Peatland restoration can provide a climate benefit under all timescales: a case study with The Wildlife Trusts

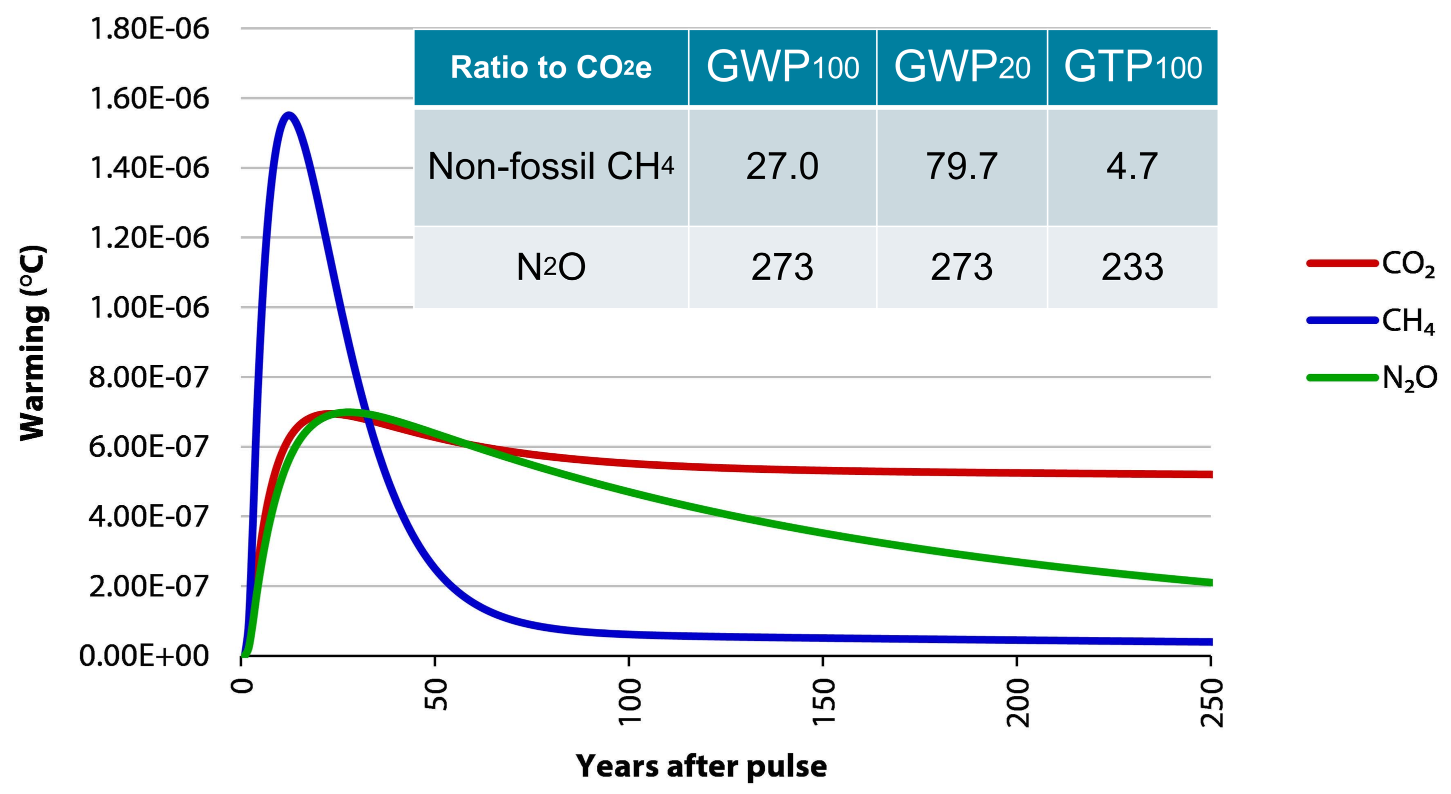
Xiao Zhang: xiao.zhang@biology.ox.ac.uk
John Lynch: john.lynch@biology.ox.ac.uk

