

Response to Reviewers

Reviewer 1

Reviewer comments are parsed and presented as higher-level bullets, our responses follow in italics:

- The title works really well. The ms is missing an abstract.
 - *We have modified the paper and added an abstract.*
- The first half of the paper is well-organized – but the second half (beginning with the “Programmatic Access” section) is very disorganized. There’s (1) a lot of repetition, (2) missing sections, and (3) an unrelated section (see below for more detail). The second half of the paper will need quite a bit of revision before resubmission.
 - *We have heavily edited this section, removing duplication and streamlining the text throughout. We believe that this editing will resolve many of the issues the reviewer has raised.*
- Yes—with the exception of the “Programmatic Access” section. The “Introduction to Neotoma” and “More Exploration” sections are particularly well-presented and high quality.
 - *Thank you, we believe that with these edits we have improved the “Programmatic access” section as well to raise it to the level of the other sections.*
- 1-2 figures could be added to illustrate the ideas in the “Educational Modules” and “Flyover” sections
 - *We have added a figure for the FlyOver Country section to show the user interface.*
- All of the figures need to be removed from the ms, saved as separate image files, and reformatted to match the Cambridge University Press requirements.
 - *We have moved all figures to a separate document as instructed.*
- Figure captions will also need to be removed and listed at the end of the ms
 - *We have moved all captions to a separate document as instructed.*
- The authors will need to ask for copyright permission to include the already published figures in Fig 1
 - *All of these figures have been heavily adapted and abstracted from the original publications. We believe that this resolves any copyright issue.*
- Figure 4 is a bit pixilated and fuzzy. Resolution could be improved.
 - *We have improved the resolution of this figure.*
- The ms is a little light on references, especially those relating to educational concepts. The authors haven’t delved into the educational literature very deeply—and there are quite a few sources that they could cite relating to authentic research in the classroom.
 - *We have introduced a number of references to pedagogical research in*

the Earth sciences. as well as elsewhere in the paper, both to improve the paper, and to act as sources for educators who wish to further explore some of the topics discussed.

- The introduction includes shockingly few references—need to cite sources for all of the background info on Quaternary geology that the authors present.
 - *We recognize this and have provided further support for our statements here.*
- Can the paper be reduced in length? How? No, although the second half of the paper needs to be re-organized and rewritten to reduce repetition.
 - *As noted above we have improved the paper, re-organized and reduced duplication.*

GENERAL COMMENTS

- Right now, the text is written for paleontologists, or specifically Quaternary paleoecologists. I'd recommend broadening your audience to include two year college faculty and geologists teaching introductory courses (including historical geology). To do this, you'll need to define a bit more of your vocab and think about how a naïve user (e.g., non-major student in an intro course) might approach this dbase.
 - *We have added more references to introductory and review literature, and explained terms more extensively where necessary.*
- Right now, the authors really only walk through one teaching activity. Would be really useful to provide 1-2 more to fully illustrate some of the resources that have been developed.
 - *We provide a set of linked exercises and describe additional exercises more thoroughly now.*
- A lot of us teach students who are climate deniers. Might be useful to provide resources re. how to use Neotoma and do these activities with that audience.
 - *While we agree, we believe this is beyond the scope of this paper as it stands. Neotoma does have digital resources to show the ways in which climate has changed, but cannot be used alone to show attribution for climate change.*
- The “Programmatic Access” section has several issues with it (repetition, missing section, unrelated section, poor writing)—see below.
 - *This section has been heavily edited and revised.*
- Format needs to be substantially revised to match the requirements from Cambridge Press. This includes font type, margins, line spacing, title page, parenthetical citations, references, placement of figures, and so on.
 - *We have adopted the style guide provided.*

INTRODUCTION TO NEOTOMA

- The wording for this heading is very similar to the first heading (Introduction). I'd recommend varying it.
 - *We have changed this section to The Neotoma Paleoecology Database.*
- I'd also recommend adding more basic info re. Neotoma. Geographic scope? Number of taxa included? What kinds of taxa (pollen, mollusks, etc.) included? Taxonomic level? Environment? Marine and terrestrial? What type of terrestrial habitats? Number of publications? Does it only include primary lit?
 - *We added further information about the record types and the availability of secondary information.*

More Exploration with Explorer: Additional SERC Teaching Exercises

- I'm confused re. the difference between the 8 SERC activities presented in this section and the 11 modules presented in the next section. Are the 11 modules part of the same SERC resource? If not, why not? How can we access the 11 modules?
 - *We have clarified the differences, both are hosted at SERC, but the original source differs, as does the content of the modules. This information is now contained at the top of the section.*

Educational Modules for Climate Change, Paleoecology, and Biogeography

- I'd recommend adding figures to illustrating some of the trends discussed in the second and third paragraphs.
 - We did not include these figures.

