Response to Review No. 2

Reviewer's general comment: This study investigates how different disturbance events affected the forest structure and a peat bog (including its hydrological and biochemical properties) over the past 2000 years, and aims to recognize and standardize patterns that could be applied to other sites. Even though the discussion deviates quite far into describing the full details of the insect outbreak and the forest fire, which are not really necessary to understand the magnitude of these events, the manuscript is overall decent. Figure 7 is inspiring and a nice conclusion of the manuscript.

I am a bit skeptical that no attempt was made to explain the strong fluctuations in the vegetation composition, according to the PcA, and I do not agree with the conclusion that the PcA shows that the rapid change already started after 1775 AD.

Author's response: We thank the reviewer for the review of the manuscript. The reviewer's comments, suggestions and opinion are valuable and provide valuable support in improving the quality of the manuscript. We hope that the responses to the following questions and comments will be comprehensive and well-reasoned, and that all the authors' efforts to improve the manuscript will be duly recognized and appreciated by the reviewer. Below are the answers to all the reviewer's questions and comments, especially those that cause the most concern and relate to the statistical analysis.

Abstract: I found the abstract not informative enough. Which palaeoecological proxies? How long was the record that you studied? The outbreak of what?

Author's response: Thank you to the reviewer for this comment. We agree that the abstract was not informative enough. We have taken steps to complete the missing information by the reviewer's suggestions.

Action: We completed the information about the age of the peat core, the name of the peatland, the type of insect which caused the outbreak, and the types of palaeoecological analysis used in this study as the reviewer suggested.

Before: *[…] Here, we examined how a peatland in one of Poland's largest pine plantation complexes responded to some of the largest environmental disasters observed in the 20th century across Central Europe – the 1922–1924 outbreak and the 1992 fire. As a disturbance proxy, we used a multi-proxy palaeoecological analysis supported by a neodymium isotope record. […]*

After: *[…] Here, we traced a 2000-year history of the Miały peatland located in one of Poland's largest pine plantation complexes and we examined how this peatland responded to some of the largest environmental disasters observed in the 20th century across Central Europe – the 1922–1924 Panolis flammea outbreak and the 1992 fire. As a disturbance proxy, we used a multi-proxy palaeoecological analysis (plant macrofossils, testate amoebae, pollen, non-pollen palynomorphs, micro- and macrocharcoal) supported by a neodymium isotope record. […]*

Introduction

Please check the language again, if all statements are in written language and not spoken language, and if no articles are missing (I think some are). I think it would be worth to

consider to move some sentences around to give the introduction a better, logical structure from beginning to end.

Author's response: We thank the reviewer for his suggestions and comments on improving the quality of the introduction. We have checked and rewritten the text of the introduction based on the reviewer's comments below. We have followed all the comments, and detailed responses to them are also presented below.

Line 39: I would replace the word 'precious' with a less personal adjective.

Author's response: We appreciate the reviewer's work on the linguistic correctness of the manuscript. We agree that the proposed change is proper.

Action: We have corrected the sentence as the reviewer suggested, replacing the word 'precious' with 'valuable'.

Before: *This is particularly important because peatlands are precious ecosystems accumulating a third of the world's soil carbon stocks (Parish et al., 2008) […]*

After: *This is particularly important because peatlands are valuable ecosystems accumulating a third of the world's soil carbon stocks (Parish et al., 2008) […]*

Line 42: Maybe "simplified linkages" can be explained in the text so that the reader doesn't have to open the referred article; it is not clear to me what these simplified linkages are.

Author's response: Thank you to the reviewer for the comment. Indeed, the sentence was constructed imprecisely and was unclear. It is about simplified linkages in the food web, which result in less resilience of the forest ecosystem to various types of disturbances.

Actions: We corrected the sentence, explaining what linkages we meant. We hope that after the correction, this part of the text is no longer in doubt and is clear for the reviewer. We meant simplified links in food webs.

Before: *The danger is even higher for peatlands located within monoculture tree plantations that have simplified linkages […] and thus are more sensitive to fires, strong winds, droughts, and insect outbreaks.*

After: *Such an environment is particularly dangerous for Poland's peatlands because monoculture tree plantations have simplified linkages in food webs and thus are more sensitive to fires, strong winds, droughts, and insect outbreaks (Chapin et al., 2012), which also causes a threat to peatlands.*

Line 45 – 51 break up the flow of the introduction, which I think should move from "negative impacts" to "recognize how these impacts work and used to work"; the description of the forest structure in Poland could maybe be moved.

Author's response: Thanks to the reviewer for the comment. We agree that the structure of the introduction should be more structured, so we have made a few changes to the text following the reviewer's suggestions.

Actions: We have rewritten much of the introduction following the reviewer's suggestion. We have arranged the structure of the text so that it is more logical, starting with the determinants of negative effects to the recognition of those effects. We have moved the description of the structure of Poland's forests before the information relating to the negative consequences resulting from this structure.

Before: *The danger is even higher for peatlands located within monoculture tree plantations that have simplified linkages (Chapin et al., 2012) and thus are more sensitive to fires, strong winds, droughts, and insect outbreaks that are more common in recent years (Seidl et al., 2014; Westerling, 2016). These negative impacts have been recorded for various peatlands, including those in Central and Eastern Europe (Leonardos et al., 2024; Łucόw et al., 2021). Forests cover 31% of Poland's area, equivalent to 94,770 km^2 (Statistical Office in Białystok, 2023). More than half of this forest cover comprises coniferous forests dominated by Scots pine (Pinus sylvestris L.). It is mainly the result of planned forest management in modern-day Poland in the 19th and 20th centuries (Broda, 2000). Pine monocultures were easier to manage and grew faster on poor soils, securing the continuous supply of raw material for the growing timber industry (Broda, 2000).*

