# Reply to Anonymous Referee #1 for "A Synthesis of *Sphagnum* Litterbag Experiments: Initial Leaching Losses Bias Decomposition Rate Estimates"

Henning Teickner[1,2,*] Edzer Pebesma[2] Klaus-Holger Knorr[1]

18 September, 2024

[1] ILÖK, Ecohydrology & Biogeochemistry Group, Institute of Landscape Ecology, University of Münster, 48149, Germany
[2] IfGI, Spatiotemporal Modelling Lab, Institute for Geoinformatics, University of Münster, 48149, Germany

[*] Correspondence: Henning Teickner <henning.teickner@uni-muenster.de>

Comments made by the reviewer start with a bold **Q** while our reply starts with a bold **A**. In section "Additional changes" we list additional changes we would like to incorporate in an updated version of the manuscript.

## 1 Reply to comments

1. **Q:** The manuscript points out additional and valuable information about the influence of leaching losses on decomposition modeling, as they can lead to notable errors over longer periods of time. From my point of view, the results from the topic under investigation underline the importance of additional research in that field. Therefore, after carefully revising the manuscript and clearing some open questions (see further comments), I believe that the manuscript has potential to be published.

   [… (see point number 2 below)]

   The authors have used enough related and up-to-date works. Together with more settled works, the authors give a nice synthesis of different litterbag studies and sum up some important obstacles. However, the paragraphs are sometimes disjointed, which can make reading difficult. Also, the wording needs to be revised in some cases to be more precise. In addition, typing errors should be corrected throughout the manuscript. The number of figures and tables is ok, the layout or graphic design could be improved.

   From my point of view, the present manuscript does not fulfil all requirements for

being published. A precise revision, especially of the abstract, the introduction section and the discussion is needed (see comments below). After addressing these points, the manuscript has potential to be published.

**A:** We thank the reviewer for their comments and questions that are useful to clarify some points we make in the manuscript. In summary, the reviewer suggests the following general changes:

1. More and restructured information on the motivation for the study.
2. Extension of the discussion with explicit information how to improve litterbag studies, especially what variables to measure to get more accurate (initial) decomposition rate estimates.
3. More precise wording.
4. Improved graphic layout and design.

In general, we made the following changes to address these suggestions:

1. We addressed the related specific comments by the reviewer (see below).
2. We addressed the related specific comments by the reviewer (see below). Summarized, the aim of our manuscript is to analyze the bias in estimated mass losses due to decomposition and decomposition rates caused by ignoring initial leaching losses and to improve litterbag experiments by reducing this bias. Our analyses suggest many conceptual knowledge gaps and we see our contribution in highlighting these conceptual gaps to stimulate future experiments that analyze how important possible confounders are. To name the most important, the next experimental steps are in our opinion (1) to define sample preprocessing conditions that are considered natural, (2) to analyze how commonly applied preprocessing steps cause different initial leaching and potentially different decomposition pathways, and (3) to develop litter preprocessing methods that are similar to natural conditions and allow accurate measurement of initial dry masses. The results of these conceptual experiments give the information required to give explicit recommendations for how to improve litterbag experiments. While we state what our results imply or suggest, we refrain from more explicit recommendations because we think that these can be made only based on the suggested conceptual experiments.
   However, we agree that we could more explicitly describe the conceptual experiments we think are necessary to develop more specific guidelines for *Sphagnum* litterbag experiments. We note that the second reviewer also suggests to expand the discussion on how to improve litterbag experiments, but more in line with our aim to point to conceptual knowledge gaps and conceptual strategies to best measure decomposition rates (Kohl, 2024). We tried to incorporate the suggestions by both reviewers by expanding the discussion (please see our suggested changes to the discussion in our reply to comment 15 by reviewer 1). If the reviewer has further suggestions or we misunderstood the suggestion, we would be thankful for further clarification.

3. We addressed the related specific comments by the reviewer (see below).

4. Unfortunately, the reviewer does not provide specific comments what could be improved in the layout or design of the figures. If the reviewer has specific comments, we are happy to consider them.

