surge, there is still a difference in volume change across the different aspect ratios for each storm duration even if the gradient is not as strong as it was for the previous simulations. We do not claim any degree of a difference beyond the decreased erosion for the low aspect ratio dunes in these simulations.

"During more intense storms, low aspect ratio dunes experience greater erosion as they are more easily overtopped than high aspect ratio dunes."
First, I cannot see how this affirmation is novel or bring something we did not know. Second, this affirmation tries to fit what is observed in figure 8C, where the very low dunes are easily eroded, however there is not a gradient in the sense that if the ratio increases, then erosion drops, but a jump in the dune response related to the magnitude of the surge. In fact, the affirmation refers only to dunes with ratios very close to zero while high ratio dunes AGAIN erode more during longer storms, in this regard, how is this different from the low or from the approach by Sallenger?

We have removed this sentence given that the instances of overtopping observed in the original set of simulations were not observed in the new simulations, and this sentence becomes redundant with the sentence addressed in the above comment from the reviewer without the references to the aforementioned instances of overwash.

Finally and also in the abstract, I was a bit disappointed to see that the authors maintained the fenced profiles. I wonder why they have not separated the effect of the fenced dune from the wider beach as well in this case? Because, the fenced profile does not only present a fenced dune but a wider beach. so, again, what are we actually looking at here? the combined effect of wider beach with the addition of a small dune, so additional volume of sand. The final result of a reduction in 50% might depend on the size of the fenced dune but also on the width of the backshore that you had to add to fit in the fenced dune. Your results also show that the increase of beach width may reduce up to 100% in dune erosion, therefore, why do you show the case of the fenced dune? I here would give this a second thought because of the message that these results are going to pass.

Given that the editor has left it up to us to determine whether to keep the fenced simulations, we are opting to include them in the manuscript. We are keeping these simulations for two key reasons:

1. Sand fences are a common feature along managed coasts but their impact on the morphology of the dune system has been understudied. Demonstrating how the fenced-natural system erodes during different storm scenarios is a new finding. It is also interesting that the 50% reduction in erosion offered by the fenced dune was observed during the original and current set of simulations. To clarify that we can separate the role of the fenced dune from the role of the beach width, we have added the following sentences to the revised manuscript:

Lines 179-183: The series of fenced profiles is the same as the series synthetic natural dune profiles in which the D_{low} position is aligned (Figure 3A) except that we added a gaussian curve on the seaward side of the dune to represent the presence of a typical fenced dune shape (Itzkin et al., 2020). *Similar to the simulations with D_{low} aligned, our fenced dune simulations control for the morphology of the beach fronting the fenced-natural dune system (Figure 3D) and therefore isolate the role of the fenced dune in mitigating natural dune erosion.*

Which compliments the following sentence from results section 3.2:

Lines 336-338: By comparing the results from these simulations with those from the toe-aligned simulations (Figure 11) *we quantify how adding a fenced dune seaward of the natural dune affects dune erosion under the varying storm scenarios (while controlling for the effects of beach width).*

2. The section on fenced dunes is self-contained but helps to support the management implications highlighted throughout the discussion section.
The compounding role of the beach width and the fenced dune in preventing dune erosion is discussed throughout section 4.2 as well as in the following from the conclusion. We have modified this text to further clarify:
Although modifying the dune aspect ratio *and/or constructing a fenced dune* does alter the amount of erosion experienced as storm characteristics vary, we find that the greatest protective service in all instances is offered by a wide beach; a finding that is *consistent with previous assertions* and also supported by our limited observations of dune erosion in the field.
Our results indicate that a tall, wide foredune fronted by a fenced dune and a wide beach *offers the greatest protection from erosion*.

Lines 30 and 31: The authors call our attention to the fact that long-term nourishment may have a negative effect on the capacity of the system to maintain its elevation. I believe that the authors are totally forgetting or dismissing the aeolian sediment transport, do you have any special reason? I agree with the authors that nourishing is not an eternal solution but because of its un-sustainability, but I do believe that the systems if they have positive budgets do not need to rollover through overwash to adapt the sea-level rise if they can also maintain it through aeolian transport. Of course the elevation of the berm will be controlled by the runup levels and then the sand only needs to be transferred inland by the wind.
It's not clear what sentence this comment is referring to as we do not address nourishment in the abstract, however the concluding sentence of the abstract that talks about overwash and island elevation is consistent with the literature (Leatherman, 1979, 1983; Moore et al., 2010) stating that barrier islands must rollover on century timescales and beyond to maintain their subaerial

elevation. We agree that aeolian processes are part of building and maintaining island elevation, but we are not aware of any studies that suggest these processes are sufficient to prevent barrier islands from needing to migrate inland to respond to SLR.