After: *Hundreds of thousands of hectares of peatlands in Poland are located in forests, as forests cover 31% of Poland's area, equivalent to 94,770 km^2 (Statistical Office in Białystok, 2023). More than half of this forest cover comprises coniferous forests dominated by Scots pine (Pinus sylvestris L.). It is mainly the result of planned forest management in modern-day Poland in the 19th and 20th centuries (Broda, 2000). Pine monocultures were easier to manage and grew faster on poor soils, securing the continuous supply of raw material for the growing timber industry (Broda, 2000). Such an environment is particularly dangerous for Poland's peatlands because monoculture tree plantations have simplified linkages in food webs and thus are more sensitive to fires, strong winds, droughts, and insect outbreaks (Chapin et al., 2012), which also poses a threat to peatlands. It should be strongly emphasized here that such extreme phenomena have become more common in recent years around the world (Seidl et al., 2014; Westerling, 2016). These negative impacts have been recorded for various peatlands, including those in Central and Eastern Europe (Leonardos et al., 2024; Łucόw et al., 2021).*

Line 73: also here I think it would be suitable to mention what kind of insect it was. Bark beetle?

Author's response: Thank you to the reviewer for the comment. We agree that it is worth specifying that it is a *Panolis flammea* outbreak.

Actions: We corrected the sentence as the reviewer suggested, explaining that there was a Panolis flammea outbreak between 1922 and 1924.

Before: *These forests were affected by some of the most severe environmental disasters of the 20th century that took place in pine-dominated forests across Central and Eastern Europe – the 1922-1924 insect outbreak and the 1992 fire.*

After: *These forests were affected by some of the most severe environmental disasters of the 20th century that took place in pine-dominated forests across Central and Eastern Europe – the 1922-1924 Panolis flammea outbreak and the 1992 fire.*

Line 76: please replace ‘dramatic’ with ‘extreme’

Author’s response: Thank you to the reviewer for the comment. We agree that it is worth replacing ‘dramatic’ with ‘extreme’.

Actions: We corrected the sentence as the reviewer suggested, replacing word ‘dramatic’ with ‘extreme’.

Before: *However, not all the evidence of past dramatic events has been well preserved in the previously studied core […]*

After: *However, the interpretation of these extreme events based solely on these two cores appears to leave many questions unanswered and highlights the need for further research into the impact of insect outbreaks and fires on peatland ecosystems.*

Line 76 -78: This seems insufficiently explained. Did all three studies mentioned in line 75 use the same sediment core? Did they search for evidence but it was not found in the core, thus suggesting that evidence did not preserve?

Author’s response: We appreciate the reviewer's curiosity and request for detailed information about previous palaeoecological studies from the Noteć Forest. To date, only two cores from a single Rzecin peatland have been analyzed and the results coming from these two cores have been published in the referred publications. Barabach (2014) is a PhD thesis (monography published in Polish) focusing on palynological data, an article by Lamentowicz et al. (2015) focuses on the reconstruction of hydrological changes in Rzecin peatland, whereas Milecka et al. (2017) offers a summary of palaeoecological research undertaken at Rzecin peatland. However, these studies have left many questions unanswered, which motivated the continuation of the work on this topic and the writing of this manuscript.

Actions: We significantly rewrote sentences referring to previous studies, detailing how many cores were previously studied and why we decided to continue the research about the impact of ecological disasters on ecosystems in the Noteć Forest.

Before: *The only palaeoecological data documenting these events in the Noteć Forest come from the Rzecin peatland (Barabach, 2014; Lamentowicz et al., 2015; Milecka et al., 2017). However, not all the evidence of past dramatic extreme events has been well preserved in the previously studied core, leaving the question of the impact of insect outbreaks and fire on peatlands open for further investigation.*

After: *The only palaeoecological data documenting these events in the Noteć Forest were derived from two cores taken from the Rzecin peatland (Barabach, 2014; Lamentowicz et al., 2015; Milecka et al., 2017). However, the interpretation of these extreme events based solely on these two cores appears to leave many questions unanswered and highlights the need for further research into the impact of insect outbreaks and fires on peatland ecosystems.*

Line 78 – 79: about small peatlands, seems out of place here. The text makes sense without referring to the size of peatlands here.

Author’s response: Thank you to the reviewer for the comment. We agree that this sentence should be removed from the introduction because it disrupts the text’s structure.

Actions: We removed the sentence as the reviewer suggested.

Before: *[…] leaving the question of the impact of insect outbreaks and fire on peatlands open for further investigation. Small peatlands are usually less resilient to disturbances than large ones (Lamentowicz et al., 2008). The changes caused by extreme events can lead a peatland to reach a critical transition, that is, to cross a tipping point after which it does not return […]*

After: *[…] leaving the question of the impact of insect outbreaks and fire on peatlands open for further investigation. The changes caused by extreme events can lead a peatland to reach a critical transition, that is, to cross a tipping point after which it does not return […]*

Methods:
Most of the methodology reads fine and is logical to me, but this being the first manuscript that I'm reading that studies Nd isotopes I did not get enough information about why and how it is used. Sometimes briefly referring to literature is not enough. It probably would suffice to borrow a few sentences from the publication by Marcisz et al (2023b).

Author's response: Indeed, neodymium isotopes are still not commonly used in palaeoecological studies of peatlands. We agree that adding more context to the 'Methods' section will help the readers understand this method.

Action: We added a bit more context to neodymium methodology at the beginning of 'Neodymium isotopes' methodology chapter. We also added information about the sampling of neodymium reference samples in the 'Fieldwork and sampling' section as this information was missing in the previous version of the manuscript.

Line 146: replace 'are' with 'were'.

Author's response: We appreciate the reviewer's work on the grammatical correctness of the manuscript. We agree that the proposed sentence form is proper.

Action: We have corrected the sentence as the reviewer suggested.