2. **Q:** The abstract section gives some background information, but the problem statement is missing. The reason why the study has been conducted should be mentioned or further elaborated to underline the importance of the present study. More background information would be necessary to understand what initial leaching is. Generally, I am a fan of short abstracts, but I would suggest including more information in the Intro and Results part of the abstract. This would increase the readers interest to read further.

   **A:** We suggest to expand the first paragraph of the abstract (ll. 1 to 4) with reasons why ignoring initial leaching losses may cause bias and larger variance of $k_0$ estimates, and why this bias and variance are important for understanding controls of decomposition and long-term peat accumulation:

   "Our knowledge of the magnitude and controls of *Sphagnum* decomposition rates is derived to a large extent from litterbag experiments that do not explicitly consider initial leaching losses. Previous research on vascular plants suggests that decomposition rate ($k_0$) estimates from litterbag experiments are biased when initial leaching losses ($l_0$) are ignored. In contrast, magnitudes and variability of $l_0$ for *Sphagnum* litterbag experiments are not well known and therefore also not the effect on *Sphagnum* $k_0$ estimates. As *Sphagnum* is the main peat forming species in many northern peatlands and as biases in $k_0$ estimates can propagate and amplify in long-term peatland models, minimizing such bias is necessary for accurate predictions of peat accumulation."

3. **Q:** L5: In the first part of the sentence, you argue that you want to test if there is a bias in k0 due to l0, while in the second part of the sentence you already argue that they do so – as your aim is to quantify error estimates.

   **A:** A bias is the expected difference between an estimate for a quantity and the true value of the quantity, i.e., the average error in many hypothetical repetitions. In contrast, errors in estimates refers to a difference between an estimate for a quantity and the true value of the quantity (see for example Hastie et al. (2009)). Also note that the first part of the sentence refers to us estimating the bias (using simulated data with different amounts of initial leaching losses and a model that ignores initial leaching losses), whereas the second part refers to our analysis how initial leaching losses *increase* the variance of $k_0$ estimates in a model that considers initial leaching losses. Thus, both parts of the sentence in l. 5 refer to different properties of an estimate and to different analyses within our study. However, we agree that the sentence currently is ambiguous and we suggest to change it to:

   "We present a meta-analysis of 15 *Sphagnum* litterbag studies to estimate initial leaching losses ($l_0$), to analyze how much *Sphagnum* $k_0$ estimates are biased when the decomposition model ignores initial leaching losses, and to analyze how much the variance of $k_0$ estimates of $k_0$ estimates increases due to initial leaching losses even when they are estimated by the decomposition model."

4. **Q:** L20: the sentence is not clear to me

   **A:** The sentence is: "Our knowledge of the magnitude and controls of decomposition rates is derived to a large extent from litterbag experiments (Rydin et al., 2013) and these estimates inform parameters in long-term peatland models (e.g. Frolking et al. (2010))." We assume the reviewer refers to the second part, "and these estimates inform parameters in long-term peatland models (e.g. Frolking et al. (2010))." Perhaps the term "inform" causes the confusion here (if the reviewer can confirm this, this would be helpful).
   We suggest to change this sentence to: "Our knowledge of the magnitude and controls of decomposition rates is derived to a large extent from litterbag experiments (Rydin et al., 2013) and these estimates are used as parameter values in long-term peatland models (e.g. Frolking et al. (2010))."

5. **Q:** L27: the sentence is not clear to me

   **A:** We assume the reviewer refers to the sentence starting in l. 27. This sentence is: "Finally, decomposition rate estimates are used to define parameter values in peatland models which are a major tool to analyze peat accumulation and process interactions during time ranges exceeding the duration of litterbag experiments."

   We are not sure what could be unclear here and it would be helpful if the reviewer could describe in more detail what is unclear here. As a first try, we suggest to reword the sentence to: "These decomposition rate estimates are used as parameter values in long-term peatland models which allow to analyze peat accumulation and interactions of decomposition with other processes controlling peat accumulation for time ranges exceeding the duration of litterbag experiments."