Background and research purpose

- Restoring degraded peatland is an important measure to reduce land-related greenhouse gas emissions and contribute to achieving net-zero.
- Our current scientific understanding is that rewetting drained peatlands reduces CO_2 and N_2O emissions, but increases CH_4 emissions.
- **It is unclear whether the elevated CH_4 emission will lead to a short-term warming effect, as it is a strong but short-lived greenhouse** (Figure 1).
- **This study investigated the climate benefit of peatland restoration by assessing the emission savings from peatland restoration under different time scales, using habitat restoration data from The Wildlife Trusts.**

Approach

1. Total emissions = sum[peatland emissions factors (Evans *et al.*, 2023) × areas]
2. Assess net climate impact using multiple conversion metrics (table in Figure 1) and GWP*, a simple approach to modelling warming (Eq.1) (Lynch *et al.*, 2020).
3. Explore the uncertainties of total emissions through Monte Carlo Simulation.



Ratio to CO2e	GWP100	GWP20	GTP100
Non-fossil CH4	27.0	79.7	4.7
N2O	273	273	233

Figure 1. The illustration of the climate responses from one off 1MtCO_2e (under GWP100) pulse of CO_2, CH_4 and N_2O (CCC,2020). The table shows the converting ratio to CO_2e of CH_4 and N_2O under different metrics.

$$E_{CO_2} - \mathrm{w.e.}_{(CH_4)} = (4\times E_{CH_4\,(t)} - 3.75\times E_{CH_4\,(t-20)})\times \mathrm{GWP100} \qquad \text{Eq. 1}$$

GWP* generates CO_2 'warming-equivalent' emissions, using equation 1 above. The year-on-year warming change from CH_4 is calculated based on the emission rate currently and 20 years ago. Resulting cumulative emissions over time correspond directly to temperature change, as is the case for cumulative CO_2 emissions.

Findings

When calculating the reported emission savings across metrics,

- Large emission reductions have already been achieved in all metrics.
- A net cooling effect from sequestration is expected after 100 years.
- Restoring to target conditions will lead to a small amount of further emission savings, but relatively larger long-term benefits.

Table 1. The total emission of each stage of The Wildlife Trusts restored peat habitats.

Total emissions (ktCO_2e/yr)	GWP100 (standard metric)	GWP20 ('near term')	GTP100 ('long term')
Starting condition	1,066	1,267	973
Latest condition (stop drainage)	86	410	-60
Target condition ('near-natural')	38	373	-112

When including uncertainties in the estimations,

- Restoring the sites to target condition is likely to further reduce net emissions, but will depend on specific emissions, given overlap in ranges.

