

Modern coastal ecosystems of the American Southeast are shaped by deep-time human-environment interactions

Corresponding Author: Dr Jacob Holland-Lulewicz

This file contains all editorial decision letters in order by version, followed by all author rebuttals in order by version.

Attachments originally included by the reviewers as part of their assessment can be found at the end of this file.

Version 0:

Decision Letter:

**** Please ensure you delete the link to your author home page in this e-mail if you wish to forward it to your coauthors ****

Dear Dr Holland-Lulewicz,

Your manuscript titled "Deep-Time Human-Environment Interactions as Primary Legacy Drivers of Modern Coastal Ecologies" has now been seen by 3 reviewers, whose comments are appended below. You will see that they find your work of some potential interest. However, they have raised quite substantial concerns that must be addressed. In light of these comments, we cannot accept the manuscript for publication, but would be interested in considering a revised version that fully addresses these serious concerns.

In your revision, make sure to accomplish the following editorial thresholds:

*****Provide a robust presentation of stratigraphic and chronological data of the sections.**

*****Clarify the term "primary legacy drivers."**

*****Explore deep-time human interactions and address archaeological data limitations.**

*****Provide quantitative data on ecological impacts, and discuss alternative models.**

We hope you will find the reviewers' comments useful as you decide how to proceed. Should additional work allow you to address these criticisms, we would be happy to look at a substantially revised manuscript. If you choose to take up this option, please either highlight all changes in the manuscript text file, or provide a list of the changes to the manuscript with your responses to the reviewers.

When resubmitting, please provide a point-by-point response to the reviewers' comments. Please submit your responses as a separate file, distinct from your cover letter where you can add responses to the Editors' comments that you do not want to be made available to the reviewers. Word files are preferred. We recommend that any figures, tables or graphs that are included in the response to reviewers are also included in the main article or Supplementary Information.

Please bear in mind that we will be reluctant to approach the reviewers again in the absence of substantial revisions.

If the revision process takes significantly longer than three months, we will be happy to reconsider your paper at a later date, as long as nothing similar has been accepted for publication at Communications Earth & Environment or published elsewhere in the meantime.

We are committed to providing a fair and constructive peer-review process. Please do not hesitate to contact us if you wish to discuss the revision in more detail.

Please use the following link to submit your revised manuscript, point-by-point response to the reviewers' comments with a list of your changes to the manuscript text (which should be in a separate document to any cover letter), a tracked-changes version of the manuscript (as a PDF file) and any completed checklist:

Link Redacted

**** This url links to your confidential home page and associated information about manuscripts you may have submitted or be reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage first ****

Please do not hesitate to contact us if you have any questions or would like to discuss the required revisions further. Thank you for the opportunity to review your work.

Best regards,

Olusegun Dada, PhD
Editorial Board Member
Communications Earth & Environment
orcid.org/0000-0001-8020-3323

Carolina Ortiz Guerrero, PhD
Associate Editor
Communications Earth & Environment

EDITORIAL POLICIES AND FORMAT

If you decide to resubmit your paper, please ensure that your manuscript complies with our editorial policies and complete and upload the checklist below as a Related Manuscript file type with the revised article:

Editorial Policy Policy requirements
(Download the link to your computer as a PDF.)

For Manuscripts that fall into the following fields:

- Behavioural and social science
- Ecological, evolutionary & environmental sciences
- Life sciences

An updated and completed version of our Reporting Summary must be uploaded with the revised manuscript

You can download the form here:

<https://www.nature.com/documents/nr-reporting-summary.zip>

For your information, you can find some guidance regarding format requirements summarized on the following checklist: (<https://www.nature.com/documents/commsj-phys-style-formatting-checklist-article.pdf>) and formatting guide (<https://www.nature.com/documents/commsj-phys-style-formatting-guide-accept.pdf>).

REVIEWER COMMENTS:

Reviewer #1 (Remarks to the Author):

The impacts of climate change on human activities is profound, especially on a long-term scale. The authors use the example of how modern ecological and geomorphological baselines along the Georgia coast of eastern North America have been shaped for past 5,000 years of interactions with Indigenous peoples, Euro-Americans to illustrate the concept of Primary Legacy Drivers. However, the paper leans more towards archaeological surveys and findings, with insufficient discussion on the interaction between humans and the environment. I recommend publishing this paper in the journal after a major revision.

- (1) Lack of Results Presentation in the Abstract: The abstract only addresses the importance and impact but does not present the results or real viewpoints. Readers do not understand how the long-term interaction between humans and the environment played out, such as the effects of climate on humans and how humans adapted to climate change.
- (2) Insufficient Focus on Environmental Impact in the Main Text: Throughout the text, including the figures, the emphasis is more on archaeological survey results. The role of environmental factors, particularly how climate change affected human production, living conditions, and migration points emphasized in the abstract and introduction is discussed less thoroughly.
- (3) Clarify the definition of "primary legacy drivers": The term "primary legacy drivers" requires a more thorough definition and contextualization within the ecological literature. It is essential to articulate how this concept integrates with existing theories of ecological change and resilience. This clarity will enhance comprehension for readers who may not be familiar with the term and its implications for understanding human-environment interactions.
- (4) Expand on the implications of deep-time human interactions: The discussion regarding the implications of deep-time human-environment interactions on modern ecosystems should be significantly expanded. Specific examples illustrating how these interactions have led to observable ecological changes, such as shifts in species composition or habitat structure, would strengthen the argument. This elaboration will help underscore the importance of historical context in conservation efforts.
- (5) Address the limitations of archaeological data: It is crucial to acknowledge the limitations and potential biases inherent in using archaeological data to infer past ecological conditions and processes. A balanced interpretation of the findings should

include a discussion of how these limitations might affect the conclusions drawn in the study.

(6) Discuss the role of Indigenous knowledge: Integrate a comprehensive discussion on the significance of Indigenous ecological knowledge in shaping our understanding of modern coastal ecosystems and their management. Highlighting this perspective could provide a more inclusive view of the interactions between human societies and their environments, emphasizing the value of traditional ecological practices.

(7) Provide quantitative data on ecological impacts: The manuscript should include more quantitative metrics or statistical analyses to substantiate claims regarding the ecological impacts of Indigenous and Euro-American activities on coastal ecosystems. Presenting data such as species diversity indices or habitat alteration measurements will lend empirical support to the assertions made in the text.

(8) Clarify the interaction between legacy drivers and climate change: A more detailed discussion is needed on how the identified primary legacy drivers may interact with ongoing climate change impacts. This should include an exploration of potential feedback mechanisms and how these interactions could influence future ecological resilience. Such insights are crucial for understanding the long-term sustainability of coastal ecosystems.