6. **Q:** L36: "in reality…" delete

   **A:** We will delete "in reality" in l. 36.

7. **Q:** L 41:" and came to the conclusion" concluded that…

   **A:** Thank you for this suggestion, we will change this sentence as suggested.

8. **Q:** L65: leach

   **A:** We will change "leach" to "leaching".

9. **Q:** L65: it is unclear which plants will be investigated. Do you focus on Sphagnum species or include others? Especially as you mention other, also vascular plants and lichens afterwards (L 75ff)

   **A:** We suggest to change l. 65 to from "What is the magnitude of initial leaching losses in and their variability between species and studies?" to "What is the magnitude of initial leaching losses in *Sphagnum* litterbag experiments and their variability between species and studies?" to explicitly state that we analyze only *Sphagnum* litterbag experiments.

10. **Q:** L69: again, litterbag experiments in general or Sphagnum litter only?

**A:** We suggest to change the beginning of the sentence in l. 69 from "To address these questions, we first simulate litterbag experiments" to: "To address these questions, we first simulate *Sphagnum* litterbag experiments" to explicitly state that we analyze only *Sphagnum* litterbag experiments.

11. **Q:** L147: why only 15% not 18% as mentioned above?

    **A:** There was no special reason to use 15 mass-% as upper bound for the simulation other than that this value is near the largest estimate for initial leaching losses that can be directly derived from previous studies. The conclusions of our simulation will not change if we also include an initial leaching loss of 18 mass-% or larger because already for an initial leaching loss of 15 mass-% the difference in estimated vs true decomposition rates was largest and also the difference in remaining mass of peat accumulated up to a certain time (see Fig. 4). That said, we understand the desire to use consistent value ranges throughout the manuscript and therefore suggest to also include an initial leaching loss of 18 mass-% in the simulation. An updated version of Fig. 4 in the manuscript is shown in Fig. 1.