Programmatic Access for Macro-Scale Paleoecological Research

- The structure of this section is extremely confusing—there's (1) a lot of repetition, (2) missing sections, and (3) an unrelated sections.
 - *We address revisions below*
- I'd recommend checking for repetition through these sections. For example, most of the sections "Accessing Data with neotoma's R package" and "Programmatic Access and Paleoecology" repeat information that was presented earlier in the "Programmatic Access for Macro-Scale Paleoecological Research" section
 - *This was an oversight in the editing process. We heavily edited these two section, the section is now simply Programmatic Access. . . and contains most of the original text (although heavily edited).*

- In this section, the authors say “In the remainder of this section, we walk through a common graduate-level introductory exercises for accessing and analyzing Neotoma data.” Did you do this? If so, I couldn’t find it. It would be a really valuable addition.
 - *We removed the reference to a teaching module directly in this paper, but provide links to HTML tutorials for chronology construction and other common workflow patterns with **neotoma**, linking to the GitHub repository.*
- Is the “Chronology Construction & Climate” section related to the rest of this section? I couldn’t figure out the connection
 - *In editing this section we made the motivation and connection to the Programmatic Access heading much clearer. We also provided additional publications in this section to strengthen its utility for educators wishing to instruct based on material herein.*
- Writing is a bit weak in this section—compared to the others. I’d recommend editing for awkwardness and flow.
 - *We have edited throughout to improve flow and have dramatically reduced awkwardness of the text, although the authors’ own awkwardness likely remains unchanged.*
- I’d recommend combining the Discussion section with the one after it “The Role” and deleting the repeated paragraph of info.
 - *We believe that our re-organization of the Discussion now addresses this issue, by partitioning the information more clearly.*

Reviewer 2

- I saw no abstract. I think part of the title “research-outreach nexus” is not delivered on in the chapter. To me, the authors are more exploring its pedagogical uses. I’d consider changing the title.
 - *We have added an abstract, and believe that the paper not more clearly indicates the concept and central idea of the research-outreach nexus.*
- I think the images of Neotoma were helpful, but could easily be reduced in size. Figure 1 could be eliminated, as should the related text as it has little to do with the purpose of the article. I also don’t think Figure 6, as it stands is helpful (unless the authors decide to go more into these ideas in the body of the article). Finally, I do not think Figure 5 is very useful.
 - *We have modified the figures throughout and believe that (old Figure six, now figure 7) has been more fully explored and discussed in the paper.*
- Yes, though I wonder if the authors really need to include the trademark and webiste each time the discuss Flyover Country®. Maybe there is another way to do this!
 - *Unfortunately we do need to include the trademark, but have removed additional website links.*

- The [J.W. Williams et al. (in press); grimm2008neotoma] citation looks a little odd. Is this correct?
 - *This was an error in the citation formatting in Markdown, and has been corrected.*
- Though well written, and interesting, I really do not think the first two pages or so of the article (i.e., the introduction) are necessary. I'd get rid of them. See notes below to authors!
 - *I believe we have strengthened the article sufficiently that the structure of the paper now represents a much more integrated whole.*

Introduction:

- I felt the introduction, though interesting, is not really needed. In fact, it really drew away from the purpose of the chapter. I might start the chapter with the last part of the paragraph on page 3 which starts, “Understanding largescale spatial phenomena such as the climate-driven range shifts. . .” After this, the authors could get to the purpose of the chapter on page 4.
 - *The introduction has been significantly restructured.*
- I think it is important to bring in the idea of proxy data in the intro (i.e., define and be clear about it). There are some places where this ideas arises, but I think that understanding this is central to understanding the big ideas that one can learn from Neotoma.
 - *Proxy data is now introduced more explicitly in the introduction. We also relate the use of Neotoma more explicitly to changing species distributions in response to climate.*
- I think neotoma should be capitalized in “neotoma R package”.
 - *The package itself is not capitalized.*
- In this section and in other parts of the chapter there is a sense that the context of the Quaternary would help people understand deep time. Why do the authors think this is true? Is it because the Quaternary is not too deep? Emeritus geoscience educator, Kip Ault, would say, humans live about 80 years and have difficulty conceptualizing time beyond a human time frame. Thus, it really doesn't much matter 2 million vs. 100 million. Both are equally abstract! Is there another argument for why the Quaternary would be a useful context? If not, I might leave this out.
 - *The introduction provides a much more forceful explanation of the importance of the Quaternary now.*

Your First Search (and the following, related, sections)

- Overall, I don't think the headings are very useful (particularly “More Searching” and “More Detials”)! I think I would use headings that would give the reader a clear understanding of what each section is about (essential, what central idea about the data base are the authors showing them).

- More importantly, I think this entire section could be improved upon if the authors were to model to their reader what an actual investigation might look like instead of doing each of the searches separately (e.g., (1) Look at ice sheets, (2) look at an organism that's range was impacted by the last glacial maximum, (3) have them form some kind of hypothesis, (4) etc. . .).