Before: *[…] of plant macrofossils, which may signal changes in peat accumulation rates, are inputted using the Boundary command.*

After: *[…] of plant macrofossils, which may signal changes in peat accumulation rates, were inputted using the Boundary command.*

Line 148: It makes sense that these two radiocarbon dates were rejected from the model, but I don't understand the explanation in the text.

Author's response: We appreciate the reviewer's contribution to improving the manuscript and taking care of its logical content. We agree that the sentence was not clear and needed rewriting.

Action: We corrected the sentence, explaining that two dates were rejected because they were outside the main trajectory of the model.

Before: *Two dates (laboratory code – Poz-150636 and Poz-150390) were rejected because they were after the initial modelling trajectory of the model.*

After: *Two dates (laboratory code – Poz-150636 and Poz-150390) were rejected because they were outside the main trajectory of the model.*

Line 182: Perhaps you could keep the same terminology here as for the previous part about the plant macrofossils.

Author's response: In our opinion the style and terminology in which testate amoeba and plant macrofossil methods are explained is similar, therefore, we do not see what we can possibly change to improve it.

Results:
Figure 2 looks very nice, but Figure 3 and Figure 4 could perhaps be a bit summarized and simplified (further). This is only an aesthetic opinion, though.

Author's response: Thank you to the reviewer for the comment. Indeed, the font was too small. In addition, the charts could have been simplified. We agree with you.

Actions: We have corrected the figure by making the font larger. We have made the figure clearer. We also reduced the number of data presented by eliminating some of the dates from the timeline, as well as some of the values from the horizontal axes next to the curves.

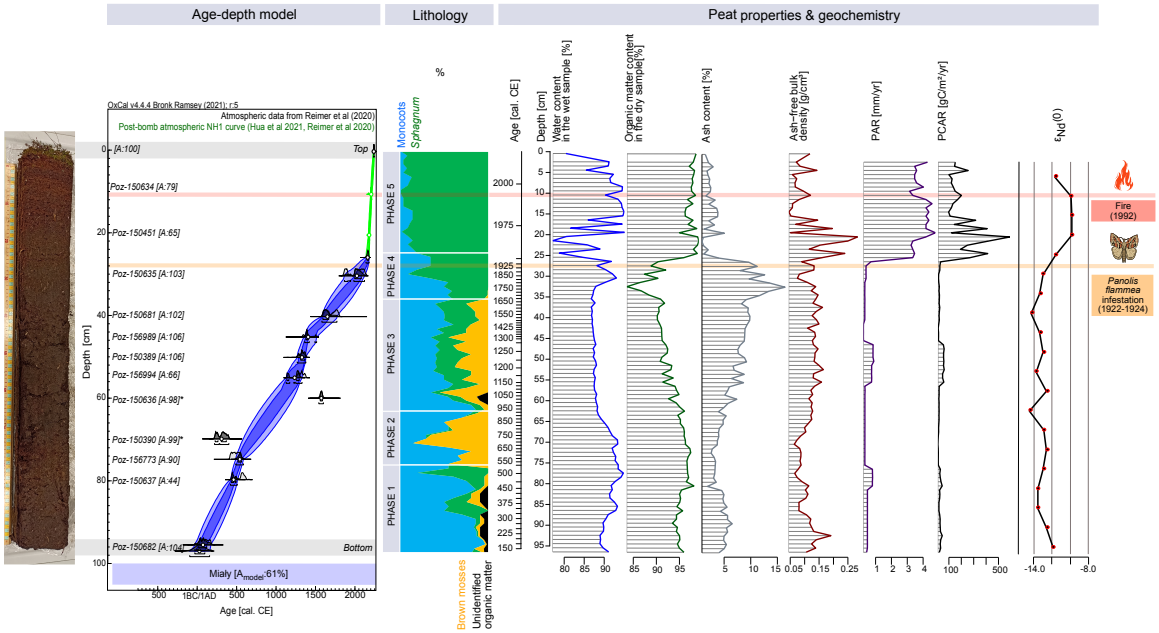
In Figure 2, we made the font larger, and we removed part of the values from the horizontal axes and the age axis.

In Figure 3, we made the font larger, we removed non-discussed taxa curves (*Cirsium* – fruits), and some of the values from the horizontal and vertical axes.

In Figure 4, we made the font larger, we removed non-discussed taxa curves (*Salix*, *Populus*, *Tilia cordata*, *Abies alba*, *Acer*, *Pteridium aquilinum, Melampyrum*, *Urtica*, *Humulus/Cannabis*, *Centaurea cyanus*, *Fagopyrum esculentum* type, *Ambrosia artemisiifolia* type, Chenopodiaceae, *Plantago major*, Apiaceae undiff, *Potentilla* type, Brassicaceae, *Anthemis* type, *Aster* type, Cichoriaceae, *Galium* type, *Typha latifolia*, *Sparganium* type, *Drosera rotundifolia*, HdV-153 *Riccia*, Filicales monolete, *Scenedesmus*, *Spirogyra* type, *Mougeotia* type. *Pediastrum* – sum, HdV-128A, HdV-128B, HdV-1 *Gelasinospora* sp., HdV-30 *Helicoon pluriseptatum*, HdV-28 Copecoda spermatophores, HdV-31 *Archerella flavum*, HdV-32A *Assulina muscorum*, HdV-32B *Assulina semimulum*), and some of the values from the horizontal and vertical axes, and some of the values from the horizontal and vertical axes.