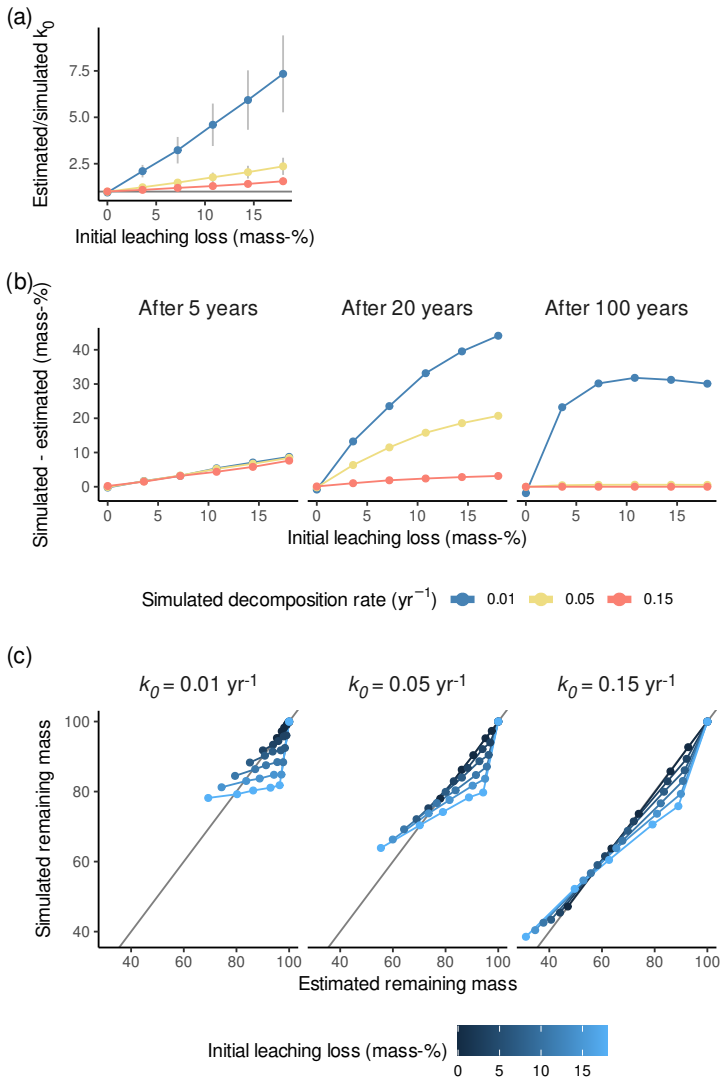


Figure 1: Results of the simulation experiment. (a) Estimated divided by simulated decomposition rates ($k_0$) versus simulated initial leaching losses ($l_0$) for the three simulated decomposition rates. Error bars are standard errors. The horizontal grey line represents a ratio of estimated to simulated decomposition rates of 1. (b) Remaining masses predicted by the model ignoring initial leaching losses minus the simulated remaining masses (considering different amounts of initial leaching losses), either after 5, 20, or 100 years of decomposition. Positive values mean that with $k_0$ estimated while ignoring initial leaching losses remaining masses are underestimated. (c) Simulated remaining masses versus remaining masses predicted by the model ignoring initial leaching losses for the three simulated decomposition rates and the simulated litterbag retrieval times.

12. **Q:** L154f: check typos

    **A:** We suggest to change the paragraph starting in l. 154 from "These simulated masses were then used to fit the model ignoring initial leach loss (equation (2)) using nonlinear

least squares regression regression to obtain estimated average and standard deviation for $k_0$, as is often done in litterbag experiments. We compared these values to the decomposition rate values that were used to simulate the data." to "These simulated masses were then used to fit the model ignoring initial leaching losses (equation (2)) using non-linear least squares regression to estimate the average and standard deviation for $k_0$, as is often done in litterbag experiments. We compared these values to the decomposition rate values that were used to simulate the data." to correct the typos.

13. **Q:** Figure 4 (a): what does the grey horizontal line indicate?

    **A:** We thank the reviewer for pointing this out. The horizontal grey line represents a ratio of estimated to simulated decomposition rates of 1 and alignment of the computed ratios with this line indicates unbiased estimates for $k_0$. We suggest to update the caption of Fig. 4 (a) in the manuscript as shown for Fig. 1 in our reply here.

14. **Q:** L355: "for several hours", what was the time span? Within 48h? or less?

    **A:** The comment refers to the sentence (l. 353 to 356): "Castells et al. (2005) used fresh *Sphagnum* plants in their study where they quantified only small initial leaching losses. Bartsch and Moore (1985) air-dried their samples for only 24 to 48 h, Schipperges and Rydin (1998) (Fig. 2 and 3) have shown that *Sphagna* can survive drying for several hours if the water content does not decrease too much. Therefore, the *Sphagnum* plants may have not been completely dead which reduces initial leaching losses".

    In Schipperges and Rydin (1998), it is stated that "There was no recovery of net photosynthesis by any of the species when rewetting followed complete desiccation, after either 2 or 4 d of dry storage" and "When the mosses were dried only until they reached their compensation water content (Expt 1a) there was some recovery of *S. magellanicum* and *S. cuspidatum* (see e.g. *S. cuspidatum*, Fig. 3)." According to Fig. 3 in Schipperges and Rydin (1998), the described rewatering occurred after about 9 to 12 hours. Thus, the *Sphagnum* plants died in the experiments in Schipperges and Rydin (1998) within a time range of about 12 hours to 2 to 4 days.

    We decided not to give a specific time range because the time without water supply is only one control of the water loss that presumably leads to the plants dying. Controls of the evapotranspiration rate (e.g. temperature, advection of air, geometry of the sample etc.) and the size of *Sphagnum* fragments thus will have an important influence on the water loss and absolute water stock of a *Sphagnum* fragment at a specific time. Thus, differences in drying times can be easily explained away by differences in drying conditions and *Sphagnum* fragment size at the moment. As indicated in the manuscript, more research is needed to support our hypothesis that initial leaching losses from dried-to-death *Sphagnum* fragments are larger than initial leaching losses from dried-but-living *Sphagnum* fragments and this requires more research on how water content controls when *Sphagnum* fragments die.

15. **Q:** L442ff: the aim is to improve litterbag experiments in the field, and you point out that the collection of litterbags shortly after the start of the experiment is necessary. Could you also give a suggestion which parameters should be measured to

describe initial decomposition rates? Could that also help to make future studies more comparable?

