

## ***Interactive comment on “The impact of land-use change on floristic diversity at regional scale in southern Sweden 600 BC–AD 2008” by D. Fredh et al.***

**D. Fredh et al.**

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-We thank the Referee for valuable comments and suggestions on our manuscript. We will adopt most of the suggested changes. The comments are answered point-by-point below.

The study's main aim is to quantify properties of a palaeoecological record of land-use change in order to test the widely held view, largely based on modern observations, that in the past traditional land-use mosaics of NW Europe fostered relatively high levels of diversity compared with those of today. In the record, changes in taxonomic richness and evenness are linked to changes in landscape openness, which themselves likely

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reflect the amount of land under some kind of agricultural management.

As an exploratory study the work has merit as it provides tentative confirmation that the projection of modern observations to past landscapes is likely correct, and this supports the strand of contemporary land management aimed at maintaining or increasing areas under traditional use as a conservation tool.

For the most part the paper is clear, but the discussion is somewhat weak and disjointed and could do with some revision. Below I list comments related to page and line numbers. These are of two kinds: first substantive comments requiring responses and then small points aimed at improving the writing and the clarity.

#### Substantive comments

19086/21 unclear what the word “distribution” means here (and in some other places in the paper). The word normally refers to patterns, for example of a species in relation to soil properties or other environmental variables, or of elements of a mosaic (clumped, fragmented). But I suspect that is not what is meant here.

-We will change ‘distribution’ to ‘relative abundance’ throughout the paper.

19088/13 Important to explain why evenness is ecologically significant/important

-We will add a sentence explaining why evenness is ecologically important.

19089/1 et seq. There is an underlying assumption here that the changes are driven by land-use. However, within the past 2000 years there have been some significant climate changes, and these have been related to expansions and contractions in upland agriculture. It is important to justify why you are sure you are looking at the impacts of land-use change. This might include a brief description of the known patterns of climate change over the study period and also something about how much of a role is played by the elevation of these quite high-latitude, but relatively low, “uplands” in terms of limiting plant growth, particularly that of agricultural crops. (link to your comments in the next paragraph)

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-We are aware that climate changes may also play a role but consider them subordinate to land-use changes. However, we will add some text justifying this assumption.

19096/22 justify assumption about *Juniperus* and *Corylus* for readers. If woodlands were open or being managed for wood, *Corylus* could be flowering in woodlands (see below also)

-We will add a sentence justifying this assumption.

19096/23 OK so they are bulk dates, but they show that the sediment has accumulated coherently, which is more than can be said of the AMS dates. While there is strong pressure to use AMS as best practice, if suitable macrofossils are not available, dates on bulk sediment should not be discounted. As far as I can tell by lining up the calibrated mid-points of the bulk dates they fit your chosen age model very well. It may be worth slowing them on the diagram. They are actually rather reassuring, as the AMS dates are all over the place.

-The bulk dates are shown in the diagram (green), specified in the figure caption. But yes, the bulk dates indicate that the sediment has accumulated coherently, which gives confidence that the sediments have not been subject to major mixing or disturbance (see section 4.1). However, when comparing the bulk dates to our preferred age-depth model, they appear 200 to 400 years older, which suggests the bulk dates are effected by a lake reservoir age. The bulk dates were therefore not included in our age-depth model, but are shown in the diagram.

19097/10 Is it not also the case the Cs is rather mobile and tends to penetrate down-core?

-Yes, that is probably the reason why the Cs cannot be used to support the chronology. We will add a complementary explanation.

19099/19 An assumption about land use and pollen production underlies the arguments in this paper, namely that tree pollen values diminish if land is cleared. However,

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certain kinds of woodland management also change tree pollen values, particularly for species that are coppiced or pollarded. It might be useful to address this in relevant places in the discussion of your results. See Waller M, MJ Grant and J Bunting (2012) Modern pollen studies from coppiced woodlands and their implications for the detection of woodland management in Holocene pollen records. *Review of Palaeobotany and Palynology* 187 11–28

-Yes, it is true that certain kinds of woodland management change tree pollen values, such as coppiced and pollarded trees. This will be mentioned in the discussion section.

19100/9 et seq The increase of *Picea* and *Fagus* at the expense of other late successional trees has been noted elsewhere, yet this is not discussed later here. Do you think it is significant and does it match with other records?

-Yes, it matches quite well with other records, although it is difficult to compare our REVEALS-based reconstruction with pollen percentage data from lakes with different sizes representing different pollen source areas. We will add one sentence in the discussion section comparing the increase of *Picea* and *Fagus* at AD 1000 with previous pollen records from the region.