Figure 2

Before:



After:

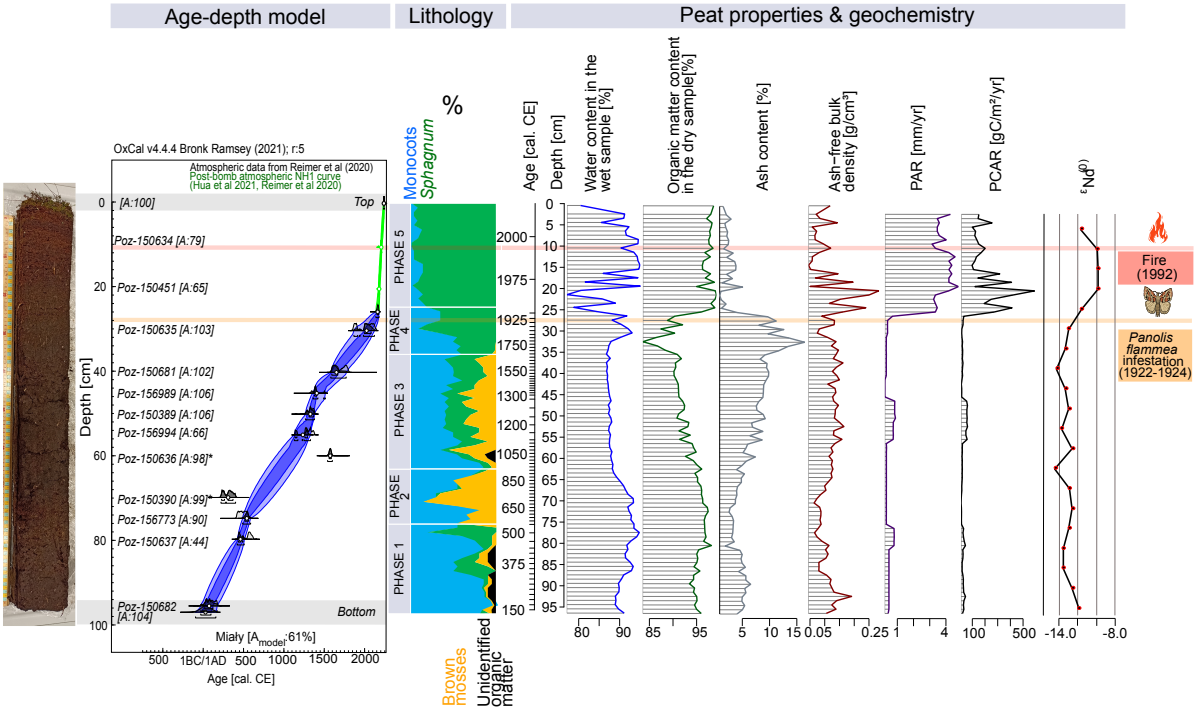
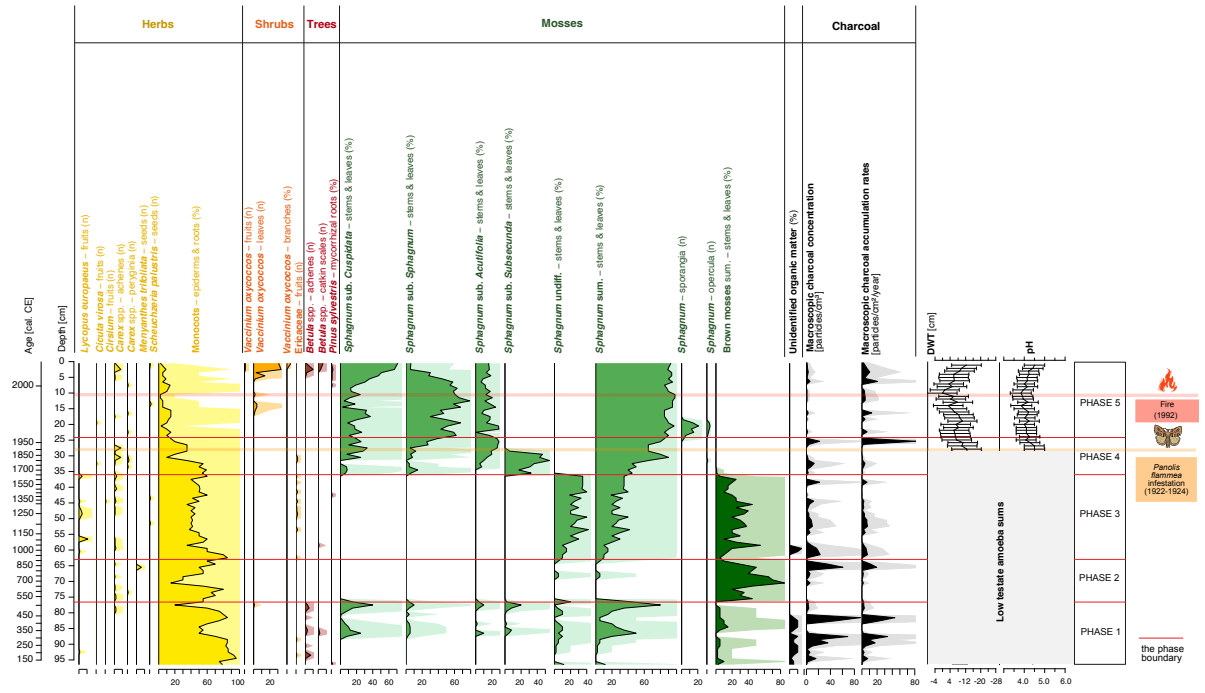


Figure 3

Before:



After:

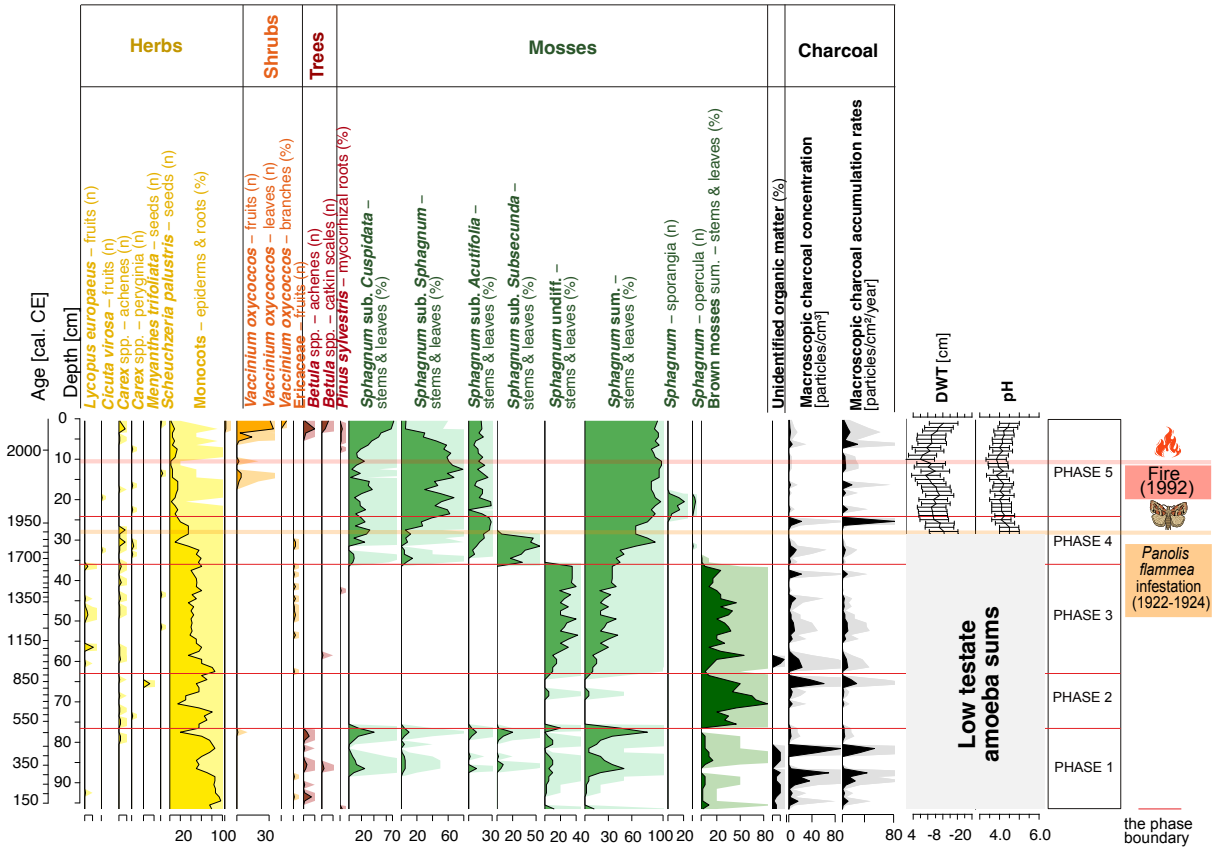
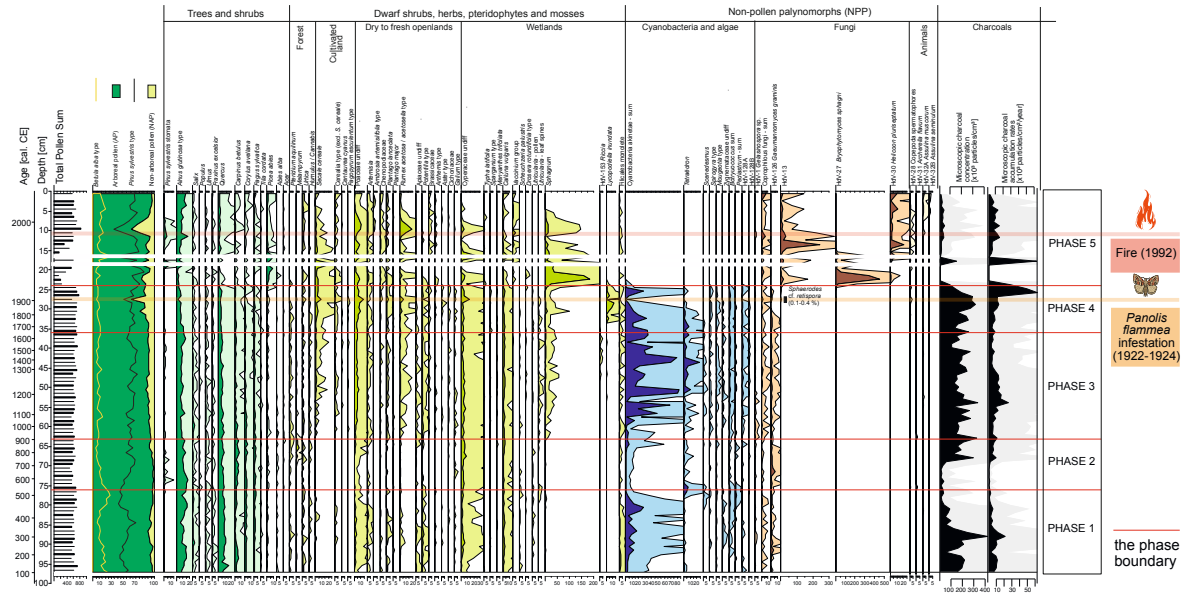
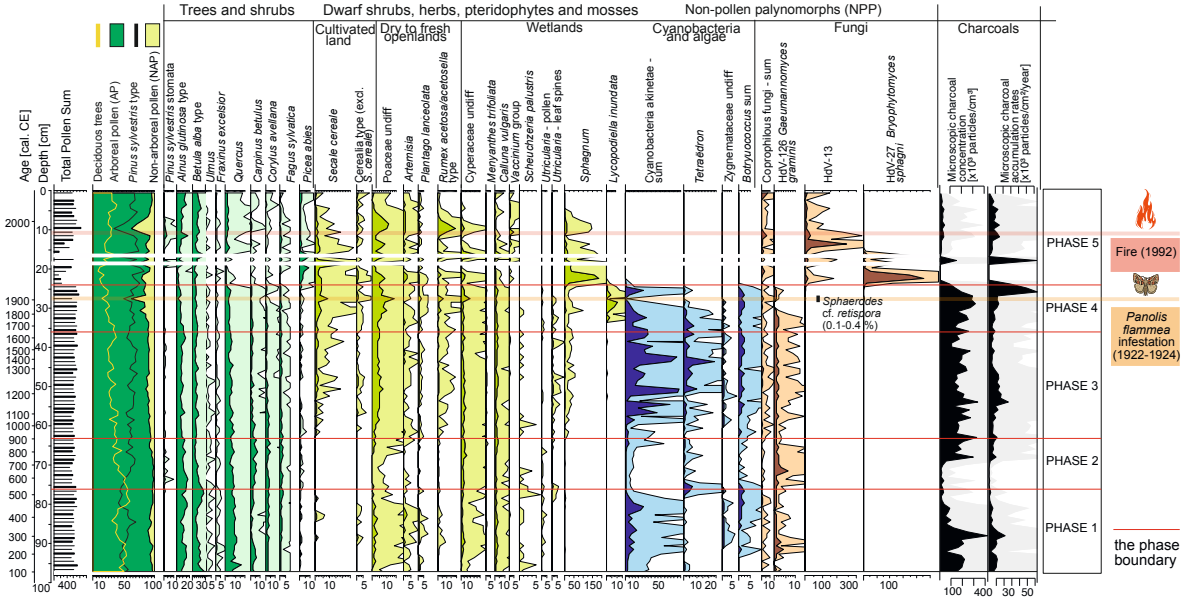