Line 60: "while the role that dune height…".
I disagree with the authors. I rather understand that the overwash potential has been widely explored and in this line the dune height appears as a passive parameter. I cannot find many works where the dune erosion depending on the storm is analysed as you are doing with the ratio. what i mean is that you seem to explore how the shape of the dune determines the degree of erosion, and not only the impact as other works (Sallenger) did.
Original Sentence: While the role that dune height plays in determining storm impact has been well studied, the role played by dune width is less clear.
Revised Sentence: While the role that dune height plays in determining storm impact has been well studied*, it is less clear how dune shape (here, characterized as an aspect ratio) influences the style and magnitude of dune erosion*.

Lines 68-69: "While vegetation zonation controls the positioning and height of the dune, the dominant plant species can influence overall dune shape", this is a bit confusing. Most works point to the sediment budget as the main factor controlling foredune height (Moore et al., 2016, Psuty).
We understand where the confusion comes from in that earlier works do point to the sediment budget as a control on dune shape and appreciate the reviewer's reference to Moore et al., 2016. However, recent work has clarified and expanded previous understanding revealing complexities. First, one must separate the sediment supply to the beach (e.g., supply can be evidenced by progradation as the reviewer indicates) and sediment supply to the dune (flux from beach to dune). The current understanding is that sand flux to the dune determines how quickly dunes form whereas the distance from shore that dune-building vegetation can establish is important in controlling dune height because of the effects of topography on the wind field and thus the shear stress exerted on the beach (see Duran and Moore, 2013, for example). In Moore et al., 2016 the effect of progradation is not to increase sediment flux to the dune, but rather to change the distance from shoreline to the dune vegetation line, yielding dunes of different heights, depending on the interplay between seaward shoreline growth, lateral dune growth and relocation of the vegetation line. Since the sentence in question is consistent with the latest literature and it is beyond the scope of this paper to explain the complexities here, we have left this sentence as is, but we have added a phrase to the previous sentence to refer readers to Moore et al., 2016 in case there is interest in better understanding the dynamics we point to here.
Dune cross-shore position and dune height are controlled by the distance between the shoreline and the seaward limit of vegetation, with longer distances typically being associated with the formation of taller dunes (Durán and Moore, 2013; Hesp, 2002; *complexities occur on prograding shorelines, see Moore et al., 2016*) While vegetation zonation controls the positioning and height of dunes, the dominant plant species can influence overall dune shape (e.g., Biel et al., 2019; Hacker et al., 2012; Woodhouse et al., 1977; Zarnetske et al., 2010, 2012).

Line 102-103: "Beach nourishment may also be used to widen the beach (and decrease its slope), limiting wave impacts to the dune and stimulating dune growth"
Here you are using what is widely known about the effect of beach width, then why this need to prove it again?

These previous works do not directly assess the effect of beach width on how dunes erode. Van Puijenbroek et al. (2017) states that increasing the beach width stimulates dune growth. Ruggiero et al. (2001, 2004) addresses how changing the beach slope modifies the total water level and wave energy reaching the dune. Cohn et al. (2019) compares dune volume loss versus beach slope. The relationship between beach width has been explored conceptually (i.e., Burrough and Tebbens, 2008; Claudino-Sales et al., 2008; Silva et al., 2018; Itzkin et al., 2020; Davidson et al., 2020; Leaman et al., 2020), here we confirm this relationship quantitatively through the use of a numerical model. Future work could be done by running these simulations on profiles that control for beach slope while varying their widths. We have clarified this by stating that we are confirming the role of beach width in mitigating dune erosion as suggested by the editor. For example:

Lines 22-24: We then control for dune morphology to assess volume loss as a function of beach width and confirm that beach width exerts a significant influence on dune erosion

Lines 413-416: This result, combined with the results of the toe-aligned scenarios confirms that beach width is the primary control on the volume of sediment eroded from dunes during storms. Our results further suggest that dune width and dune height also affect the volume of sediment eroded by determining the "longevity" of the dune (thereby affecting the transition from avalanching to overwashing, e.g.) under erosive conditions.

Lines 472-475: Although modifying the dune aspect ratio and/or constructing a fenced dune does alter the amount of erosion that occurs as storm characteristics vary, we find that the greatest protective service in all instances is offered by a wide beach; *a finding that is consistent with previous assertions* and also supported by our limited observations of dune erosion in the field.

Line 116: "the main goal…"
I believe the goal of the work is to assess dune erosion and you use a model to do so, but not all the way around.
Thank you, yes. This is a much better way to express our goal.

Original sentence: The main goal of the work presented here is to use a numerical model to assess how dunes erode during a single storm as a function of dune aspect ratio, beach width, and sand fence construction.

Revised sentence: The main goal of the work presented here is to assess how dunes erode during a single storm as a function of dune aspect ratio, beach width, and sand fence construction.

