Response to comments by Artz et al. on Yamulki et al. (2013) paper on lowland afforested peatbog GHG fluxes.

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Thank you for the opportunity to comment on this critique of our paper on Flanders Moss GHG fluxes. We accept the main point that Artz et al., make that our estimation and comparison of the net GHG balances of the tree-planted and other treatments were incorrect, which we regret; therefore some of the conclusions about these that were made are erroneous. Below we discuss the key points raised by Artz et al., which we also discussed with them in the preparation of their paper.-

1. Artz et al., are correct in pointing out that the CO_2 fluxes measured in the different treatments are comprised of different components – measurements from the un-planted and n-pris plots have the vegetation in them, as we pointed out in the Methods, 3.1 and in the Discussion, 5.1. We agree that comparison of measured CO_2 fluxes between tree-planted and unplanted treatments is therefore incorrect, and we do not have sufficient information to calculate either R_{soil} for the unplanted and n-pris treatments, or a complete R_{eco} for the tree-planted treatments, so cannot compare the CO_2 fluxes properly.

2. As Artz et al., have pointed out there are errors in Table 4 and consequently problems in the discussion of that table. We clarify the problems below:

    a. The row label 'total *soil* GHG emission' is wrong because the CO_2 emissions from the vegetation is included for uDuP and n-pris treatments, but not for the tree-planted treatments.

    b. The row labelled 'net ecosystem CO_2 exchange' gives for the n-pris site NEE values derived from literature, so the summing of these values with the R_{eco} of the n-pris site to derive the net GHG flux is wrong, and overestimates greatly the emissions. However, if the range of peatland literature NEE values we quoted in Table 4 of -110 to -420 g CO_2 m^{-2} y^{-1} is combined with the CH_4 and N_2O emission rates we measured this gives a range of net GHG balance of +172 to +482 g CO_2e m^{-2} y^{-1}, (i.e. small to moderate net GHG emissions).

    c. The row labelled 'net ecosystem CO_2 exchange' is wrong for the tree planted treatments (DP and uDP) because the absolute numerical value is an estimate of tree NPP. We derived NPP from the C stock assessed in the trees in 2008 (the Methods section in error said 2001). As we stated, by not including litterfall (both needles, cones, twigs and coarse woody debris) we have underestimated NPP for the tree planted plots. These litterfall components can be a substantial fraction of productivity in conifer stands, but we have no measurements or literature values that are appropriate for the study site.

d. We also stated that root respiration was included in the measured CO_2 fluxes and therefore calculating net CO_2 loss from NPP-R_{soil} overestimated the CO_2 emissions. Some literature values of R_h indicate it can be as small as ½ R_{soil} as Artz et al., suggest, although the review by Subke et al. (2006, Global Change Biology 12, 921-943) indicates that for conifer forests in cooler environments the ratio may be larger. Subke et al. (2006) and other papers have also discussed the issue of whether component mycorrhizal respiration should be included in R_h or R_a. Given these issues, we do not feel able to estimate R_h, and consequently the CO_2 balance remains uncertain. However, we note that the draft IPCC emission factors for CO_2 for drained forested peatland (1.71 kg m^{-2} y^{-1}, Table 2.1 for Chapter 2) are very similar to the R_{soil} value we derived in Table 3 (1.66 kg m^{-2} y^{-1}).

e. Artz et al. have also questioned our linear interpolation of biomass accumulation rates. The modelled tree growth rate time courses for lodgepole pine (using the UK Forestry Commission 'M1' and 'Bsort' models based on yield class tables) do not show a pronounced curvature of biomass vs time around the 40-50 year period, (not until much later) so that averaging the growth over the first 44 years is probably underestimating NPP at the time of the GHG measurements.

f. Taken together, points c, d & e above relating to the estimation of the CO_2 balance, suggest that the estimates of net GHG emissions for the tree planted treatments shown in Table 4 are likely to be considerable overestimates. Thus we agree with Artz et al. that these planted treatments may be "much less of a net source" than shown.

3. Artz et al. question the measured CH_4 fluxes at the n-pris site as being high. We stated in the Discussion 5.3 that the annual CH_4 fluxes from the n-pris treatment (22.6 g CH_4 m^{-2} y^{-1}) were "at the higher end of the range… reported by Jungkunst and Fiedler (2007)" for drained and restored peatlands in boreal and temperate regions (-0.06 to 50.9 g CH_4 m^{-2} y^{-1}), although much higher values have also been reported. Clearly, as CH_4 emissions are mainly a function of water table, carbon content and peat depth comparisons should be made accordingly. In the Levy et al. (2012) analysis for the UK (*Methane emissions for soils: synthesis and analysis of a large UK data set*, Global Change Biology 18, 1657-1669), only 2 sites (Whim and Loch More) have similar conditions to Flanders Moss of wet, deep peat and they have the highest CH_4 emissions of 11.2 and 13.8 g CH_4 m^{-2} y^{-1}.

4. Artz et al. have questioned the nature of the n-pris site. On further investigation, we have found a report (Harrison, J.G., 2003. *A historical background of Flanders Moss*. Scottish Natural Heritage, Commissioned Report No. 002 (ROAME No. F02LG22) indicating that water reservoirs may have been made on the bog surface around 1790-1800 to supply water for flushing away the peat being cut from the moss edges to clear land for arable use (clearance continued in the area until around 1860). However, there is no specific reference to our particular site and it is not shown on any of the old maps. Another possibility for the n-pris site is that it was originally a pond created by digging out peat for retting flax or hemp but there is "no historical evidence for retting pools on the East Flanders Moss" (Harrison, 2003, p.84). A 1947 aerial photograph predating the original tree-planting shows that the site was

distinguishable from the surrounding area. So we now conclude that this is a wet peatbog site that is likely to have been disturbed some time ago, and may not be representative of other areas, restored or pristine.

5. Artz et al. have also asked about whether the measurements at the n-pris site covered the heterogeneous nature of the peatbog site, and for more information on the plant species cover. The site was quite homogeneous, perhaps because of its relatively small area of 20 x 30 m and the previous management during the 18th and 19th century. Our survey of its vegetation showed that the site was dominated by *Sphagnum fallax* and *S. magellanicum* with some *S. cuspidatum*. There was also a substantial but patchy cover (30% overall) of *Eriophorum vaginatum* and occasional *E. angustifolium*. Therefore, we agree that transport of CH_4 mediated by these aerenchymatous plant species may have contributed to the high CH_4 emissions. We note also that a recent analysis of the association of CH_4 fluxes and plant species in 5 wet, deep peat sites in the UK, (Gray et al., 2012, *methane indicator values for peatlands: a comparison of species and functional groups*, Global Change Biology) indicated that the above species are all associated with high CH_4 emissions.

We hope the above points clarify and redress some of the regrettable limitations of our paper. Despite these problems with the site comparisons and overall GHG balance calculations, we hope that the GHG flux and ancillary measurements reported remain useful. In particular we believe that the comparisons between the tree-planted drained (DP) and undrained (uDP) treatments and the conclusion regarding the effect of drainage are valid. Although the n-pris site may not be representative of other pristine or restored area in the UK, the relationships between the GHG effluxes (R_{soil} CO_2 fluxes and CH_4 and N_2O fluxes) and site environmental data are important for modelling.