Figure 4

Before:



After:



My biggest comment on the results is on the statistical analysis. I am quite skeptical about how a line was fitted through the data points (Fig 5), as the PCA values seem quite stable between 1775 – 1920. Have you already tried to plot the rate of change?

Author's response: Thanks for the thoughtful comment. While the PrC scores appear relatively stable during the 18th into the early 19th centuries, there is a subtle but consistent increasing trend beginning around the late 16th century (also identified by the CONISS in the pollen diagram). This upward trend contrasts with the previous period which shows higher short-term variability, reflecting fluctuations in the relative abundance of NPPs at this time, mainly cyanobacteria. This increase in the PrC scores becomes more pronounced during the 19th century as this taxon disappear from the record.

This trend is more clearly captured in the asGAM fit, shown in Supplementary Figure A1. However, adaptive spline GAMs cannot yet incorporate a temporal correlation structure, making them unsuitable for this analysis. In contrast, the GAMM used here includes a

correlation structure that penalizes sharp deviations between temporal adjacent samples, resulting in a smoother fit that is better able to detect sustained directional changes over time and to distinguish underlying shifts from random noise. In this case, it appears the model includes the small but consistent increase around 1775 AD as statistically significant in terms of slope, even if this is not visually dramatic in the raw PrC values.

Importantly, the purpose of the PrC analysis is to identify periods of significantly rapid rates of change (lines 266-267|). The GAMM framework, following the approach of Burge et al., 2023, allows for the identification of directional shifts and when these begin to accumulate beyond the level expected from random variation (lines 267-269). This is included in the text (lines 271- 273) and we have added additional clarification where needed, including in the figure caption.

In the caption of Fig 3 it should be mentioned that DWT is calculated from the testate amoeba. And perhaps it should be mentioned again that the two largest recorded calamities are included again, like in Fig 2.

Author's response: We thank the reviewer for his suggestions to improve the caption of Figure 3. We agree that this additional information is needed.

Actions: We completed the caption with the information that the reconstruction of water levels and pH was carried out based on testate amoeba analysis. We also added information about the marked periods of the analyzed ecological disasters in Figure 3.

Before: *Figure 3. A diagram showing macrofossil percentages, macroscopic charcoal concentrations and influx as a local fire proxy. Depth-to-water table and pH curves for 27–0 cm layers are also presented. Ten times exaggeration is marked.*

After: *Figure 3. A diagram showing macrofossil percentages, macroscopic charcoal concentrations and influx as a local fire proxy. Testate amoeba-based depth-to-water table and pH curves for 27–0 cm layers are also presented. The timing of the most critical catastrophic disasters in the 20th century is also marked. Ten times exaggeration is presented.*

The second line in Fig 3, marking between zone 2 and zone 3, should be replaced with a thin one. It actually confused me.

Author's response: All lines marking the transitions between zones in Figure 3 are of equal thickness - 0.8 pt. The entire figure was prepared in a single graphics program. We have no idea why the thicknesses of the lines seem different to the reviewer.

Line 348: microscopic charcoal already starts to increase halfway the phase, it appears.

Author's response: I appreciate the reviewer's input on the consistency of the text with the figures. We agree that the comment is right.

Actions: We corrected the sentence, taking into account the differences between the first and second halves of the zone.

Before: *Through much of the phase 2, fire activity is low.*

After: *For the first half of phase 2, fire activity is low, but increases in the second half.*

Line 362: It is already clear from Fig 3 that you did not reconstruct DWT up until zone 4.

Author's response: We agree that the information is already known from Figure 3. On the other hand, we would like Figure 3 to be completely consistent with the text. We would also like the text to clearly indicate the reasons why we decided to hide the reconstruction of the water level up to zone 4 in Figure 3.

Line 367: this is not a result but rather a point of discussion, or conclusion.

Author's response: We thank the reviewer for his comment. We agree with the reviewer that the sentence was an interpretation or conclusion.

Actions: We removed the sentence from this section as the reviewer suggested.

Line 413 – 414: this is about zone 4 and not zone 5.

Author's response: We thank the reviewer for his comment and care about the logical structure of the text. We agree that there was an error in phase numbering.

Actions: We have corrected the numbering of the zones in the sentence.