Line 122: "the relative role of beach width in dune erosion processes requires further investigation (Davidson et al., 2020)."
This is not what the authors are stating, in fact the authors have not doubt and they present the beach width as a major factor preventing dune scarping, what the authors mention is that further research could be done on: "Surfzone–beach type controls on beach erosion and the degree of scarping. Observations and tests that record the difference in the magnitude or degree of scarping occurring on reflective versus intermediate versus dissipative beaches under the same storm and offshore swell conditions would be very

useful." Any reader can understand that this is quite different from the effect of beach width, which effect is well-known.

We have removed the reference to Davidson et al., 2020 as we can see that the connection is tenuous. The revised text reads:

While previous studies of storm impacts have primarily focused on dune height (e.g., Long et al., 2014; Sallenger, 2000; Stockdon et al., 2007), recent studies suggest that dune width may also be a key predictor for how much dune erosion will be experienced (Leaman et al., 2020). Additionally, although beach width has been posited as a strong predictor of dune erosion (e.g., Burroughs and Tebbens, 2008; Claudino-Sales et al., 2008; Itzkin et al., 2020; Silva et al., 2018), we seek to quantify and understand the relative role of beach width in dune erosion processes.

Line 136: "dune toe erosion"
Do you mean retreat or erosion?

Revised for consistency with the rest of the paper.
Original sentence: Dune toe erosion was measured as the final minus initial cross-shore position of the dune toe.

Revised sentence: Dune toe *retreat* was measured as the final minus initial cross-shore position of the dune toe.

Line 142: I would not include any mention to the beach slope. First because you are not using it in any of your plots and second because the beach slope computation should not include the backshore beach. any equation that you apply to estimate the runup etc. so, the processes to which the slope of the beach could have any effect are related to waves, and therefore they apply the foreshore slope or the combined foreshore and nearshore or only nearshore, but never the backshore because that is only important for the overwash potential, not for the runup, in fact you could induce to error because you may have a wide dry beach (as it is the case of your crest- and heel-aligned profiles) but the foreshore is the same and therefore the runup should not change.

Original sentence: Simulations with the D_{low} position aligned ensured that all scenarios share the same beach morphology, thereby controlling for the effects of beach slope on wave runup (i.e., Stockdon et al., 2006).

Revised sentence: Simulations with the D_{low} position *control for the morphology of the beach fronting the dune to isolate the role of dune morphology on erosion*.

From section 3.1 Erosion on synthetic Dunes:
Lines 258-261: "Foredunes erode under most simulated conditions, except when they have a high dune aspect ratio, are situated farther from the shoreline, or when the storm is of low intensity, in which case there is slight accretion at the dune toe due to wave processes (e.g., Cohn et al., 2019, Figure 8)."
If referring to fig. 8, please review this affirmation as I cannot see what you describe to see. How do you notice the wave processes? could you explain it using the graph? Because you mention this here but not in the subsections, so it is disconnected from the data. If you refer

to all your experiments, then you should refer to them or to cite all the figures, not only to fig.8. I cannot agree that high aspect ratio do not erode, at least from your results and here you should only refer to fig.8 experiments as otherwise you are looking at the effect of the beach width. So, please fix this as it might be the case that remained from the previous version.

We agree with the reviewer that this sentence does not translate accurately from the previous version of this manuscript, and we appreciate the reviewer's astute observation of a change needed. To fix this oversight, we have revised this sentence to read: Foredunes erode under most simulated conditions (Figures 8, 9, 10, and 12), except when they are situated farther from the shoreline (Figure 11).

Section 3.1.1:
Line 277: "..especially pronounced.."
I would rather say "clear" or I would try to lower the importance as it is not so pronounced. Also, for the intense storm and long duration the difces are not obvious anymore as well. What about the low ratio dunes which have the greatest losses?

We have changed the phrase "especially pronounced" in this sentence to say "clear" following the reviewer's comment.

The small difference in erosion between the low and high aspect ratio dunes for the intense storm, long duration simulations is addressed in the following sentence, which we have revised for increased clarity: For the *longest and* most intense storms, the difference in volume loss between the high and low-aspect ratio dunes is ≤10 m^3/m.

Line 306: "In some cases, the tall/narrow dune toes prograde seaward by up to ~12m"
If this is related to avalanching, it should be more clearly stated. If that is the case, maybe I would give it a second thought and see if the dune actually eroded? Are you computing the avalanched dune sand as erosion? Could you explain this with more detail?

The erosion (change in dune volume) is calculated as the change in the volume of sediment contained within the initial dune region as we explain in the methods (Lines 103-104): The dune volume is calculated by integrating over the portion of the profile contained within the original cross-shore location of the dune (D_{low} to D_{heel}) in the first-time step and above the D_{low} elevation (0.6 m, NAVD88). Given this, the dune can experience erosion (negative change in volume) while the toe progrades seawards when avalanching occurs.

We have revised the line as follows:
In some cases, the tall/narrow dune toes prograde seaward *likely via avalanching* by up to ~12m (Figure 8F).