**A:** We assume that the reviewer defines "initial decomposition rates" in line with our definitions for decomposition (as depolymerization and possibly mineralization of litter material) and the time range considered as initial (i.e., up to three weeks, see l. 33). Thus, we assume the reviewer asks what variables to measure to accurately estimate depolymerization rates during the first days to approximately three weeks and whether accurate estimates of such initial decomposition rates could make future studies more comparable.

We think that an affirmative answer to this question has as necessary condition that litter preprocessing and litterbag experiments itself can be standardized such that initial leaching can be accurately measured, and it also depends on how large initial leaching losses are during litterbag experiments. If initial leaching losses are large, say larger than 5 mass-%, we currently assume that the mass loss due to depolymerization during the first three weeks would be negligible. This would make separation of initial leaching losses from decomposition easy in practice since the error one makes in assuming all initial mass loss are leaching losses would be small. It would also indicate that measuring initial decomposition would not make future studies more comparable because of the difficulty to accurately measure the small mass fluxes identifiable as losses due to depolymerization. If initial leaching losses are small, it would not any more be a small error to assume all initial mass losses are initial leaching losses, but we still assume that depolymerization losses are so small that they are hard to quantify and we currently do not think that this would help to make litterbag experiments comparable. If initial mass fluxes from both processes are not negligible, this would require to differentiate mass losses from both processes which would require more sophisticated strategies than simple litterbag experiments, for example using stable isotope labels, as brought up by Lukas Kohl in his review (Kohl, 2024), or addition of antibiotics to suppress enzymatically catalyzed depolymerization (e.g., Coulson and Butterfield (1978)).

We suggest that the first step in future research on this topic should be to check that litterbag experiments are representative for the sample preprocessing and decomposition process under natural conditions (see section 4.2 in our manuscript) because we assume that in most cases decomposition rate estimates are useful only when they are representative for the decomposition process under natural conditions. To this end, one has to define what usually happens to *Sphagnum*, i.e., what the natural conditions are, during the transition from a living plant to litter that gets decomposed, and how sample preprocessing steps in litterbag experiments differ from that. In addition, one has to estimate how sample preprocessing steps — in particular the drying — control enzymatic activities and microbial growth in litter samples. If any of these differs in an ecologically relevant magnitude this would imply that at least some preprocessing steps make litterbag experiments unrepresentative for decomposition under natural conditions. The aim should be to adjust preprocessing steps such that the process measured is representative for decomposition under natural conditions and it

is nevertheless possible to accurately estimate initial dry masses.

If initial leaching losses (as defined in our study) are negligible under these conditions (as e.g. suggested by Coulson and Butterfield (1978)), initial decomposition rates could be directly measured. As mentioned above, we assume that the initial time period is too short to expect that the presumably small mass differences can be accurately quantified by measuring mass differences of litter bags because import of material from the matrix probably is a large error source. However, one could use stable isotope labeled litter and use gas flux and pore water measurements to estimate initial decomposition rates under these conditions, as mentioned above.

If initial leaching losses are not negligible under natural conditions, the next step would be to develop a model that accurately describes the controls of initial leaching losses and thus also the magnitudes of initial leaching losses. Here, experiments similar to those described in Lind et al. (2022) may be useful, as well as stable isotope labelling experiments.

We note that this is only a very rough outline and we do not attempt to provide a full plan for how to design litterbag experiments, simply because there are many open questions and uncertainties. A step-wise approach with adaptions as new information becomes available is required.

Our suggestions to improve litterbag experiments are therefore mainly of conceptual nature: We point out what experiments would be required to check that decomposition rate estimates align with the natural decomposition process, what experiments would likely show important differences in sample pre-treatment on initial leaching, and that litterbag experiments need to be designed to accurately estimate and differentiate initial leaching from decomposition if they should provide useful information on effects of some treatment on decomposition to parameter values for peatland models. One step to accurately estimate and differentiate initial leaching from decomposition is to sample one batch of litterbags shortly after the start of the litterbag experiments.