(9) Discuss alternative ecological models: Address alternative ecological models or hypotheses that may challenge the primary legacy driver framework. Providing a nuanced discussion of competing theories will enrich the analysis and demonstrate a comprehensive understanding of the ecological discourse surrounding human impacts on ecosystems.

(10) Suggest future research directions: Propose specific avenues for future research that could further investigate the role of human-environment interactions in shaping ecological outcomes. This could include interdisciplinary studies that combine archaeological, ecological, and climate science perspectives to foster a deeper understanding of these complex systems.

Reviewer #2 (Remarks to the Author):

“Deep Time Human Interactions as Primary Legacy Drivers...” is an excellent manuscript drawing on a rich set of archaeological and environmental data with broad implications and international significance. The paper is well constructed, researched, and has excellent illustrations. I highly recommend it be published in Communications Earth and Environment. I have some minor suggestions for revision noted below by line number geared at helping expand the reach of the article even further or help clarify a few points to non-archaeologists. None of these should be particularly difficult to address. Congrats on an excellent study!

Line 51. It is not the Southeast but this is a very germane study: <https://www.nature.com/articles/s41893-023-01186-6>

Line 58 (and throughout): I always get a little confused when I see “ecologies” used. Do you mean ecosystems? Something different?

Line 92. I love the term primary legacy drivers and think it is a very important contribution of the paper. That said. The definition of the term that starts here could potentially be a little clearer. In particular “captures the holistic range of impacts of deep-time human histories on their ecosystems”. Perhaps “captures the full-range of people’s deep time influence...”. Also in here, I use the term deep time a lot too. However, my paleo colleagues always scoff at this since we are working in pretty near time. No change needed just something to think about.

Line 116: reword “continuing challenging of conceptions...”

Line 132: Since it doesn’t come up all the way until the end of the paper. What is the Georgia Archaeological Site File?

Line 132 and into Line 157 are archaeology term heavy. Consider ways to add parenthetically clarification or change terms for non archaeologists. Particularly, around line 142, what does this mean for the non-archaeologist? This is a ton of sties and really dense, but it might be hard for the uninitiated to grasp. Could also mention that the archaeological record is only a fraction of what was actually there at a given time period and place.

Line 174: Sentence ending here on longer and more intensive occupation could use a reference or point to the data in the paper that shows this.

Line 184. Along the lines of the above. What does “massive amounts of oyster shell” actually mean?

Line 191. Need a reference to altered soil geochemistry or “see below” statement here.

Line 225, 277, or perhaps in the Discussion could be mentioned that this is continent wide or global phenomenon to help expand the impact. Could cite the paper below or take a few of the primary citations outside of the southeast in the section in this paper on landscape legacies. <https://link.springer.com/article/10.1007/s10814-023-09189-9>

Line 237-258. Could use a reference or two somewhere in this section.

Line 308. I get the use of “unintentional” here, but how do we really know what was intended from the archaeological record?

Lines 341-343. I think you could be more direct here. Specifically, how can this be incorporated into management plans? It is obvious to archaeologists, but not everyone.

Line 344. Could delete "as we previously pointed to in our introduction"

Line 352-354. Strong and important conclusions. Something for the authors to consider, but by no means don't need to add, is the link here between environmental and social justice. How can this study help integrate the two? Cultural keystone places is another framework that could be linked here that is trying to do this. Here are two papers that work towards this. Again just a suggestion and not necessarily something the authors need to integrate here

<https://anthrosource.onlinelibrary.wiley.com/doi/abs/10.1111/aman.12893>

<https://www.cambridge.org/core/journals/american-antiquity/article/cultural-keystone-places-and-the-chumash-landscapes-of-kumqaq-point-conception-california/16A429D7AA4ACF06CE3005A1578A054B>

Excellent paper!--Torben Rick, Smithsonian Institution

Reviewer #3 (Remarks to the Author):

Deep-Time Human-Environment Interactions as Primary Legacy Drivers Shape Modern Coastal Ecologies

The paper "Deep-Time Human-Environment Interactions as Primary Legacy Drivers Shape Modern Coastal Ecologies" by Holland-Lulewicz et al. is interesting. It tries to demonstrate "how modern ecological and geomorphological baselines along the Georgia coast of eastern North America are structured by 5,000 years of Indigenous and Euro-American interactions with these environments."

The manuscript aims to highlight the following points:

The expanse and time-depth of human occupation across estuarine landscapes, (2) the cumulative nature of these occupations, (3) the local and landscape-scale impacts of the deposition of trillions of oyster shells onto landforms by Indigenous communities, and (4) the large-scale landscape modifications of Euro-American plantation owners and enslaved communities. However, there are several issues that should be taken into account before it can be accepted.

In general

-The lack of stratigraphic evidence from the study sites makes it difficult to understand anthropic modification versus natural sedimentation. A single figure (Fig. 5) is included in the text, which is not enough. I suggest including the key stratigraphic sections (profiles) of every study site.

-The absence of a comprehensive description and discussion of all the radiocarbon analyses used in each studied site is hindering the interpretation of the beginning of human-induced landscape changes around 5000 years ago. I suggest including a radiocarbon table for each site, along with details of the calibration method used.

- Overinterpretation of geomorphological process should be avoided in the text. The exposed data are not enough to describe complex geomorphological processes. For example:

"For the shorelines, tidal creek banks, and marsh islands in particular, shell accumulation is adding critical elevation and a more resilient substrate, both of which are buffering ecological structures against increasing erosional rates, rising sea levels, and saltwater intrusion."

The specifics can be found in the attached file.

** Visit Nature Research's author and referees' website at www.nature.com/authors for information about policies, services and author benefits**

Communications Earth & Environment is committed to improving transparency in authorship. As part of our efforts in this direction, we are now requesting that all authors identified as 'corresponding author' create and link their Open Researcher and Contributor Identifier (ORCID) with their account on the Manuscript Tracking System prior to acceptance. ORCID helps the scientific community achieve unambiguous attribution of all scholarly contributions. You can create and link your ORCID from the home page of the Manuscript Tracking System by clicking on 'Modify my Springer Nature account' and following the instructions in the link below. Please also inform all co-authors that they can add their ORCIDs to their accounts and that they must do so prior to acceptance.

<https://www.springernature.com/gp/researchers/orcid/orcid-for-nature-research>

For more information please visit <http://www.springernature.com/orcid>

If you experience problems in linking your ORCID, please contact the Platform Support Helpdesk.