Section 3.1.2:
Lines 333-334: "… no appreciable increase in the amount of protection offered by the narrowest beaches as storm duration increases, …"
Is this needed? Why don't you also include what is left to be eroded from the beach to

exemplify this? If the beach was already eroded because it is narrow, how it could increase the amount of protection as the storm duration increases? This affirmation or perspective is missing the beach morphodynamics and therefore it seems rather pointless.

We have removed this sentence as it is clearer to explain this through the results presented in Figure 11 and explained in the sentences that follow the one highlighted by the reviewer.

Line 341: "…that wider beaches lead to a greater seaward migration of the dune toe." This again needs further explanation, why when you subtract the volumes then the change in volume relative to the toe-aligned profiles is volume loss prevented and the dune toe is interpreted as additional progradation? are not you just subtracting the retreat of the alternative experiments from the toe-aligned? If so, then is again distance prevented to migrate inland, but not progradation. Besides, how would you explain dune progradation? or is this related again to avalanching? But is it normal to have 30m (around double) progradation due to avalanching? Is this because the erosion is less intense? Or in other words, the energy reaching the base of the dune decreased.

We have deleted the portion of the sentence highlighted by the reviewer as the first part of this sentence explains the effect seen here more clearly without it:

The final dune toe position is consistently farther seaward of the initial dune toe position for all dunes fronted by wider beaches than it is for the equivalent toe-aligned simulations and this effect was proportional to the beach width.

We have also added the following sentence for clarity (Lines 341-):

During the crest- (heels-) aligned simulations when these same dunes are fronted by wider (widest) beaches, *the post-storm dune toe location* of the high aspect ratio dune is *located* 15m (30m) *farther landward* compared to those observed in the toe-aligned simulations (where the toe of the high aspect ratio dune does not change) while the *post-storm dune* toe of the low aspect ratio dune is unchanged relative to the toe-aligned simulation (Figure 9F, Figure 10F). *The more seaward final dune toe position in the crests- (heels-) aligned simulations, compared to that in the toes-aligned simulations, is likely arising from avalanching of the dune as well as wave driven sediment transport to the beach/dune (e.g., Cohn et al., 2019).*

Lines 342-343: "…while the toe of the lowest aspect ratio dune retreated by ~10m during the same storm during the toe-aligned simulations (Figure 7F)."
This makes sense as the beach is wider, but how do you explain that the same dune (low ratio) with a wider beach shows progradation? could you explain the process?
Also, I imagine you intended to refer to Figure 8, please fix.

We have fixed the figure citation to Figure 8.

This sentence is in reference to the simulations presented with the toes-aligned, wherein the beach width is the same for all simulations. The differences are explained throughout section 3.1.1. We have added the following parenthetical here for clarity:

For example, the toe of the highest aspect ratio dune (*toes-aligned*) did not migrate during the longest storm with 1.5X surge while the toe of the lowest aspect ratio dune retreated by ~10m during the same storm during the toe-aligned simulations (Figure *8*F).

Line 345: "progrades 15m (30m) landward compared"
What do you mean by landward progradation?

This line was corrected while addressing the reviewer's comments for Line 341. Copied here:

During the crest- (heels-) aligned simulations when these same dunes are fronted by wider (widest) beaches, *the post-storm dune toe location* of the high aspect ratio dune is *located* 15m (30m) *farther landward* compared to those observed in the toe-aligned simulations (where the toe of the high aspect ratio dune does not change) while the *post-storm dune* toe of the low aspect ratio dune is unchanged relative to the toe-aligned simulation (Figure 9F, Figure 10F). *This change is likely driven through avalanching from the dune as well as wave driven sediment transport to the beach/dune (e.g., Cohn et al., 2019).*

Lines 347-349: "Wave energy reaching the dune is reduced by up to 6000 Nm/m2 for the high aspect ratio dunes during the most intense storms with the widest beaches (heel-aligned; Figure 10I) while the energy impacting the dune is reduced by 1000 Nm/m2."
You are still mixing up ratios and beach widths. The energy reduction is because of the widest beach, so do not mention the ratio as it is not the factor controlling that, and then could you explain better the second part of the sentence in relation to the first part? Is something missing in the sentence?

Revised to: Wave energy reaching the dune is reduced by up to 6000 Nm/m^2 during the most intense storms in simulations with the widest beaches compared to a reduction of 1000 Nm/m^2 when the dunes are fronted by a narrower beach (heels-aligned; Figure 10I).

Section 3.2:
General comment: I still do not get the need of this simulations, also, as you were discussing the effect of beach width, could you explain how much different is this from enlarging the beach?? or how much extra-protection is due to the fenced dune and how much to the wider beach width?