To provide these information in our manuscript, we suggest to expand section 4.3 after l. 470 as follows:

"Our results indicate that to develop more specific recommendations and standards for reporting *Sphagnum* litterbag experiments, further conceptual research with the aim to address the knowledge gaps outlined in the previous two sections is necessary. Specifically, in our opinion the next important experimental steps are (1) to define sample preprocessing conditions that are considered natural such that the decomposition process measured in litterbag experiments represents the process intended to be measured, (2) to analyze whether and how commonly applied sampling protocols (e.g. due to seasonal variations in water extractable compounds) and preprocessing steps (in particular different drying methods) cause different initial leaching losses and potentially different decomposition pathways, and (3) to develop litter preprocessing methods that are similar to natural conditions and at the same time allow accurate measurement of initial dry masses. Methods that my be helpful here are experiments similar to those conducted by Lind et al. (2022) or described in Bärlocher (1997), and

a combination (or replacement) of litterbag experiments with stable isotope labeling and direct measurement of different mass fluxes (e.g., Kammer and Hagedorn (2011), Cotrufo et al. (2015)) to improve measurement accuracy and exclude additional potential confounding factors such as the long debated influence of meshes on initial leaching losses and litter fragmentation (e.g., Bokhorst and Wardle (2013)).
Also with regard to refining decomposition rate parameter values in long-term peatland models, more research is necessary, in particular to understand the slow down of decomposition rates when litter chemistry changes during decomposition. As discussed in previous studies Frolking et al. (2001) and shown here, current litterbag experiments do not allow to estimate such a slow down. Therefore, more precise decomposition rate estimates are a necessary but not sufficient condition for addressing this problem."

We are not sure whether this addresses the reviewer's question, but if there are additional suggestions the reviewer would like to discuss or ideas the reviewer has why measuring initial decomposition rates would be useful, we are happy to discuss these.

16. **Q:** Could you sum up the take home message? How can initial leaching effects be prevented in further studies?

    Regarding the take home messages, these can be summarized as follows:

    1. Initial leaching losses in *Sphagnum* litterbag experiments should not be assumed negligible in general.

    2. Initial leaching losses in *Sphagnum* litterbag experiments may vary in dependency of environmental conditions and sample pre-treatment, particularly between drying procedures.

    3. Therefore, if the aim is to quantify mass losses due to decomposition, *Sphagnum* litterbag experiments should explicitly estimate initial leaching losses to make sure estimates for decomposition as mass loss or decomposition rates are not confounded with these initial leaching losses. Moreover, future research needs to address whether sample pre-treatment makes the decomposition process in litterbag experiments unrepresentative for natural conditions and suggest adjustments to allow litterbag experiments to measure decomposition under natural conditions if necessary.

    We think that all of these points appear in the conclusions section of the manuscript, but we agree that this section can be improved to better summarize key points of our study. We therefore changed the conclusions section (please see our reply to comment 17 of reviewer 1).

    Regarding the second question — How can initial leaching effects be prevented in further studies? — We think that our reply to comment 15 by reviewer 1 does address this question. We cannot give an explicit recipe to design litterbag experiments now because a series of conceptual experiments is necessary first to define natural conditions for sample preprocessing, to identify preprocessing strategies that align with these conditions, to estimate initial leaching losses and the factors controlling them, and finally

to analyze whether this leads to reproducible results and how precise decomposition rates can be measured then.

17. **Q:** General notes:

    - Abbreviation C carbon
    - Check spelling and typesetting
    - Air-dried/ air dried, keep it uniform
    - One-pool/one pool
    - Check tables and figures
    - Your discussion points out clearly, that many studies lack in information about the methodology, including sample preparation, corrections and calculations. This could also be included in the Conclusion.