Your First Search

- Related to the Marion Lake Search. . . To make this clearer, the authors might want to let the reader know the scale the explorer should be at. Initially, I only saw 1 site as it was zoomed in on OR and WA (where the northern site was off the screen in Canada).
- When I click on the pollen data online, I had to download the data in order to see it. In doing so, I didn't see the "Tabs" the authors refer to in the article in the CSV file I saved to my computer. The "Tabs" are referenced at the top of page 7.
- *This section does not refer to the downloaded data, but rather the window that appears when the "P" is clicked. We have revised this sentence to make that clearer:* The icons represent pollen data and geochronological data respectively. *Click on the icon that represents the pollen data* (the green P) first and scroll through the tabs available within the window.

More Details-

- I'd use the name on the top of the website instead of a description of what the tool looks like (i.e., "Display glacial boundaries. . ." instead of "white polygon"). The authors can describe it as a "white polygon", but when one hovers over it there is an actual name. Use that!
 - *Fixed*
- Also, is there a particular taxa the authors would recommend exploring to see something interesting about paleo-distributions related to the ice sheets?
 - *We mention Spruce in the last sentence of the section, and indicate how a user might proceed to see the effects of warming in the late Pleistocene.*

Research Questions

- It seems pretty abrupt to jump to go right into an activity here. There is no set-up for it. I would recommend a transition (I think my overall comment about building a single activity that the reader would follow throughout this section would make it work better).

- *We have edited this section, and added a sentence to the end of the Neotoma Explorer section to provide better flow but also to indicate that the following sections are cumulative: The following sections, through to Research Questions, are cumulative and are expected to follow one another.*
- In my search for the “Mammut” it was unclear if this a North American search only or worldwide? Also, it is unclear if this is separate from the last activity (I think it is, but...??) so should the reader still have the ice sheets on or not? Again, a single activity that readers follow through would help make all of this clearer!
 - *See above.*

More Exploration with Explorer...

- I am not quite sure I clearly understand what kind of scaffolding the authors are talking about in this section (i.e., “This kind of scaffolding...”). I think the authors should clearly articulate what the scaffolding is across the activities and make sure it relates to what “guided inquiry” is (see the National Science Education Standards and Inquiry and the National Science Education Standards and INSES for support with a definition for guided inquiry. There are also plenty of articles that will also give clear definitions) as guided inquiry is not defined! I can see what guided inquiry “does” based on the citation the authors included, but I don’t see a definition that allows me to attach guided inquiry to the under developed idea of what the activities designed at SERC really were.
 - *We have provided a reference and clarified this section, in particular to the use of the term ‘scaffolding’ in this context.*

Educational Modules for Climate Change...

- Are these modules discussed in this section the same thing the authors discuss above (i.e., those that were designed at SERC by scientists and ed researchers)? If so, make this clear. If not, where are these 11 modules located and what are they?
 - *We have modified the text to indicate where the modules can be found and to distinguish them from the other modules.*
- Coming back to a big idea from the beginning of this article, I think it might be nice to link what they are looking at (i.e., proxy data) to what they are measuring with these data!
 - *This is a challenging comment, here we are discussing not the fossil data as a proxy for an environmental variable, but for the species presence itself. We have left the more detailed interactions between environment and fossil that result in them being a proxy as a secondary issue.*

Programmatic Access for Macro...

- I think this section would be better if the authors were to curate the workshop materials for readers. It is not very helpful to just say go see the materials. Some sense of what the materials are and some information on their use would be a good addition.
 - *We have modified this section to provide a broader context for the utility of these programmatic modules, in particular the rise of best practices in version control (with git/GitHub) and point now to a specific example with regards to chronology construction.*

Chronology Construction & Climate

- This heading doesn't quite follow the previous two headings as a "point of access" (perhaps I am missing something here?)
 - *We believe that the re-written section about programmatic access now flows more completely.*

Discussion

- CCDRs at the Research-Outreach Nexus CCDR- This term needs to be defined and delimited!
 - *This has been modified and referenced to the Neotoma Williams paper, where the concept is further defined.*
- The following sentence occurs in this section and next section: Traditionally, CCDRs have been a resource for data storage: systems of record; collating, aggregating and cleaning data, largely supervised by domain experts (Kapoor et al. 2015).
 - *This duplication has been removed.*

Role for CCDRs in Outreach

- If Figure 6 is important the authors should describe it in the text and go into it a little more. Figures don't speak for themselves!
 - *We have added more context and more direct references to the figure in this section.*
- Later in this section: I think it is great to discuss use of this software with K-12, but most of this article focuses on university level, thus it seems strange to bring in "elementary" here! Is there a reason for this?
 - *This reference has been moved.*