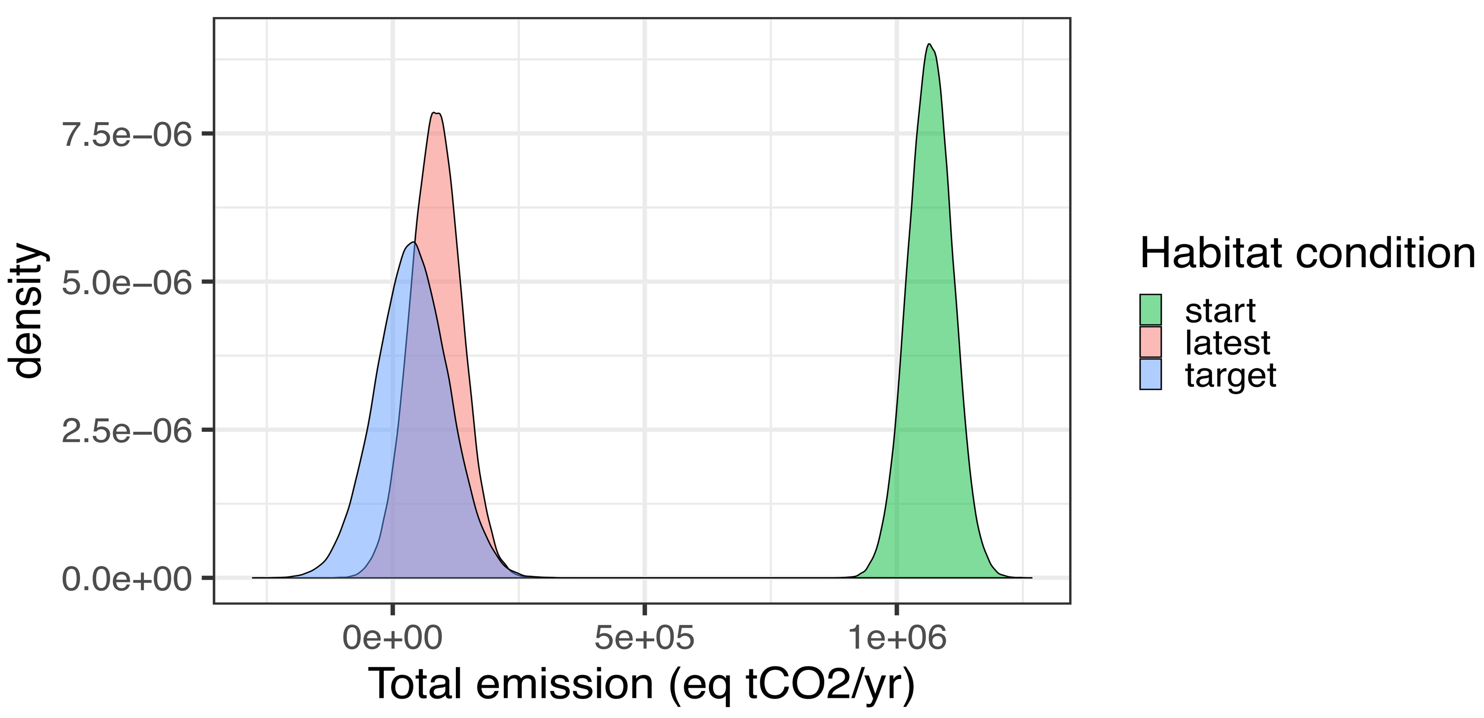


Figure 2. The density plot showing the distributions of total emissions of the starting, latest and target conditions obtained by Monte-Carlo simulation, in GWP100.