    **A:**

    - The abbreviation for carbon (C) appears for the first time in l. 432, but is not defined there. We will replace this abbreviation by "carbon" in l.432 in the updated version of the manuscript.
    - We will correct the typos pointed out by the reviewer and combine some paragraphs, as suggested by the reviewer.
    - We will change all occurrences of "air dried" to "air-dried" in the text.
    - We will change all occurrences of "one-pool" to "one pool" in the text.
    - Apart from comment 13 by reviewer 1 we are not aware of explicit recommendations what to change in tables or figures. If the reviewer has further specific comments in addition to comment 13 we would like to consider them.
    - We thank the reviewer for this suggestion. While this is also a result of our study, we think that it is less important within the scope of our study and would not fit well within the conclusions without distracting from our core results. We think that our expanded discussion and conclusions imply that special attention should be paid to any aspects of sample collection, sample pre-processing, and experimental design that could have an influence on initial leaching losses. We suggest to rewrite the conclusions to pronounce this aspect more:

      "Simulations, estimated initial leaching losses from 15 litterbag studies, and error analysis suggest that decomposition rates are overestimated if initial leaching losses are ignored. With average initial leaching loss magnitudes as reported in previous studies and as estimated here (3 to 18 mass-%), this implies an overestimation of remaining masses up to several tens of percent during decades of decomposition.
      Our estimates indicate that initial leaching losses $> 5$ mass-% are not uncommon and vary as much within species as overall, somewhat contradictory to the results of many previous studies measuring small initial leaching losses from *Sphagnum*. This may be explained by pre-treatment of litter — even only air-drying — which may increase initial leaching losses compared to fresh Sphagnum and may cause

large intra- and inter-study variation in initial leaching losses for the same species, similar to what has been observed for leaves from trees.
We therefore suggest that a correct estimation of mass losses due to decomposition and of decomposition rates in *Sphagnum* litterbag experiments requires to explicitly estimate initial leaching losses.
Our analyses also suggest that future *Sphagnum* litterbag experiments should sample a batch of litterbags few days to weeks after the start of the experiment because this allows a more accurate estimation of both initial leaching losses and decomposition rates than is possible with currently available data, especially in experiments with small decomposition rates.
Finally, if differences in sampling protocols (e.g. seasonal variations in contents of water extractable compounds) and drying procedures (even only air-drying) cause different amounts of initial leaching and change relative amounts of leaching of inhibiting or facilitating compounds, this may make litterbag experiments with large initial leaching losses caused by pre-treatment unrepresentative for decomposition under natural conditions where our results suggest less initial leaching losses."

# 2 Additional changes

1. l. 45: We will change "Available estimates from direct measurement and few two-pool litterbag experiments …" to "Available estimates from direct measurement and few litterbag experiments …" because some of the studies do not explicitly consider two pools whem modeling decomposition.

2. l. 107: We will change "… the Holocene Peatland Model (Frolking et al., 2010), one of the peatland models studied in many studies." to "the Holocene Peatland Model (Frolking et al., 2010), one of the most widely applied and tested peatland models."

3. l. 293: We will change "The overestimation of $k_0$ when ignoring initial leaching losses becomes however …" to "However, the overestimation of $k_0$ when ignoring initial leaching losses becomes …"

4. l. 345: We will change "In the following paragraphs we suggest what caused small initial leaching losses in these studies." to "In the following paragraphs we suggest causes for small initial leaching losses in these studies."

5. l. 396 to 398: We will change "… whether initial leaching losses differ between studies which discard capitula, which use whole plants, or which use stem parts of different length, as can be expected from previous studies and the observation that already senesced or decomposed *Sphagnum* litter has smaller initial leaching losses …" to "… whether initial leaching losses differ between studies that discard capitula, that use whole plants, or that use stem parts of different length, as can be expected from previous studies and the observation that already senesced or decomposed *Sphagnum* litter has smaller initial leaching losses …"