Version 1:

Decision Letter:

**** Please ensure you delete the link to your author home page in this e-mail if you wish to forward it to your coauthors ****

Dear Dr Holland-Lulewicz,

Your revised manuscript titled "Deep-Time Human-Environment Interactions as Primary Legacy Drivers of Modern Coastal Ecosystems" has now been seen by our original reviewers #1 and #2, and a new reviewer (#4) whose comments appear below. In light of their advice we are delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Earth & Environment.

We therefore invite you to revise your paper one last time to address the remaining concerns of reviewer #4. At the same time we ask that you edit your manuscript to comply with our format requirements and to maximise the accessibility and therefore the impact of your work.

EDITORIAL REQUESTS:

Please review our specific editorial comments and requests regarding your manuscript in the attached "Editorial Requests Table".

*****Please take care to match our formatting and policy requirements. We will check revised manuscript and return manuscripts that do not comply. Such requests will lead to delays. *****

Please outline your response to each request in the right hand column. Please upload the completed table with your manuscript files as a Related Manuscript file.

If you have any questions or concerns about any of our requests, please do not hesitate to contact me.

SUBMISSION INFORMATION:

In order to accept your paper, we require the files listed at the end of the Editorial Requests Table; the list of required files is also available at <https://www.nature.com/documents/commsj-file-checklist.pdf>.

OPEN ACCESS:

Communications Earth & Environment is a fully open access journal. Articles are made freely accessible on publication. For further information about article processing charges, open access funding, and advice and support from Nature Research, please visit <https://www.nature.com/commsenv/open-access>

At acceptance, you will be provided with instructions for completing the open access licence agreement on behalf of all authors. This grants us the necessary permissions to publish your paper. Additionally, you will be asked to declare that all required third party permissions have been obtained, and to provide billing information in order to pay the article-processing charge (APC).

Please use the following link to submit the above items:

Link Redacted

**** This url links to your confidential home page and associated information about manuscripts you may have submitted or be reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage first ****

We hope to hear from you within two weeks; please let us know if you need more time.

Best regards,

Carolina Ortiz Guerrero, Ph.D.
Associate Editor
Communications Earth & Environment

Olusegun Dada, PhD
Editorial Board Member
Communications Earth & Environment
orcid.org/0000-0001-8020-3323

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

The manuscript has been fully updated and improved. I have no more further comments. It could be accepted now.

Reviewer #2 (Remarks to the Author):

The revised manuscript has done a nice job in addressing the reviewer's comments and clarifying a few key issues. I think it is now ready for publication and do not have further comments.

Reviewer #4 (Remarks to the Author):

The study of Holland-Lulewicz et al. addresses long-term human-environmental interactions in the coastal region of Georgia over about 5000 years, demonstrating that this highly fragile landscape never experienced a period when humans were not present. To do so, the authors compile a large amount of different geomorphological, chronological and archaeological/historical data. Given that the role of pre-European human impact on landscapes in America has been underestimated for a long time, this interesting work opens new perspectives on human-environmental interactions and the discussion about historical ecological and geomorphological baselines for modern landscapes, and is hence worth of being published in Communications Earth & Environment.

However, I have two general points and some detailed remarks that should be fixed prior to a publication of the paper:

General points

- The authors just focus on oyster shells (also in the Supporting Material only 'total shells' are given). However, what about other (shell) species that were probably also found in the studied middens, although in lower quantities? I assume that also their evolution through time and spatial distribution could give highly interesting information about former human nutrition and paleoecology.
- What about the Late Holocene tectonics of the region? Given the location of the studied landscape very close the sea level, also very small-scale tectonic movements (subsidence or uplift) could have large consequences for the settlement and economic pattern through time. Given the long-term perspective of several millennia discussed in this paper, this important aspect should necessarily also be discussed here.

Detailed remarks

- 48: ...of the United States in the state of Georgia.
- 281: Please explain the abbreviation 'STP', since not all readers will be familiar with this.
- 318:(67,68). It is....
- 370:legacy effects we observe, are removed....
- 398:marsh islands, serve....
- 457:communities managed landscapes....
- 542: ...kernel density...
- 547:were included in the models....
- Figure 1:
 - * Please give sources for the satellite images.
 - * 860: Kernel density....
 - * Sub-figure A does not show 'the total distribution of Indigenous and Euro-American historical sites across the study area', but is just an overview map. Please re-label.
- Figures 2, 4, 6: Legends for the Lidar topographical data are missing (it is just given for Fig. 3).
- Figure 2: Please use a unified magnitude scale for shell thickness in all subfigures, to allow a direct comparison.
- Figure 3, sub-figure C: What mean the red triangles in the upper part? Please explain.
- Figure 5:
 - * The sequence of numbering of the sub-figures (A-F) seems rather chaotic: Please re-organize to make it stringent.
 - * Since you used capital letters for the sub-figures (A-F), please also use them in the caption (currently you use lowercase letters here).

** Visit Nature Research's author and referees' website at www.nature.com/authors for information about policies, services and author benefits**

Open Access This Peer Review File is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

In cases where reviewers are anonymous, credit should be given to 'Anonymous Referee' and the source.

The images or other third party material in this Peer Review File are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>

Deep-Time Human-Environment Interactions as Primary Legacy Drivers Shape Modern Coastal Ecologies

The paper “Deep-Time Human-Environment Interactions as Primary Legacy Drivers Shape Modern Coastal Ecologies ” by Holland-Lulewicz et al. is interesting. It tries to demonstrate “how modern ecological and geomorphological baselines along the Georgia coast of eastern North America are structured by 5,000 years of Indigenous and Euro-American interactions with these environments.”

The manuscript aims to highlight the following points:

The expanse and time-depth of human occupation across estuarine landscapes, (2) the cumulative nature of these occupations, (3) the local and landscape-scale impacts of the deposition of trillions of oyster shells onto landforms by Indigenous communities, and (4) the large-scale landscape modifications of Euro-American plantation owners and enslaved communities. However, there are several issues that should be taken into account before it can be accepted.

In general

-The lack of stratigraphic evidence from the study sites makes it difficult to understand anthropic modification versus natural sedimentation. A single figure (Fig. 5) is included in the text, which is not enough. I suggest including the key stratigraphic sections (profiles) of every study site and their corresponding radiocarbon dating location.

-The absence of a comprehensive description and discussion of all the C-14 analyses used in each studied site is hindering the interpretation of the beginning of human-induced landscape changes around 5000 years ago. I suggest including a radiocarbon table for each site, along with details of the calibration method used.