Lines 358-359: "Additionally, the aspect ratio of the dune behind the fence plays a minimal role in influencing volume loss except in the case of the most intense storms,"
Is there a need to state this? it is too obvious that if the width of the beach is enlarged, and even you add a small dune in front, you would have to have a very long group of storms to reach the dune behind, i only see the point of this experiment in long-term simulations, not at the same temp scales as the previous as you have already shown that the beach width already prevents erosion

The fenced dune simulations all have the same beach width, which we explain in the newly added lines referenced on page 3 in this document as well as Lines 285-288 within the results:

We performed a suite of simulations using the same dune profiles as the dune toe-aligned scenarios but with a portion of the beach replaced by a fenced dune (Figure 1D). By comparing the results from these simulations with those from the toe-aligned simulations (Figure 11) we quantify the effectiveness of artificial dunes (formed via the emplacement of sand fences) under varying storm scenarios while controlling for the effects of beach width.

These simulations show the erosion prevented purely because of the presence of the fenced dune. To the extent that we can compare the mitigation from the fenced dunes and increased beach width, this is performed in discussion section 4.2 where the management implications of this study are discussed (see also the bottom of Page 3 and top of Page 4 in this response).

Lines 364-366: "… 21C). While the presence of a fenced dune prevents volume loss from the natural dune, there is little to no change (<10 m) in the dune toe position relative to the toe-aligned simulations where the fenced dune was not present (Figure 365 21D, E, F)." Please fix the reference to the figure to 12.
Could you explain this better, it is not clear what you are trying to express. How do you explain that if the dune is not eroded (you say "prevented volume loss") the position of the dune toe changes less than for the toe-aligned profiles without fenced dunes in front?

We agree that this sentence is confusing and have determined that it is not necessary and so we have deleted it. This effect is more clearly articulated in existing lines 337-343:

We find that the fenced dunes prevent more volume loss (up to ~20 m^3/m) as the surge increases (Figure 12A, B, C) however, for any given surge level, there is a minimal (<10 m^3/m) difference in the amount of dune toe retreat mitigated by the fenced dune between the longest and shortest storms (Figure 12D, E, F). Additionally, the aspect ratio of the dune behind the fence plays a minimal role in influencing volume loss (because the natural dune is never impacted until the fenced dune is eroded) except in the case of the most intense storms when the lowest aspect ratio dunes performs better than the higher aspect ratio dunes (Figure 12C).

Section Comparison with Field Surveys:
Line 397: "…a weak relationship…"
I cannot see this relation, not even weak. But you could plot the aspect ratio vs the volume change in order to make your point clearer. I see high aspect ratio are the ones showing smaller vol change and lower aspect with the greatest vol change. Is this actually in agreement with what you showed…not very clear.

We have revised these lines for clarity to demonstrate the comparison between the field data and the results from the toes-aligned simulations.

Original: The field data show a weak relationship between dune aspect ratio and erosion (sand volume loss). However, similar to model results for the toe-aligned (constant beach width) dune configurations, those profiles with a lower aspect ratio dune experience similar or even less erosion than high aspect ratio dunes with the same beach width (i.e., at a beach width of 40 m in Fig. 13).

Revised sentence: Similar to model results for the toe-aligned (constant beach width) dune configurations, comparing volume loss for dunes fronted by equally wide beaches, profiles with a lower aspect ratio dune generally experienced similar or even less erosion than high aspect ratio dunes with the same beach width. For example, the field profiles with a beach width of ~30 m show slightly more erosion for the higher aspect ratio dunes compared to the lower aspect ratio dunes (Figure 13).

Lines 399-400: "those profiles with a lower aspect ratio dune experience similar or even less erosion than high aspect ratio dunes with the same beach width (i.e., at a beach width of 40 m in 400 Fig. 13)".
Once again, this is not clear to me, the diff for the 40m is that you have only one point with low aspect ratio, but the high aspect ratio shows a large variability for the 40m, so this is not clear at all.

Considering the points clustered around the 40 m beach width, the lowest aspect ratio dune increased in volume while the high aspect ratio dunes all eroded (with variability). The profiles clustered around 30 m beach widths can also be considered here which show slightly more erosion for the highest aspect ratio dunes compared to the low aspect ratio dunes. We have adjusted this in the text to better highlight the result from the field data.

Original sentence: Similar to model results for the toe-aligned (constant beach width) dune configurations, comparing volume loss for dunes fronted by equally wide beaches, profiles with a lower aspect ratio dune generally experienced similar or even less erosion than high aspect ratio dunes with the same beach width (i.e., at a beach width of 40 m in Fig. 13).

Revised sentence: Similar to model results for the toe-aligned (constant beach width) dune configurations, comparing volume loss for dunes fronted by equally wide beaches, profiles with a lower aspect ratio dune generally experienced similar or even less erosion than high aspect ratio dunes with the same beach width. For example, the field profiles with a beach width of ~30 m show slightly more erosion for the higher aspect ratio dunes compared to the lower aspect ratio dunes (Figure 13).

Discussion section:
Line 435: "accretion occurring at the dune toe for the high aspect ratio dunes that weren't…"
Accretion at the toe, but dune crest retreat, right?