19101/15 This paragraph (beginning /15) is a little hard to follow. “Many plants” is a vague term. Is this about just more SPECIES in a uniform landscape or are you actually recording a more complex mosaic of land cover that then allows more species overall to be present in the sampled area?

-In this paragraph we discuss the inferred expansion period at AD 350 to 550. During this period the palynological richness increase which indicates more species in the area. Equally important, also evenness for both trees and herbs increase, which indicates that all 26 taxa reconstructed by the REVEALS model are represented by more similar spatial coverage compared to other periods. This is rather complex and we will rephrase this paragraph to make it clearer.

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19102/8 Can you be a bit more precise about how this “migration period” might have been manifested in Southern Sweden, particularly in the study area?

-Yes, we will add some information how the ‘migration period’ might have been manifested in southern Sweden.

/13 “discontinuous management” – as far as I can tell, there is no previous mention of this idea. What is it, exactly? It seems as if it should occur over a period not at a specific date.

-Discontinuous management is when areas are repeatedly abandoned, with periods of intense cultivation, grazing or mowing in between. This may occur on many different temporal and spatial scales, and may allow succession of species and areas to be overgrown, which have been suggested to be an important component to favour biodiversity. We will add a short explanation of ‘discontinuous management’.

/17 "domination of tree plantations and crop cultivation". Change to dominance. But also it is rather hard to imagine how the landscape mosaic changes. What is included in small-scale agriculture – does this include extensive or only intensive land-use, for example? Or is it only a few farms in a landscape? And what kind of "tree plantations" are likely in AD 550? Orchards? Coppice? Plantations is an odd concept here – is there historical evidence for this? Or do you actually just mean reversion to high forest?

-Small-scaled agriculture includes mainly crop cultivation, mowing and animal husbandry, which may be both intensive and extensive. The tree plantation is referring to the transition to modern agriculture ca. 100 years ago when forestry was introduced. This paragraph compares the inferred agricultural land-use change AD 350-550 with the transition to modern land-use AD 1880-1940. We will change ‘domination’ to ‘dominance’. We will also rephrase this paragraph for clarification.

19103/9 Do you think the fact that Cerealia affect the value strongly means the rich-

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ness is based on rather few herb taxa, and is this something that should be discussed further?

-Palynological richness is based on 17 trees, 66 herbs and 9 ferns, i.e. not much affected by changes in single taxa. However, evenness is only based on 14 trees and 12 herbs, and the value is strongly affected if one or a few taxa dominate the cover. During the last few hundred years (sentence 19103/8) Cerealia covers relatively large areas, and therefore strongly affect the evenness calculation for herbs. In other periods, Poaceae dominates, and affect the evenness values strongly. But this is the nature of evenness calculations in general. In the method section it is clearly stated that evenness calculations are based on the 26 taxa reconstructed by the REVEALS model. These taxa represent about 70-90% of the total vegetation cover in the area today, i.e. most of the taxa relevant for evenness calculations are included. We think this is described enough in the paper.

/20, I would be inclined to put this discussion of the dating at the beginning of your discussion section. After all, the way you deal with the dating problems defines the chronology and when you interpret changes to have taken place.

-Yes, we will move some of the discussion of the dating to the beginning of the section.

19104/19 et seq. This paragraph is a bit hard to follow. How much difference in biomass produced in a year is there if a hay crop is taken before flowering (and it then grows back) versus the meadow is left to flower? I am not sure biomass is particularly relevant here. This is more about if the meadows are allowed to flower. Perhaps this is what you are saying?

-In this paragraph we are discussing if the observed increase in herbs represent an increase in coverage or an increase in representation due to increased flowering. Increased flowering may be due to that meadows and pastures were left to overgrow, and during the succession the herbs could increase its biomass during the first stage. So this paragraph does not discuss when the meadows are cut during the year, but what

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happens during transition to a new land-use type. This paragraph will be rephrased to make this clearer.

19105/11 et seq – the remainder of this paragraph rather repeats information discussed before. Not clear what you are saying here that is new. Omit?

-In this paragraph we are high-lighting important results and discuss these in a different context. However, some of this information is repeats. We will remove some of this information and some will be moved to the final paragraph where it will be discussed more in relation to ecosystem management.

/21 this last paragraph is a little weak as a concluding statement. Perhaps you can think a bit more about how this informs contemporary management and expand and clarify this last paragraph. See below.

-This paragraph will be expanded to include how our results inform contemporary management. We will also move some information here from the previous paragraph.