- An overinterpreted geomorphological process should be avoided in the text. The current data are not enough to describe complex geomorphological processes. For example:

“For the shorelines, tidal creek banks, and marsh islands in particular, shell accumulation is adding critical elevation and a more resilient substrate, both of which are buffering ecological structures against increasing erosional rates, rising sea levels, and saltwater intrusion.”

Abstract

Lines 15-21 The abstract introduction between lines 15-21 needs to be shorter. It would be better to divide the abstract into a short introduction, the main hypothesis, methods, and results in brief.

Lines 21-22 “In this paper, we highlight how modern ecological and geomorphological baselines along the Georgia coast of eastern North America are structured by 5,000 years of Indigenous and Euro-American interactions with these environments”.

The paper lacks a systematic geomorphological analysis. Please suppress or change this sentence.

Lines 24-26 “We refer to these deep time interactions as primary legacy drivers, and argue that through both intentional and unintentional impacts, modern estuarine ecologies around the world are products of these engagements, alterations, and creative transformations”.

I agree that modern and past human activities have extensively shaped diverse continental and coastal landscapes. However, modern estuarine ecologies are more than the product of anthropic transformation. Several sedimentological or climatic processes interact with these landscape types. Please rewrite the sentence.

Main text

Lines 39-42 Such transformations manifest variably as rising sea levels, warming sea-surface temperatures, more frequent extreme weather events and storm surges, and subsequent changes to salinity and freshwater regimes.

Please include references.

Lines 50-51 For instance, nutrient levels and ratios were altered in just a single month

Which ratios?

Historical baselines are often established as simply and homogeneously “pre-European” (25) and are subsequently used as “referents” by which modern ecosystem functions are compared to those of the past (27).

Totally agree.

Results

Pre- and Early Industrial Human Settlement along the Georgia Coast is Extensive and Cumulative

Lines 122-125 The coastal and wetland environments of the Georgia coast include barrier islands, small marsh islands, saltwater marsh, brackish marsh, tidal creeks, river channels, and maritime forests. These environments are anchored by large, Pleistocene barrier islands that separate the marsh ecosystems, located between the mainland and the barrier islands, from the open ocean.

Do Pleistocene barrier islands anchor barrier islands? Please rewrite or clarify this paragraph.

Lines 124-125 These environments are anchored by large, Pleistocene barrier islands that separate the marsh ecosystems, located between the mainland and the barrier islands, from the open ocean.

Please include a reference.

Lines 132-133 Recorded in the Georgia Archaeological Site File, there are c. 3,300 known Indigenous archaeological sites across the six counties that make up Georgia's coast (Fig. 1b).

This figure needs work. Please see my comments on the figure section.

Lines 134-139 Along the immediate coast, including the large barrier islands themselves and the small marsh islands, or hammocks located in the marsh, there are 1,047 known Indigenous archaeological sites representing settlement and occupation over the last 5,000 years, coeval with entire life history of these ecosystems themselves. Of these 1,047 sites, roughly two-thirds (n=710) are located on the large barrier islands while one-third are located across the small hammocks (n=337) (

I suggest to represent this info in a single regional map. Then, the described occupation pattern variability respect landscape attributes could be better described.

Lines 158-161 On Ossabaw Island, one of the most thoroughly surveyed coastal barrier islands, Indigenous sites dating to the last 5,000 years span the 36km² of wooded upland (Fig. 3a). To date, 220 Indigenous archaeological sites have been recorded on Ossabaw Island, at a density of 6.1 sites per square-kilometer (53).

This is a critical point in this research for establishing the baseline to distinguish between natural variability and human influence.

The referenced work: "Pearson, C. E. (2014). Prehistoric settlement and sites on Ossabaw Island, Georgia: An atlas. *Manuscript*, 614" does not include a proper methodology regarding the radiocarbon analyses. How was the human occupation age determined? Were the Irene ceramics used as chronological control points? Moreover, were the Person's radiocarbon age or ages recalibrated using the IntCal.20 for this research? If so, this should be included in the methods section.

Reimer, P. J., Austin, W. E., Bard, E., Bayliss, A., Blackwell, P. G., Ramsey, C. B., & Talamo, S. (2020). The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). *Radiocarbon*, 62(4), 725-757.

This led me to an additional question: How many new radiocarbon ages were produced to establish the baseline concept in this research?

Are there any stratigraphic dated sections to demonstrate that the transition between natural landscape and human presence is a homogenous transition lasting about 5,000 years?

Lines 174-176 These figures demonstrate that the cumulative and intensive Indigenous occupation of landscapes heavily influenced subsequent environmental conditions that were found to be highly favorable for industrialized plantation agriculture.

I agree that cumulative and intensive Indigenous occupation could modify the landscape. Nevertheless, the mechanism behind this has to be better explained, such as a rise in erosion, modification in flooding frequency, or eutrophication.

Indigenous Communities Shaped Ecological and Geomorphological Processes through the Extraction and Deposition of Trillions of Oyster Shells

Lines 188-189 Indirectly, however, the accumulation of 5,000 years of oyster shell across these coastal landscapes has played a “keystone” role in ecosystem functioning (37,38).

Please see my comment radiocarbon data.

Lines 195-198 Middle Place was a large, Indigenous town occupied for roughly 350-years between c. AD 1150-1500. Approximately one-third of the site remains intact, untouched by destructive historic plowing during the plantation period (c. 1790s to 1861).

Please include a reference regarding the radiocarbon ages or, if these are new data, a table where they are described, and the methodology applied in the methods chapter.

Lines 201-202 “we extrapolated the abundance of oysters across the rest of the 168 middens for which we have reliable dimensions”.

What extrapolation method did you use? This must be described in the methods chapter.

Lines 209-212 Radiocarbon dating shows that Kenan was occupied consistently since at least 4500 cal. BP, though the primary occupation, and majority of shell deposition, spans the last 1,000 years.

I think that you got the radiocarbon ages for this publication:

Brannan, S., & Birch, J. (2016). Settlement ecology at Singer-Moye: Mississippian history and demography in the Southeastern United States. In *Settlement ecology of the ancient Americas* (pp. 69-96). Routledge.

The reference is not included in the publication.

Lines 229-234 While these shell-bearing landforms provide substrate for unique plant and animal communities, they also contribute to the overall geomorphological resilience of the coastal landscape. Indeed, in many cases, current (and future projected) high-tide lines would have already overtaken the natural ground surface (38) (Fig. 5). Combined with the lack of historic plantation use or plowing, these shell deposits, in some places up to a meter deep, are a key reason why parts of these islands are not underwater or are not (yet) being eroded away.