We don't quantify dune crest retreat in this paper, but if the dune is scarping/avalanching then the crest position will retreat once the dune is eroded back to and beyond the initial crest position. We have clarified this in the revised manuscript with a parenthetical comment as shown below.

Original sentence: The high aspect ratio dunes are more likely to collapse when scarped because of avalanching as the dune face slope approaches an angle of repose. This process also likely explains accretion occurring at the dune toe for the high aspect ratio dunes that weren't completely eroded (Palmsten and Splinter, 2016).

Revised sentence: High aspect ratio dunes are more likely to collapse when scarped because avalanching is likely to occur as the dune face slope approaches the angle of repose. Avalanching also likely explains accretion occurring at the dune toe for the high aspect ratio dunes (Palmsten and Splinter, 2016; *which may also be accompanied by dune crest retreat as the dune face is eroded beyond the initial crest position*).

Line 445: "resilient"
Do you mean resistant?

We changed "resilient" to "resistant here

Line 448-449: "While dune morphology plays a primary role in describing how dunes erode, particularly with respect to whether or not sediment is piled at the toe of the dune (high aspect ratio dunes) or transported offshore"
Why particularly? From your results and interpretation, I can only see with respect to this, so if the aspect is important with respect to additional aspects it should be clearly stated.

We have revised the sentence in question to remove the qualifier "particularly.": While dune morphology plays a primary role in describing how dunes erode, with respect to whether sediment is piled at the toe of the dune (high aspect ratio dunes) or transported offshore (low aspect ratio dunes), it plays a secondary role to the beach morphology in terms of explaining the amount of erosion that will occur.

Line 453: "Wider beaches lead to less sediment loss from the dune and more progradation of the dune toe."
This has not been explained, which process is this? Is only avalanching? If so, how do you explain that low aspect ratio dunes also prograde???

We have revised this sentence for increased clarity: Wider beaches lead to less sediment loss from the dune and *a* more *seaward post-storm location* of the dune toe.

This is also now consistent with the revised explanation in results section 3.2 (see also the explanation at the bottom of Page 8 in this response).

Line 457-458: " beach width is the primary control on dune erosion, followed by dune width, and then dune height."
I agree with the first part of the sentence, but i do not agree with the affirmation that dune width controls dune erosion, it may control the relative erosion, meaning that if your dune is narrow, it will disappear faster, but the width does not influence the process of erosion itself as does the beach width, which determines the wave energy impacting the dune. alternatively, i agree that high aspect may help erode the dune.

We have rewritten this sentence for increased clarity:

This result, combined with the results of the toe-aligned scenarios confirms that beach width is the primary control on the volume of sediment eroded from dunes during storms. Our results further suggest that dune width and dune height also affect the volume of sediment eroded by determining the "longevity" of the dune (thereby affecting the transition from avalanching to overwashing, e.g.) under erosive conditions.

Lines 469-471: "Thus, the aspect ratio of the natural dune is secondary to the morphology of the fenced dune in providing protection to back-barrier environments (a taller fenced dune would offer even greater protection)."
I think that here there are mixing concepts, i think that if you would address this as volumes of sand as defence, distributed within the fenced dune and the additional beach width because of the space needed to place an artificial dune, it would make much more sense to me.

Our simulations with the fenced dune do not consider variations in the beach width (see Page 9 of this response) and in fact control for the beach width. The decrease (and differences) in erosion observed in the natural dunes in these simulations is due to the fenced dune serving as a barrier between the runup and the natural dune. The role played by the "morphology of the fenced dune" is explained in the preceding sentence, which has been revised for clarity:

We find that the small dune formed by fencing can significantly decrease dune erosion by providing a barrier that must be removed by erosion before the "natural" dune behind it is impacted. In our simulations, the fenced dune was not sufficiently eroded until ~60 hours into the storm, which prevented the dune behind it from experiencing the peak of the storm (Figure 4). The key dynamic in this case (regardless of actual storm duration), was that the fenced dune was sufficiently high *and wide* to protect the natural dune until the peak of the storm had passed. Thus, the aspect ratio of the natural dune is secondary to the morphology of the fenced dune in providing protection to back-barrier environments (a taller fenced dune would offer even greater protection).

Line 471: "can reform"
Do you actually mean reform? From their work I understood form or develop.

Given that the paper being referred to (Charbonneau and Wnek, 2016) discusses dune recovery following a storm, we used the word "reform." However, we have changed it in the revised manuscript to "form" following the reviewer's comment.

Line 472: "can sand fences effectively prevent storm-induced erosion,"
Sand fences do not prevent storm erosion, but the volume of sand accumulated or the sand fencing or the fenced dune.