Before: *G. discoides dominates for most of the phase 4, and the abundance of N. tincta increases towards its end.*

After: *G. discoides dominates for most of the phase 5, and the abundance of N. tincta increases towards its end.*

My suggestion is to move Table 2 to the supplementary materials, since values are already displayed in Fig 2.

We agree with the reviewer that the neodymium isotope values can be seen in Fig. 2. However, they refer only to peat samples, not to surface samples. The table containing the values of peat samples and surface samples allows the neodymium isotope signatures to be compiled in one place, and additionally allows the values to be compared between sample types. In our opinion, a better solution is to leave the table in the text.

Discussion

I'm missing a discussion about why the fluctuating values in the PCA don't appear to reflect any significant environmental changes. So what caused these fluctuations? Is the pattern unique for this record or was it found in other studies as well?

Author's response: Thank you for your thoughtful comments. We suspect there may be some confusion arising from the conflation of Principal Correspondance Analysis (PCA) and Principal Response Curves (PrC), the latter being the method used in this study. While both are ordination techniques used to summarise variation in multivariate datasets, they serve different purposes. PrCs explore temporal changes relative to a baseline or control- in this case, the first sample in the dataset. The differences in the PrC curves reflect how the pollen spectra deviate

over time from this point- based on shifts in the relative abundance of both pollen and non-pollen palynomorphs in the record.

The trend in the PrC aligns broadly with the patterns seen in the data, as shown by the correspondence between the PrC scores and the relative contributions of deciduous trees, arboreal pollen, *Pinus sylvestris* type and NPPs. While these fluctuations are driven by changes in the palynological record, the primary aim of the PrC was not to characterise these trends (as one might do using a PCA) but to track the rate of change over time by fitting a GAMM to the PrC axis against time.

The shifts in pollen and NPP are well discussed in the text, so to further clarify the distinction between PrC and other, more commonly used ordination methods, we have added a statement to line # stating that the PrC results trace changes in the relative abundance of pollen and NPP over time and have added further clarification of the purpose of the PrC in the methods section.

L 488: I'm sure the fitting of the complete function was statistically significant, but the portion 1775 – 1900 seems to be deviating from the data points.

Author's response: This issue is (somewhat) acknowledged and referenced in the main text (line 468 - 474, Supplementary Figure A1). In brief, although we tested different numbers for k, the flexibility of the model fit remained unchanged, constrained by the correlation structure used within the model, which is essential to account for temporal autocorrelation in the data (see Burge et al., 2023- and Simpson 2018).

As shown in Supplementary Figure A1, an adaptive spline GAM (asGAM) produced a better visual fit to the PrC scores. However, these cannot currently be used within the GAMM framework, which is required to specify correlation structures (See Simpson, 2018 and Burge et al., 2023). Our focus is on the slope of the fitted line- i.e. the rate of change, rather than the individual points. While the slope from the asGAM increases more sharply closer to the period associated with the infestation (so supports are argument better!), the selected model still captures the key shift, albeit earlier. Given current methodical limitations with using asGAMs in this framework, we opted for the more conservative estimate provided by the GAMM.

We have clarified the summary of the model performance in the results (lines 476-482), mirroring the above information.

L 500 – 501: those are quite lot of references just to mention that this is the first record that captures a much longer history of the Notec Forest.

Author's response: Thank you for this comment. However, we propose to leave all these citations as they highlight the lack of data from the Noteć Forest. All these references refer to a single site - the Rzecin bog. To date, no other work has been produced from other peatlands. We want to emphasize this, so we kept all these citations.

L 502 – 505: This sentence was quite confusing to me. Do you mean to say, that the analysis of your record allow for the reconstruction of not only the forest but also the peatland itself, and how it reacted to forestry practices?

Author's response: Thank you to the reviewer for the comment. Indeed, the sentence was constructed imprecisely and was unclear.

Actions: We rewrote the sentence to make it more logical.

Before: *The knowledge of the historical background is essential for the interpretation of the ecosystem response to forestry practices because it enables tracing not only the composition of the forest surrounding the peatland but also the peatlands' hydrological and trophic conditions (Bąk et al., 2024).*

After: *The knowledge of the historical background is essential for the interpretation of the complex response of the peatland ecosystem to a change in forest management, as it allows for the long-term tracing of reference conditions relating to both the composition of the forest and the trophic and hydrological variants of the peatland (Bąk et al., 2024).*

L 512: I think you meant replaced, rather than misplaced

Author's response: We thank the reviewer for his contribution to the grammatical correctness of the manuscript. However, we do not use the verb 'misplace' but 'displace', which is actually a synonym for the verb 'replace'. In the University of Cambridge's online dictionary, 'displace' means 'to replace something or someone'. So, we stayed with the version with the verb 'displace'.

L 530 – 532: You only investigated the last 2000 year of the forest.

Author's response: Yes, that is correct, here we reconstructed last 2000 years of environmental history of the site. We guess that what the reviewer is referring to here is that young glacial sediments are older than 2000 years and so the connection between neodymium data and our record may be weak. Neodymium isotopes are stable isotopes therefore they do not change their signatures through time. Thanks to that, by comparing Nd ratios obtained from the peat core and the soil in peatland's surrounding, we can define whether the mineral supply (and also recorded disturbances) was of local or extra-local origin.

L547 – 550: See my previous comments on Fig 5 and L 488.

Authors response: I guess see my previous response to previous comments. However, I would suggest changing the text here from critical transitions to 'periods of significantly rapid change' or words to that effect- because that is what the GAMM model shows. It's not necessarily wrong that they can reflect critical transitions, but the model doesn't specifically identify critical transitions like other methods can, e.g. TITAN it can detect non-critical transitions too if they are happen quickly enough!).

L633: Have you tried to isolate butterfly wing scales (Girona, 2018)?

Author's response: We thank the reviewer for his comment. Unfortunately, we did not use the method by Girona et al. (2018) to extract the wings of the insect.