This is an interesting point. Are you planning to conduct a geomorphological analysis using GIS? The terrain and hydrological characterization of the site will provide valuable data regarding the geomorphological alteration.

Indigenous and Euro-American Communities Intentionally Modified Island Landscapes and Landforms

Line 243 There are roughly 165km of landscape modifications across Ossabaw Island (Fig. 6a)

Better to express this on area (km²)

Figure 6 is confusing. In 6a, please include a symbology to indicate the canals, ditches, roads, causeways, dams, and fences. The profile does not clearly display the described stratigraphic attributes. Please review my comment about the stratigraphy.

Lines 267-269 Using our estimations from Middle Place and Kenan Field, large Indigenous sites would provide anywhere from 100,000 up to 1,000,000 pounds per acre of arable land.

How did you estimate it? Is there any figure or map representing this?

For example, in the Kenan Field, the shovel test represents the area with high shell content. Without any previous geomorphic characterization of the place, is it possible to distinguish between the natural and anthropic surface extension?

Discussion

Lines 300-303. As we have shown, some of the islands and landforms of the Georgia coast have never experienced a period in which humans were not present. In fact, for Ossabaw Island, the last permanent resident moved off the island in 2016, which was the first time in its 5,000-year history without a permanent human occupation.

This difficult to proof, without a proper stratigraphic evaluation of any of studied islands, how did you determine this? Please delete this or rephrase the idea.

Lines 323-326 For the shorelines, tidal creek banks, and marsh islands in particular, shell accumulation is adding critical elevation and a more resilient substrate, both of which are buffering ecological structures against increasing erosional rates, rising sea levels, and saltwater intrusion.

What is the effect of the elevation addition on the islands? Without a proper geomorphological site evolution, this is difficult to determine. This landscape is quite complex. A geomorphological

analysis combining paleo records should be applied to determine the real effects of island elevation. As this is far beyond the publication's scope, this affirmation should be avoided.

Methods

-How did you scale the circle size with the measured thickness in the shovel tests? Please include a brief explanation.

-Which method did you use to extrapolate your results?

Please include key stratigraphic sections or profiles for study sites. The sections need to show the contact stratigraphic position of radiocarbon samples and archaeological material found there.

- Please include LiDAR resolution and a brief description of the employed sensor.

Figures

Figure 1

-Please include coordinates. In fact, all the maps need coordinates.

-Include a chart with all the used symbology

Figure 2

- I imagine that colors represent elevation variability. If so, please include the symbology.

Figures 1 to 4 and Figure 6 have the same issues. All figures need a coordinate system, and all symbology employed should be summarized in a chart in each figure. For example, colors that represent elevation variability.

Figure 5

I suggest replacing or complementing Fig 5 with representative stratigraphic sections for the excavation units discussed in the publication. This could include the radiocarbon age position at the stratigraphy section.

Note to Reviewers, Summary of Responses

Please find below responses to each reviewer's comments and suggestions. Overall, these comments have contributed invaluablely to the manuscript. More specifically, the substantial changes include the addition of more data (e.g., radiocarbon data summaries, more examples of stratigraphic profiles) and formal modeling of landscapes in the hypothetical absence of Indigenous land use (e.g., topographic modeling and relationships of landforms to modern tidal elevations). Beyond inclusion of these datasets and models, we have also clarified and expanded our discussion of "primary legacy drivers." In addition, we also better define the scope of the manuscript which is about modern landscapes and the impacts of past land use practices on these landscapes, and not about how past peoples navigated climate change (which is an important question! But not within the scope of the current manuscript's goals or questions).

We also note that this manuscript draws on decades (if not a century) of intensive and extensive archaeological work up and down the Georgia coast. The inclusion of the sheer amount of data that exists for the sites at which we work and those mentioned in the text is beyond the scope of this paper. For instance, there are over 1,000 stratigraphic profiles drawn for Kenan Field alone. In lieu of including all data (or even examples) from every single site from which we synthesize data, we include key examples from across the coast that represent typical depositional contexts. Likewise, for radiocarbon data, instead of tackling each site independently, we compile all the radiocarbon dates from the Georgia coast to track the temporality (and intensity) of Indigenous land use and occupation across the region. We think this might be a more useful treatment of the radiocarbon data in the context of the scope of the manuscript, which is more about the modern, cumulative impacts of these land use practices, and not about individual site histories or even about Indigenous historical trajectories. In this way, we have taken your reviewer comments below and used them to creatively think about how we can address the underlying concerns raised by each comment.

All additions or changes in the manuscript are highlighted in yellow.

Reviewer #1 (Remarks to the Author):

The impacts of climate change on human activities is profound, especially on a long-term scale. The authors use the example of how modern ecological and geomorphological baselines along the Georgia coast of eastern North America have been shaped for past 5,000 years of interactions with Indigenous peoples, Euro-Americans to illustrate the concept of Primary Legacy Drivers. However, the paper leans more towards archaeological surveys and findings, with insufficient discussion on the interaction between humans and the environment. I recommend publishing this paper in the journal after a major revision.

The results of the archaeological surveys are the data that we use to demonstrate how humans have altered these landscapes. The deposits of shell, the constructed canals, are all archaeological data. So, this is indeed archaeological data, but these archaeological deposits are also landscape data, geological data, ecological data. For instance, the depth of shell across a landform is archaeological data. And this data is key for understanding how humans completely altered the elevation and topography of a landform. We do not see our use of archaeological data to demonstrate these processes as a weakness. One of the main goals of the paper, even, may be to encourage non-archaeologists to consider archaeological data in their ecological and geomorphological studies.

(1) Lack of Results Presentation in the Abstract: The abstract only addresses the importance and impact but does not present the results or real viewpoints. Readers do not understand how the long-term interaction between humans and the environment played out, such as the effects of climate on humans and how humans adapted to climate change.

A discussion of the specifics of the long-term interactions between human and the environment, and these coupled human-nature histories, is beyond the scope of this paper. We have clarified a bit better that this paper is not about the character of past peoples' interactions with the environments. We are only interested here in how those interactions (whatever they may be) are inscribed on modern landscapes and how they currently contribute to ecosystem processes. As such, the ways that past peoples adapted to climate change (while a wonderful question!), is a bit beyond the scope of the manuscript's current aims and discussion.