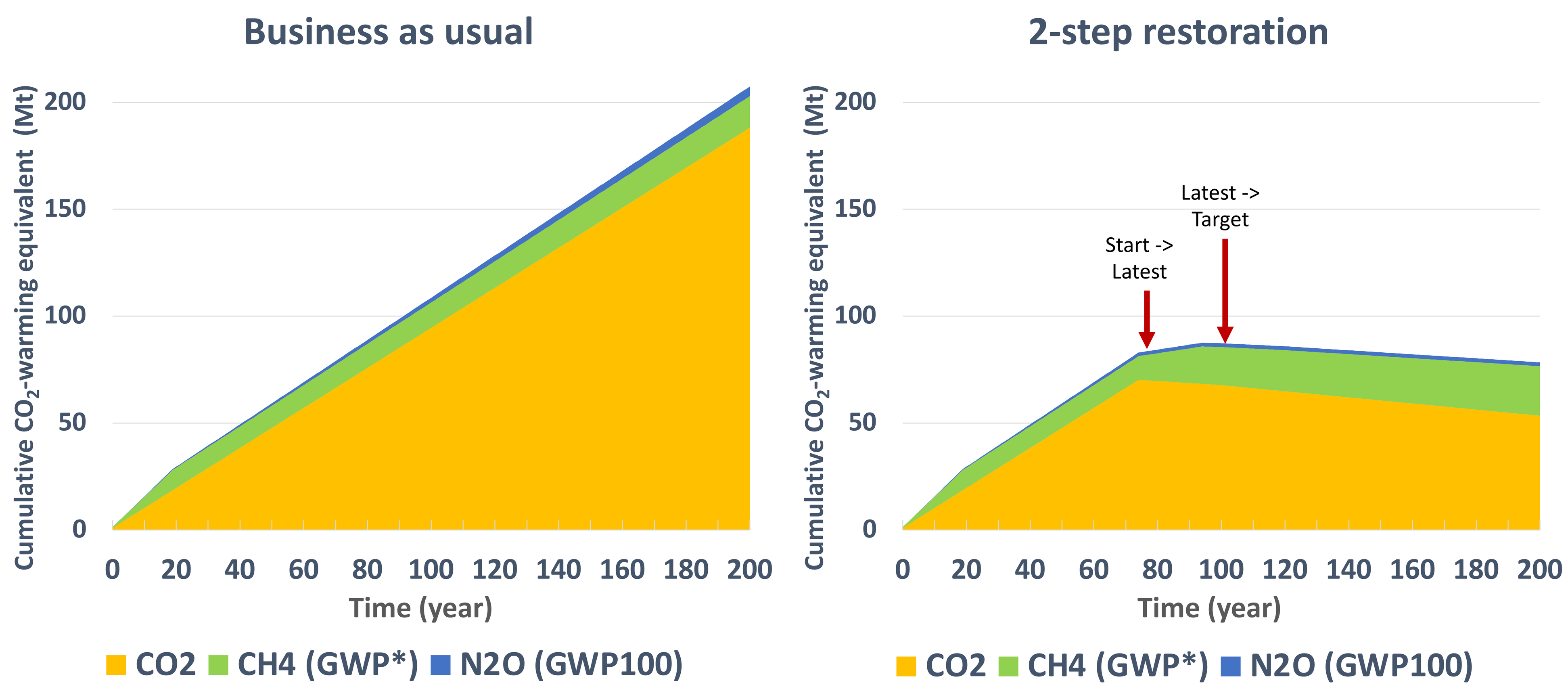


Figure 3. Cumulative total 'CO_2-warming equivalent' emissions using GWP*. Scenarios assume 0 emission initially as arbitrary starting point of degraded peatlands and generation of emissions. In business as usual scenario (left), all sites remain in this condition; in 2-steps restoration scenario (right), all sites change from starting conditions to latest conditions on year 75, and then change to target conditions on year 100.

When illustrating impacts over time using GWP*,

- Restoration immediately reduces warming contribution.
- Shift to carbon sequestration overcomes increased CH_4 warming at all times
- Long-term cooling (reversal of past warming)

Conclusion

Peatland restoration is universally beneficial for emission reduction, and if peatlands are maintained in a restored state, benefits go beyond emission savings to provide long-term, ongoing temperature decrease.

References

1. Evans, C., *et al.* (2023) Aligning the peatland code with the UK peatland inventory. *Report to Defra and the IUCN Peatland Programme.*
2. CCC (2020) Land use: Policies for a Net Zero UK.
3. Lynch, J., *et al.* (2023) Demonstrating GWP*: a means of reporting warming-equivalent emissions that captures the contrasting impacts of short- and long-lived climate pollutants. *Environ. Res. Lett.* 15 044023

Funded by the Agile Initiative at the Oxford Martin School through Natural Environment Research Council as part of the Changing the Environment Programme: grant reference number NE/W004976/1
https://www.agile-initiative.ox.ac.uk/sprints/uncertainties-in-habitat-greenhouse-gas-fluxes/

Acknowledgement

Thanks to The Wildlife Trusts for collecting and sharing the peatland restoration data. Special thanks to Kathryn Brown, Eleanor Johnston and Nigel Doar from The Wildlife Trusts for their support throughout this project.