Actions: We have added information to this section of the text that there are methods for extracting butterfly wings, but they were not the subject of our analysis. We have rewritten the text accordingly.

Before: *Unfortunately, they do not preserve well in the sediment (Bąk et al., 2024).*

After: *Unfortunately, they do not preserve well in the sediments (Bąk et al., 2024). However, we emphasize that we did not use advanced extraction methods the delicate structures of the butterfly wing remains (Montoro Girona et al., 2018), but only observation under light and stereoscopic microscopes when viewing the samples in the analyses used.*

L690: what are stable ecosystem links, exactly?

Author's response: Thank you to the reviewer for the comment. Indeed, the sentence was constructed imprecisely and was unclear. It is about simplified linkages in the food web, which result in less resilience of the ecosystem to various types of disturbances.

Actions: We corrected the sentence's meaning, clarifying what linkages we meant. We hope that after the correction, this part of the text is no longer in doubt.

Before: *Fire danger is also a result of the young age of the tree stands, which have not yet developed stable ecosystem links.*

After: *Fire danger is also a result of the young age of the tree stands, which have not yet developed stable ecosystem links in food webs.*

L703: are these bark beetle outbreaks? And this was not evident in your record?

Author's response: Thanks to the reviewer for the comment. We would like to remind you that we are describing the *Panolis flammea* outbreak, not the bark beetle outbreak. After the *Panolis flammea* outbreak in 1922-1924, the Noteć Forest was affected by many other insect outbreaks. However, they were smaller, less severe and involved different locations of the Forest. They did not occur near the study site. So, it is difficult to get a clear signal of these events.

Action: We have rewritten the text, adding information about later known pest outbreaks. We also explained why the record of these other outbreaks is invisible in our data.

Before: *In the 1970s, Hernik (1979) and Ratajszczak (1979) signalled that the tree stands of the Noteć Forest were weakened by repeated insect outbreaks.*

After: *In the 1970s, Hernik (1979) and Ratajszczak (1979) signalled that the tree stands of the Noteć Forest were weakened by repeated insect outbreaks (Panolis flammea: 1956; Lymantria monacha: 1947, 1964; Barbitistes constrictus: 1964; Diprion pini: 1961; Bupalus piniarius, 1966; Dendrolimus pini: 1970). Compared to the 1922-1924 Panolis flammea outbreak, however, they were smaller, less severe, and covered different locations of the Noteć Forest, rather than a larger area.*

L725: It could also have played a role that Mialy is situated next to a railroad and your study site was surrounded by trees.

Author's response: Thank you for the reviewer's comment. We clarify that the fire started near the railroad north of the village of Miały (Fig. 6). It spread very quickly in the eastern direction, destroying a dense forest complex. The fire also directly reached our site located in this dense forest complex, as we show in Fig. 6. It seems that the location of the research site, a few kilometers from the railroad, is of little importance for these considerations, since the fire directly

Action: We have modified and improved the text of this paragraph. Previously, the description might have raised doubts about whether the fire reached the studied peatland or not. We hope that the description is now clear and logical.

Before: *[…] these values do not reflect the actual scale of the forest destruction, especially since the fire took place near the peatland (Fig. 5). A smaller-than-expected signal from the 1992 fire in charcoal analysis was also obtained by Barabach (2014) in the nearby Rzecin peatland. The small amount of macroscopic charcoal may be explained by the fact that the more intense the fire, the smaller the charcoal particles it produces (Schaefer, 1973). Additionally, before the particles are deposited, their dispersion by wind and water plays an important role (Patterson et al., 1987). By the time the fire reached the peatland, heavy rain had fallen, reaching a value of 31.5 mm (Institute of Meteorology and Water Management, 2025). This rain stopped the smoke from spreading further away, however, it reached the Miały peatland (Fig. 6).*

After: *[…] these values do not reflect the actual scale of the forest destruction, especially since the fire also took place on the peatland (Fig. 6). A smaller-than-expected signal from the 1992 fire in charcoal analysis was also obtained by Barabach (2014) in the nearby Rzecin peatland. The small amount of macroscopic charcoal may be explained by the fact that the more intense the fire, the smaller the charcoal particles it produces (Schaefer, 1973). Additionally, before the particles are deposited, their dispersion by wind and water plays an important role (Patterson et al., 1987). Shortly after the fire reached the peatland, heavy rain had fallen, reaching a value of 31.5 mm (Institute of Meteorology and Water Management, 2025). This rain stopped the fire from spreading further away and significantly limited the movement of charcoal by the wind.*

L756: How is slow tree growth affecting forest fires?

Author's response: We would like to thank the reviewer for his comment. We realize that this section of the text may have been questionable. The idea was that frequent fires in May are a consequence of the lack of rainfall in May. In another study, we observed that the growth of pine annual rings from another monoculture complex in Poland showed a negative correlation with the amount of precipitation in May. This observation strengthens the message about the high number of fires in May resulting from the drought in that month.

Action: We have rewritten this section of the text so that it is more logical and not questionable.

Before: *Forest fires in Poland were, therefore, frequent but covered small areas (0.4 ha/fire on average). Most fires in Poland occurred in May (more than 25%). This pattern is vital when compared with dendroclimatic data. A recent study from the pine-dominated Tuchola Forest in Poland revealed a negative correlation between Scots pine growth and rainfall in May (Bąk et al., 2024). A water deficit in May carries, therefore, many dangerous consequences.*

After: *Therefore, forest fires in Poland were-frequent but covered small areas (0.4 ha/fire on average). Most of the fires in Poland occurred in May (more than 25%), a significant percentage of which were drought-induced. A recent study from the pine-dominated Tuchola Forest in Poland revealed a negative correlation between Scots pine growth and rainfall in May (Bąk et al., 2024), which indeed indicates a water deficit in that month.*