(2) Insufficient Focus on Environmental Impact in the Main Text: Throughout the text, including the figures, the emphasis is more on archaeological survey results. The role of environmental factors, particularly how climate change affected human production, living conditions, and migration points emphasized in the abstract and introduction is discussed less thoroughly.

I think this is a just a bit of miscommunication. The abstract begins by outlining the vulnerability of coastal ecosystems in the modern day. We use this as a way to frame the fact that anthropogenic land use histories should be considered when thinking about modern coastal ecosystems and their resiliency to climate change. The aim of the manuscript is to highlight the importance of archaeological data (which is the most direct evidence we have for long term land use histories) to our ability to "model potential loss, predict and prepare for future regime shifts, or to build effective conservation policies." This is the framing of the paper, but we do not claim to undertake these analyses. We simply aim to show how the coastal landscape whose ecosystems we are trying to better understand and protect, are driven in important ways by the legacies (material remnants) of past human land use.

(3) Clarify the definition of "primary legacy drivers": The term "primary legacy drivers" requires a more thorough definition and contextualization within the ecological literature. It is essential to articulate how this concept integrates with existing theories of ecological change and resilience. This clarity will enhance comprehension for readers who may not be familiar with the term and its implications for understanding human-environment interactions.

More discussion of the term "primary legacy drivers" has been included, especially on Page 3 and in the discussion.

(4) Expand on the implications of deep-time human interactions: The discussion regarding the implications of deep-time human-environment interactions on modern ecosystems should be significantly expanded. Specific examples illustrating how these interactions have led to observable ecological changes, such as shifts in species composition or habitat structure, would strengthen the argument. This elaboration will help underscore the importance of historical context in conservation efforts.

We do cite studies that have specifically been conducted on the Georgia coast that show how, for instance, unique plant communities are found growing only at archaeological sites and at places with substantial shell deposits. We also note ecological studies that demonstrate how marsh islands are involved in 45% of ecosystem processes, and thus the added elevation of anthropogenic deposits that keeps these landforms above water, contribute substantively to ecosystem functioning and biodiversity across the salt marsh system.

To go further, we have added more formal modeling of the relationship between anthropogenic deposits, marsh island elevations, and tidal fluctuations. We use the archaeological survey data to remove the elevation added by Indigenous deposited shell to model how much of these landforms no longer be above water if it weren't for this long-term anthropogenic land use.

(5) Address the limitations of archaeological data: It is crucial to acknowledge the limitations and potential biases inherent in using archaeological data to infer past ecological conditions and processes. A balanced interpretation of the findings should include a discussion of how these limitations might affect the conclusions drawn in the study.

Our study does not use archaeological data to infer anything about past ecological conditions and processes. We use archaeological data only as modern landscape data (e.g., the scale of shell deposits, what percentage of modern landscapes are made up of deposited shell, how much modern elevation is the result of shell deposition, how many archaeological sites (and the density) are found along the coast, how many kilometers of canals have been carved into the landscape, etc. etc.). In this paper, we do not actually use archaeology to “do archaeology.”

In this way, the main limitations of archaeological data in this study are that we are VASTLY underestimating the anthropogenic legacies of land use on modern landscapes. That is, the TOTAL number of archaeological sites that has existed along the coast can never be known. Sites have been destroyed for urbanization, for roads, and by shifting sea levels and erosion. So, our estimates here in this paper would be on the lowest end possible. We have added this to the paper.

Given the aim and scope of the paper, none of our conclusions rest on the use of archaeological data to infer anything. In fact, our archaeological data is almost purely descriptive (of modern land forms). Like going out and measuring the thickness of a natural sand layer, or the accumulation of sediments in tidal estuary. We are treating the archaeological data in the same way.

(6) Discuss the role of Indigenous knowledge: Integrate a comprehensive discussion on the significance of Indigenous ecological knowledge in shaping our understanding of modern coastal ecosystems and their management. Highlighting this perspective could provide a more inclusive view of the interactions between human societies and their environments, emphasizing the value of traditional ecological practices.

Much has already been written on this topic and is beyond the scope of our expertise and of the current manuscript. That said, we have added more to this discussion in the final paragraph of the paper and have included some references to relevant work. We have also gone further to mention the potential relationship between this kind of work and environmental social justice aims.

(7) Provide quantitative data on ecological impacts: The manuscript should include more quantitative metrics or statistical analyses to substantiate claims regarding the ecological impacts of Indigenous and Euro-American activities on coastal ecosystems. Presenting data such as species diversity indices or habitat alteration measurements will lend empirical support to the assertions made in the text.

Our manuscript is a starting point for these studies. One of the impetuses for our manuscript is that many ecological disciplines do not consider deep-time anthropogenic land use as an

independent variable. The point of our manuscript is to make the argument that it is an absolutely key variable that must be considered.

Echoing our response to a previous comment, though, we do cite studies that have specifically been conducted on the Georgia coast that show how, for instance, unique plant communities are found growing only at archaeological sites and at places with substantial shell deposits. We also note ecological studies that demonstrate how marsh islands are involved in 45% of ecosystem processes, and thus the added elevation of anthropogenic deposits that keeps these landforms above water, contribute substantively to ecosystem functioning and biodiversity across the salt marsh system.

To go further, we have added more formal modeling of the relationship between anthropogenic deposits, marsh island elevations, and tidal fluctuations. We use the archaeological survey data to remove the elevation added by Indigenous deposited shell to model how much of these landforms no longer be above water if it weren't for this long-term anthropogenic land use.

We have also added a future directions paragraph that explicitly calls for more quantitative ecological and geomorphological work that integrated the consideration of anthropogenic land use.

(8) Clarify the interaction between legacy drivers and climate change: A more detailed discussion is needed on how the identified primary legacy drivers may interact with ongoing climate change impacts. This should include an exploration of potential feedback mechanisms and how these interactions could influence future ecological resilience. Such insights are crucial for understanding the long-term sustainability of coastal ecosystems.

See modeling of marsh island elevations and expanded discussion of “primary legacy drivers.”

(9) Discuss alternative ecological models: Address alternative ecological models or hypotheses that may challenge the primary legacy driver framework. Providing a nuanced discussion of competing theories will enrich the analysis and demonstrate a comprehensive understanding of the ecological discourse surrounding human impacts on ecosystems.

We consider existing/alternative frameworks in our updated discussion.

(10) Suggest future research directions: Propose specific avenues for future research that could further investigate the role of human-environment interactions in shaping ecological outcomes. This could include interdisciplinary studies that combine archaeological, ecological, and climate science perspectives to foster a deeper understanding of these complex systems.

Future directions paragraph added to the discussion.