Revised sentence:
Charbonneau and Wnek (2016) demonstrated that fenced dunes (*especially when paired with nourishment*) can form quickly (on the order of months) *meaning that not only can the fenced*

dunes effectively prevent storm-induced erosion, but it is possible for them to recover prior to the next storm if the frequency of storm impacts is sufficiently low, and assuming the fences are still present following the storm or are re-built.

Line 476: "are still present following the storm or are re-built."
In their work, they also mention nourishment in those areas, so is not only the fences, but the extra sand that helps, don´t you agree?

We agree that nourishing the beach helps facilitate fenced dune growth (Itzkin et al., 2020) and that nourishing the beach will limit erosion (Lines 374-387) but the phrase highlighted here by the reviewer is referring to construction of the physical fence and their condition following a storm. We have modified the sentence for clarity in the revised manuscript:

Charbonneau and Wnek (2016) demonstrated that fenced dunes (*especially when paired with a nourishment*) can form quickly (on the order of months) *meaning that not only can the fenced dunes effectively prevent storm-induced erosion, but it is possible for them to recover prior* to the next storm if the frequency of storm impacts is sufficiently low, and assuming the fences are still present following the storm or are re-built.

Lines 478-479: "widens the dune but does not add to its elevation will cause the dune to assume a lower aspect ratio than it had in its pre-management state."
Of course, and I insist, this implies widening the beach as you state below, and in fact i would change the order and start stating that any management practice aiming to enlarge the dune needs to be paired with nourishment.

This comment by the reviewer is referring to the following set of sentences:

Any management strategy that widens the dune but does not add to its elevation will cause the dune to assume a lower aspect ratio than it had in its pre-management state. Further, if management is not paired with a beach nourishment (i.e., Itzkin et al., 2020) then the wider dune will likely come at the cost of a slightly narrower beach. The lower aspect ratio (Figure 8) could serve to reduce erosion, but this potential decrease in erosion may well be offset by increased erosion associated with the narrower beach (Figure 10).

While we agree that strictly following the results of this study, dune management should be paired with a nourishment, we are being intentional with the wording throughout the paper to avoid unintentionally advocating for increased instances of nourishment. The suggested revision here could do that and thus it would be our preference to avoid saying that nourishment is needed.

Lines 491-492: "slope (βf), which lowers incident band swash (e.g., Ruggiero et al., 2004) and total wave runup (Stockdon)"
You could explain this better and make sure you explain what slope you are refereeing to. Usually, these works use the foreshore slope, and the foreshore+nearshore, i understand that the beach width increase in your case is related to the backshore width, should not you compute the slope of the intertidal beach? how is the backshore included in the equation

from stockdon? the slope of the beach should be constant if you change the position of the toe of the dune with not additional changes in the morphology of the beach.

The reviewer here is referring to the following sentence:

For a given dune aspect ratio and wave duration and intensity, the only difference between the simulations is the increase in beach width (toe-aligned < heel-aligned). This increase in beach width decreases beach slope (β_f), which lowers incident band swash (e.g., Ruggiero et al., 2004) and total wave runup (Stockdon et al., 2006), reducing the likelihood of dune erosion.

The beach slope being used in this manuscript is consistent with the beach slope used by Stockdon et al. (2006), which is measured from MHW to the dune toe. We also explain this in the methods section (Lines 106 -108), which we have further modified for clarity:

Beach width is calculated as the cross-shore distance between MHW and D_{low} at every time step. Given that pre-storm D_{low} was held constant across all simulations, the beach slope *(measured between MHW and D_{low})* is inversely proportional to the beach width in our simulations (i.e., beach slope decreases as beach width increases).

Line 492: "reducing the likelihood of dune erosion."
Not because of the slope, but because of the beach width of the dry beach. If your beach is widening because you move the dune behind in your synthetic profiles, it means that what actually grows is the width of the beach berm, which implies large volume of sediment but that does not affect the wave runup.

The reviewer's comment refers to the following sentence:

For a given dune aspect ratio and wave duration and intensity, the only difference between the simulations is the increase in beach width (toe-aligned < heel-aligned). This increase in beach width decreases beach slope (β_f), which lowers incident band swash (e.g., Ruggiero et al., 2004) and total wave runup (Stockdon et al., 2006), reducing the likelihood of dune erosion.

In this instance, it is fair to say that the slope is reducing the likelihood of erosion because the slope is being measured between MHW and the dune toe. Ruggiero et al. (2004) and Stockdon et al. (2006) demonstrate how this decrease in the slope limits wave runup and wave energy reaching the dune.

Line 508: "thereby increasing the likelihood of eventual barrier drowning"
I still don' t get this point. If you are adding sand to your beach/dune, you may not have rollover because the system is able to cope with sea-level rise and maintained, why should it drown? The nourishment can even help build the backbarrier through aeolian transport. I do agree and I am glad to read that the main problem is the sustainability of these type of measures.