Overall, I am not excited by the conclusions, which basically reiterate the findings and thus parallel the abstract. I wonder if a different slant can be found for this. Perhaps looking to how this approach can be refined, or tested elsewhere, and how particularly it might help management.

-The conclusions are formatted so the main message is included and you can read it without reading the discussion. At this stage, we prefer to keep the conclusions in its current form.

Minor technical comments and corrections

General writing point, you use the words “cover” and “coverage” apparently interchangeably. I can see no advantage to “coverage”, which is longer and more unusual and tends to be used in a slightly different context (like news broadcasts). I suggest a universal replace to “cover”

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-We will replace 'coverage' with 'cover' throughout the text.

19086/17 REVEALS-based ??? what?

-We will change 'REVEALS-based' to 'REVEALS-based evenness'

19087/13 Sentence about steppe plants unclear. What do you really mean here? The species have adaptation to disturbance and stress caused by factors such as wind and drought, and these are similar to the conditions in cultivated fields.

-This sentence will be rephrased.

/19 based more on crop cultivation – more than? need to understand what this is being compared with.

-This sentence will be rephrased.

19088/1 from lake or mire sediments?

-We will add 'lake or mire' for clarification.

/3 use "among" rather than "between"

-Rephrased.

5/ Moreover, it now makes it possible. . .

-Rephrased.

/7 ..two parameters: richness and evenness

-Rephrased.

/12 The aims are as follows:

-Rephrased.

19089/8 The bedrock is mainly crystalline granite and gneiss, . . .

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9, C9044–C9055, 2013

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-Rephrased.

/17 “largely” or “mostly” fit better than “usually” . . . . . and were therefore colonized. . .

-Rephrased.

19091/26 explain why you excluded samples or refer reader to place in text where this I explained.

-We will refer to place in the text where this is explained.

19092/5 Say why lead pollution dating also used – as an independent check on other dating?

-We will add a short description why lead pollution dating was used.

/11.and in some cases other markers are also observable.

-Rephrased.

/16 medieval times have a typical. . . . .

-Rephrased.

19093/5 ..we had to be selective in the use of. . . . .

-Rephrased.

19095/12 unclear what “relative abundance between the taxa” means – needs a bit more explanation

-In the introduction we have explained evenness as: ‘High evenness describes situations when all species within an area are represented by similar spatial coverage, whereas low evenness characterizes landscapes where a few species cover large areas and other species cover small areas.’ Evenness is also explained further down in this section. We think these explanations are enough.

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19096/table 2 and fig 2. I suggest that either you add an AD-BC column in the table or change the time axis on the graphs to BP. At the moment it is confusing.

-We will add an AD/BC column in the table.

/27 Fig 4 caption – what does “excluding bushes” refer to? Do you mean shrubs? Does this include Juniperus and Corylus? Needs clarifying.

-Rephrased.

/25 The quantification of taxa coverage related to human impact – is it the taxa or the cover – or both – that is related to human impact? Please clarify.

-Rephrased.

19098/10 Figure 3 – I find this figure hard to read. I should prefer two axis facing right with the uncorrected and corrected values, or failing that, a much clearer divider between the left- and right-facing curves.

-If possible, we will add a clearer divider between the left- and right-facing curves.

19101/4 Fyfe et al?

-Yes, will be corrected.

/8 agriculture

-Rephrased.

/9 “equal distribution” – see previous comment, not clear – needs further development or re-wording.

-This sentence will be rephrased.

/19 trees

-Rephrased.

19102/2 “the vegetation” to expand does not make sense, clarify what is meant here

-Rephrased.

/3 You say that this type of land use change is not good for herbs. How do you know this? You need to explain that the change in richness was driven by herb taxa disappearing from the record.

-Rephrased.

/23 REVEALS-based ?

-We will change ‘REVEALS-based’ to ‘REVEALS-based evenness’.

/19 Is Calluna a herb?

-Calluna is a low-growing shrub, but we have included Calluna in ‘other herbs’, which indicate open land. We will rephrase the text to make this clearer.

19103/7 agriculture

-Rephrased.

/23 clarify this in “this study” and

-Rephrased.

/26 clarify “this is not obvious”.

-Rephrased.

19105/3 We have been long aware. . .

-Rephrased.

19106/ move sentence “We identified. . .” to before the preceding sentence – makes better temporal sense.

-We will move sentence.

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/13 Not sure why this is a contrast. The pattern is actually the same except the process is reversed?

-Rephrased.

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Interactive comment on Biogeosciences Discuss., 9, 19085, 2012.

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