Reviewer #2 (Remarks to the Author):

“Deep Time Human Interactions as Primary Legacy Drivers...” is an excellent manuscript drawing on a rich set of archaeological and environmental data with broad implications and international significance. The paper is well constructed, researched, and has excellent illustrations. I highly recommend it be published in Communications Earth and Environment. I have some minor suggestions for revision noted below by line number geared at helping expand the reach of the article even further or help clarify a few points to non-archaeologists. None of these should be particularly difficult to address. Congrats on an excellent study!

Line 51. It is not the Southeast but this is a very germane study:
<https://www.nature.com/articles/s41893-023-01186-6>

Citation has been added.

Line 58 (and throughout): I always get a little confused when I see “ecologies” used. Do you mean ecosystems? Something different?

This has been changed to “ecosystems.”

Line 92. I love the term primary legacy drivers and think it is a very important contribution of the paper. That said. The definition of the term that starts here could potentially be a little clearer. In particular “captures the holistic range of impacts of deep-time human histories on their ecosystems”. Perhaps “captures the full-range of people’s deep time influence...”. Also in here, I use the term deep time a lot too. However, my paleo colleagues always scoff at this since we are working in pretty near time. No change needed just something to think about.

An expanded discussion of the term has been included in the introduction.

Line 116: reword “continuing challenging of conceptions...”

Reworded.

Line 132: Since it doesn’t come up all the way until the end of the paper. What is the Georgia Archaeological Site File?

Description added.

Line 132 and into Line 157 are archaeology term heavy. Consider ways to add parenthetically clarification or change terms for non archaeologists. Particularly, around line 142, what does this mean for the non-archaeologist? This is a ton of sties and really dense, but it might be hard for the uninitiated to grasp. Could also mention that the archaeological record is only a fraction of what was actually there at a given time period and place.

We have added a simplified summary of what this actually would mean. And have also noted that the limitations of archaeological data in this study are that we are certainly underestimating the extent and intensity of past occupations.

Line 174: Sentence ending here on longer and more intensive occupation could use a reference or point to the data in the paper that shows this.

Added.

Line 184. Along the lines of the above. What does “massive amounts of oyster shell” actually mean?

A bit of clarification added.

Line 191. Need a reference to altered soil geochemistry or “see below” statement here.

“See below” added.

Line 225, 277, or perhaps in the Discussion could be mentioned that this is continent wide or global phenomenon to help expand the impact. Could cite the paper below or take a few of the primary citations outside of the southeast in the section in this paper on landscape legacies.

<https://link.springer.com/article/10.1007/s10814-023-09189-9>

Citation and statement added in discussion.

Line 237-258. Could use a reference or two somewhere in this section.

Citations added.

Line 308. I get the use of “unintentional” here, but how do we really know what was intended from the archaeological record?

Adjusted.

Lines 341-343. I think you could be more direct here. Specifically, how can this be incorporated into management plans? It is obvious to archaeologists, but not everyone.

Short discussion added.

Line 344. Could delete “as we previously pointed to in our introduction”

Deleted.

Line 352-354. Strong and important conclusions. Something for the authors to consider, but by no means don't need to add, is the link here between environmental and social justice. How can this study help integrate the two? Cultural keystone places is another framework that could be linked here that is trying to do this. Here are two papers that work towards this. Again just a suggestion and not necessarily something the authors need to integrate here

<https://anthrosource.onlinelibrary.wiley.com/doi/abs/10.1111/aman.12893>

<https://www.cambridge.org/core/journals/american-antiquity/article/cultural-keystone-places-and-the-chumash-landscapes-of-kumqag-point-conception-california/16A429D7AA4ACF06CE3005A1578A054B>

Citations added and discussed.

Excellent paper!--Torben Rick, Smithsonian Institution

Reviewer #3 (Remarks to the Author):

The paper “Deep-Time Human-Environment Interactions as Primary Legacy Drivers Shape Modern Coastal Ecologies ” by Holland-Lulewicz et al. is interesting. It tries to demonstrate “how

modern ecological and geomorphological baselines along the Georgia coast of eastern North America are structured by 5,000 years of Indigenous and Euro-American interactions with these environments.”

The manuscript aims to highlight the following points:

The expanse and time-depth of human occupation across estuarine landscapes, (2) the cumulative nature of these occupations, (3) the local and landscape-scale impacts of the deposition of trillions of oyster shells onto landforms by Indigenous communities, and (4) the large-scale landscape modifications of Euro-American plantation owners and enslaved communities. However, there are several issues that should be taken into account before it can be accepted.

In general

-The lack of stratigraphic evidence from the study sites makes it difficult to understand anthropic modification versus natural sedimentation. A single figure (Fig. 5) is included in the text, which is not enough. I suggest including the key stratigraphic sections (profiles) of every study site.

We note that this manuscript draws on decades (if not a century) of intensive and extensive archaeological work up and down the Georgia coast. The inclusion of the sheer amount of data that exists for the sites at which we work and those mentioned in the text is beyond the scope of this paper. For instance, there are over 1,000 stratigraphic profiles drawn for Kenan Field alone. In lieu of including all data (or even examples) from every single site from which we synthesize data, we include an updated figure that includes key examples from across the coast that represent typical depositional contexts.

By way of communicating a bit more about the shell deposits, they are chock full of artifacts including broken pottery, butchered and discarded food remains, etc. The stratigraphic profiles will certainly depict the relationships between these units and natural ones, but there is not mistaking big piles of discarded oyster shell filled with Indigenous artifacts in the middle of an island.

We were not clear enough about the nature of these deposits.

-The absence of a comprehensive description and discussion of all the radiocarbon analyses used in each studied site is hindering the interpretation of the beginning of human-induced landscape changes around 5000 years ago. I suggest including a radiocarbon table for each site, along with details of the calibration method used.

Likewise, for radiocarbon data, instead of tackling each site independently, we compile all the radiocarbon dates from the Georgia coast to track the temporality (and intensity) of Indigenous land use and occupation across the region. We think this might be a more useful treatment of the radiocarbon data in the context of the scope of the manuscript, which is more about the modern, cumulative impacts of these land use practices, and not about individual site histories or even about Indigenous historical trajectories. To this end, we include three modeled KDE (kernel density estimates) plots for (1) all dates from the entire coast, (2) all dates from Kenan Field, and (3) all dates from Middle Place. These plots are included now in Figure 1. And all data are included as supplemental.