The reviewer's comment refers to the following sentences:

It is important to recognize that although management initiatives such as widening beaches and building dunes with particular aspect ratios can be effective at mitigating erosion during a single storm, these actions may have effects that are undesirable in the long-term as the effects of multiple storms compound. For example, overwash facilitates barrier rollover—a process that is necessary if islands are to maintain subaerial exposure *in the long-term future* as sea level rises (e.g., Leatherman, 1979; Moore et al., 2010; Lorenzo-Trueba & Ashton, 2014; Rogers et al., 2015). Thus, constructing dune and beach systems that reduce the amount of overwash that would otherwise naturally occur may inhibit rollover, thereby increasing the likelihood of eventual barrier drowning (e.g., Magliocca et al., 2011; Rogers et al., 2015).

The barrier island literature demonstrates that developed barrier islands are susceptible to drowning because the flux of sediment to the bay side of the island is limited or even prevented (i.e., Magliocca et al., 2011; Rogers et al., 2015) and even with nourishment on the frontside, drowning can occur from the backside as sea level rises in the more distant future. This is what we are pointing to here. We have added the italicized text above because, yes, for some time, nourishment efforts may offset sea level rise.

Conclusions section:
Line 518: "dunes, although high aspect ratio dunes offer greater protection against more intense storms."
Can you expand this? If i got it right, it is not the case, from the results section as you do not properly explain the case of the overwashed dunes. The volume of erosion is of the same order of magnitude for the high ratio dunes (Fig. 8).

This comment is referring to the following sentence:
We find that low aspect ratio (lower and wider) dunes are more resistant to erosion from increased storm duration than high aspect ratio (taller and narrower) dunes, although high aspect ratio dunes offer greater protection against more intense storms.

It's not clear how we do not properly explain overwash here, as we do not discuss (or observe) overwash in any of the simulations presented in this iteration of the manuscript. The differences in erosion between the low- and high-aspect ratio dunes as a function of storm duration are discussed in the results section 3.1.1.

Lines 520-522: "eroded sediment is lost offshore whereas the high aspect ratio dunes lose greater amounts of sediment through persistent scarping, more of the sediment is preserved at the toe of the dune as a result of avalanching."
You mention this here, but how did you see this? it cannot be easily taken from the results.

This comment refers to the following sentence, which we have revised for clarity:
For low aspect ratio dunes, eroded sediment is lost offshore whereas the high aspect ratio dunes lose greater amounts of sediment through persistent scarping, more of the sediment is preserved at the toe of the dune, *consistent with the piling up of sediment at the base of the dune as would occur* as a result of avalanching.

In results section 3.1.1 we show that the dune toe location tends to move seawards for the high aspect ratio dunes while it tends to move landwards for the low aspect ratio dunes despite all dunes experiencing a loss in volume. Overwash does not occur so the sediment must be moving seaward from the dunes. The seaward movement of the dune toe for high aspect ratio dunes is consistent with sediment piling up at the base of the dune from avalanching (we explain that the high aspect ratio dunes are close to the angle of repose), but since we cannot observe this directly in the model we have added the italicized text above to clarify the consistency with avalanching

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Lines 528-529: the sentence is missing something.

It is not clear which sentence is being referred to here by the reviewer as the line numbers do not correspond to the paper but we did revise the following sentence which was incomplete:

Our results indicate that a tall, wide foredune fronted by a fenced dune and a wide beach *offer the greatest protection from erosion*.

Lines 544-545: "management initiatives reduce overwash flux, which is essential for barrier islands to maintain elevation as sea level continues to rise"
Not only because of this, but also because of sustainability of the resources needed. You may also need to keep in mind that if you nourish a beach, what also may happen is that the dune will rise and likely the backbarrier because of aeolian sed transport, which is not mentioned here but also contributes to keep the elevation of the coastal barrier.

Please see our response to the comment at the top of Page 15 of this document, which also refers to this concept. We do state in the paper here that there is a sustainability issue:

Given the challenges of achieving such a foredune morphology in the face of rising sea level and within resource limitations (i.e., sand availability, cost, etc.), our findings suggest that the greatest increase in short-term protective service can be achieved by widening beaches, regardless of the frontal dune morphology.

Our comment on the need for overwash for barrier survival is in line with the literature that looks at the survivability of developed barrier islands over long timescales (i.e., Magliocca et al., 2011, Rogers et al., 2015). We do refer to managed retreat, which suggests a way to widen a beach without advocating for nourishment (see the bottom of Page 13 of this document):

Alternative strategies for widening beaches would also have a similar protective effect (e.g., managed retreat; Cutler et al., 2020; Gibbs, 2016) while allowing for more of the natural processes to occur that allow an island to evolve and persist in the face of rising sea levels. Along the NC coast, aeolian sediment transport to the back-barrier is minimal (and removed from roads and properties, for example) because the dunes are well vegetated. We are not aware of studies that indicate aeolian sediment transport is sufficient to raise island elevation to avoid drowning from the backside, but this is an interesting concept that would be fun to explore further.