6. l. 398: We will change “Ssystematic” to “Systematic”.
7. l. 406: W ewill change “Relevance of considering leaching losses in litterbag experiments” to “Relevance of considering initial leaching losses in litterbag experiments”.
8. l. 462: We will change “samples” to “sampled”.
9. l. 464: We will change “temperal” to “temporal”.
10. l. 490: We will change “The data used in this study is derived from Teickner and Knorr (2024a).” to “The data used in this study are derived from Teickner and Knorr (2024a).”
11. l. 497: We will add “We thank Cristian Estop-Aragonés for helpful comments that improved an earlier version of this manuscript.”
12. In the caption of Fig. 4 in the main text we will change “Remaining masses predicted by the model ignoring initial leaching losses minus remaining masses with the simulation model …” to “Remaining masses predicted by the model ignoring initial leaching losses minus the simulated remaining masses (considering different amounts of initial leaching losses) …”
13. In the caption of Fig. 5 in the main text we will state explicitly that the shown values do not include data from Bengtsson et al. (2017).
14. In supporting information S1, l. 43 to 45 we gave the wrong estimate for initial leaching losses in the fen in Moore et al. (2007). The corrected sentence is: “Samples in the pond had the lowest initial leaching losses (on average -1 percent of the initial mass) and samples in the fen the largest (on average 14 percent of the initial mass).”
15. In the formulas in the supporting information we changed “inv_logit” to “$\text{logit}^{-1}$” to make the formula consistent with the main text.

# References


Bärlocher, F.: Pitfalls of traditional techniques when studying decomposition of vascular plant remains in aquatic habitats, Limnetica, 13, 1–11, 1997.

Bengtsson, F., Granath, G., and Rydin, H.: Data from: Photosynthesis, growth, and decay traits in *Sphagnum* – a multispecies comparison, 83493 bytes, https://doi.org/10.5061/DRYAD.62054, 2017.

Bokhorst, S. and Wardle, D. A.: Microclimate within litter bags of different mesh size: Implications for the “arthropod effect” on litter decomposition, Soil Biology and Biochemistry, 58, 147–152, https://doi.org/10.1016/j.soilbio.2012.12.001, 2013.

Clymo, R. S., Turunen, J., and Tolonen, K.: Carbon accumulation in peatland, Oikos, 81, 368–388, https://doi.org/10.2307/3547057, 1998.

Cotrufo, M. F., Soong, J. L., Horton, A. J., Campbell, E. E., Haddix, M. L., Wall, D. H., and Parton, W. J.: Formation of soil organic matter via biochemical and physical pathways of litter mass loss, Nature Geoscience, 8, 776–779, https://doi.org/10.1038/ngeo2520, 2015.

Coulson, J. C. and Butterfield, J.: An investigation of the biotic factors determining the rates of plant decomposition on blanket bog, The Journal of Ecology, 66, 631, https://doi.org/10.2307/2259155, 1978.
Frolking, S., Roulet, N. T., Moore, T. R., Richard, P. J. H., Lavoie, M., and Muller, S. D.: Modeling northern peatland decomposition and peat accumulation, Ecosystems, 4, 479–498, https://doi.org/10.1007/s10021-001-0105-1, 2001.
Hastie, T., Tibshirani, R., and Friedman, J.: The Elements of Statistical Learning, Springer New York, New York, NY, https://doi.org/10.1007/978-0-387-84858-7, 2009.
Kammer, A. and Hagedorn, F.: Mineralisation, leaching and stabilisation of $\delta^{13}$C-labelled leaf and twig litter in a beech forest soil, Biogeosciences, 8, 2195–2208, https://doi.org/10.5194/bg-8-2195-2011, 2011.
Kohl, L.: Comment on egusphere-2024-1686, https://doi.org/10.5194/egusphere-2024-1686-RC2, 2024.
Lind, L., Harbicht, A., Bergman, E., Edwartz, J., and Eckstein, R. L.: Effects of initial leaching for estimates of mass loss and microbial decomposition—Call for an increased nuance, Ecology and Evolution, 12, https://doi.org/10.1002/ece3.9118, 2022.
Moore, T. R., Bubier, J. L., and Bledzki, L.: Litter decomposition in temperate peatland ecosystems: The effect of substrate and site, Ecosystems, 10, 949–963, https://doi.org/10.1007/s10021-007-9064-5, 2007.
Schipperges, B. and Rydin, H.: Response of photosynthesis of *Sphagnum* species from contrasting microhabitats to tissue water content and repeated desiccation, New Phytologist, 140, 677–684, https://doi.org/10.1046/j.1469-8137.1998.00311.x, 1998.