- Overinterpretation of geomorphological process should be avoided in the text. The exposed data are not enough to describe complex geomorphological processes. For example:

“For the shorelines, tidal creek banks, and marsh islands in particular, shell accumulation is adding critical elevation and a more resilient substrate, both of which are buffering ecological structures against increasing erosional rates, rising sea levels, and saltwater intrusion.”

We have added more formal modeling of the impacts of shell deposition on upland land areas and elevations relative to tidal fluctuations (and thus impacts on ecosystem functioning). The observation that canals move water from the estuaries to the interior of the island, or that landforms would be underwater if not for meters of shell accumulation, we take as evidence for impacting geomorphology of these landscapes.

Note to Reviewers, Summary of Responses

First, thanks to all for your invaluable comments and suggestions. They have GREATLY improved and strengthen the submitted manuscript. You will find attached an edited manuscript with yellow highlighted areas from R1 and blue highlighted areas indicating changes made for R2 (primarily for Reviewer #4 and the editorial checklist).

Reviewer #1 (Remarks to the Author):

The manuscript has been fully updated and improved. I have no more further comments. It could be accepted now.

Reviewer #2 (Remarks to the Author):

The revised manuscript has done a nice job in addressing the reviewer's comments and clarifying a few key issues. I think it is now ready for publication and do not have further comments.

Reviewer #4 (Remarks to the Author):

The study of Holland-Lulewicz et al. addresses long-term human-environmental interactions in the coastal region of Georgia over about 5000 years, demonstrating that this highly fragile landscape never experienced a period when humans were not present. To do so, the authors compile a large amount of different geomorphological, chronological and archaeological/historical data. Given that the role of pre-European human impact on landscapes in America has been underestimated for a long time, this interesting work opens new perspectives on human-environmental interactions and the discussion about historical ecological and geomorphological baselines for modern landscapes, and is hence worth of being published in Communications Earth & Environment.

However, I have two general points and some detailed remarks that should be fixed prior to a publication of the paper:

General points

- The authors just focus on oyster shells (also in the Supporting Material only 'total shells' are given). However, what about other (shell) species that were probably also found in the studied middens, although in lower quantities? I assume that also their evolution through time and spatial distribution could give highly interesting information about former human nutrition and paleoecology.

Indeed, the exploitation and use of different invertebrate species is interesting! Other papers focusing on the lifeways, food systems, and resources exploitation patterns of Indigenous communities along the coast have certainly looked at these data to understand diet and economy. That particular angle is of course beyond the scope of this paper, as we do not discuss the mechanics and structure of past Indigenous foodways, but rather the long-term consequences of Indigenous shell fishing. In this regard, that is why we focus on oyster. It is makes up the VAST majority of shellfish byproduct (discarded shell).

Unfortunately, one of the limitations of understanding differential invertebrate exploitation is that VERY few archaeologists actually analyze invertebrates. They are routinely ignored (or not even kept, e.g., discarded in the field without being analyzed or counted). Our Middle Place data is the ONLY site on all of Ossabaw Island where oyster counts have ever been undertaken and

published. More commonly, total shell (all species together) are simply weighed and discarded, with no quantification.

Full invertebrate analysis is currently underway for Middle Place. Oyster makes up 99% of shellfish species and volume. Others include minimal amounts of hard-shell clam, various mussels, and other small species like snails. So, when talking about the landscape modifications induced through shellfish discard, oyster is the most relevant to these conversations and studies.

While most relevant to the kind of study submitted here, quantifying the range and diversity of species exploited by Indigenous communities is OF COURSE key for understanding their past economies including property regimes, seasonality, sustainable management etc. These are themes and questions that have been published on substantially across the Georgia coast as well as globally.

- What about the Late Holocene tectonics of the region? Given the location of the studied landscape very close the sea level, also very small-scale tectonic movements (subsidence or uplift) could have large consequences for the settlement and economic pattern through time. Given the long-term perspective of several millennia discussed in this paper, this important aspect should necessarily also be discussed here.

Tectonics are not a factor in this region. As Huddlestun (1988; A Revision of the Lithostratigraphic Units of the Coastal Plain of Georgia, The Miocene through Holocene) points out: “the Georgia coastal plain is determined to be structurally stable, with evidence of only minor uplift or subsidence.” Even small-scale movements (to our knowledge) do not have any observable consequences on the landscape, at least over the last 5,000 years. The major drivers of settlement patterns and patterns of engagements with these ecosystems are (1) sea level change and (2) rainfall, which themselves work in concert to affect changes to ecosystems which substantively affect human behavior (e.g., settlement patterns, economies). Sea level is the key driver for long-term settlement shifts. But even these drivers only affect the availability of landforms for occupation. When land is above sea-level, it is used by Indigenous peoples and communities, which has been documented archaeologically. Almost immediately when marsh islands form, they are inhabited and occupied.

The only other major geological process that may have affected settlement would be erosional processes. In general, ocean currents are driving the “migration” of the barrier islands. That is, most of the large barrier islands are experiencing erosion at their northern ends and new land formation at their southern ends as sediment is redeposited. We do think that these processes have potentially sped up in recent decades, the overall shape, size, and habitable land area have not been substantively affected by these processes and likely were not a primary factor in Indigenous settlement patterns or economies.

Even so, while very interesting, these dynamics are a bit beyond the scope of this paper. We are interested in demonstrating the broad, cumulative manifestations of human-environment interactions. So the specifics of all of the drivers and dynamics of particular interactions are slightly beyond the scope of this manuscript.

Detailed remarks

All following edits have been made:

- 48: ...of the United States in the state of Georgia.
- 281: Please explain the abbreviation 'STP', since not all readers will be familiar with this.
- 318:(67,68). It is....
- 370:legacy effects we observe, are removed....
- 398:marsh islands, serve....
- 457:communities managed landscapes....
- 542: ...kernel density...
- 547:were included in the models....
- Figure 1:
 - * Please give sources for the satellite images.
 - * 860: Kernel density....
 - * Sub-figure A does not show 'the total distribution of Indigenous and Euro-American historical sites across the study area', but is just an overview map. Please re-label.
- Figures 2, 4, 6: Legends for the Lidar topographical data are missing (it is just given for Fig. 3).
- Figure 2: Please use a unified magnitude scale for shell thickness in all subfigures, to allow a direct comparison.
- Figure 3, sub-figure C: What mean the red triangles in the upper part? Please explain.
- Figure 5:
 - * The sequence of numbering of the sub-figures (A-F) seems rather chaotic: Please re-organize to make it stringent.
 - * Since you used capital letters for the sub-figures (A-F), please also use them in the caption (currently you use lowercase letters here).