Counting carbon in the landscapes of North East England: Searching for the evidence required to tackle the climate crisis

Take home messages:

1) Accounting for where carbon is stored ('stock'), and how it moves through the landscape ('flux'), will form a critical part of how the new environmental land management schemes target the climate and biodiversity crises.
2) In a new pilot project, NEECCo has created the first ballpark estimates of carbon stock and flux for North East England, broken down by local authority.
3) The cover types with the most carbon stock were bog, coniferous woodland, broadleaf woodland, improved grassland, and arable, yet there were wide uncertainty ranges associated with all estimates.
4) Data on carbon flux by land cover type were more uncertain than stock. Broadleaf woodland, coniferous woodland and saltmarsh were the only three types where the uncertainty ranges did not overlap zero, indicating that we can be reasonably confident carbon sequestration is taking place.
5) Better data on both carbon stock and carbon flux of key cover types, alongside more localised information on management history and environmental conditions, are required if we are to base land management decisions on sound environmental evidence.

The North East of England Climate Coalition (NEECCo) aims to respond to the climate emergency through empowering the region with the resources to deliver change. In its Working Group 3 report earlier this year, the IPCC suggested that 'it's now or never if we want to limit global warming'. To achieve the Paris climate goals, we will need to put carbon stocks and flows at the heart of decision making on land use and management.

Working with the NEECCo Land Use and Agriculture Planning Group in a new pilot project, Groundwork NE & Cumbria and Northumbria University developed a simple means of 'counting' the carbon locked up in the habitats and land cover types of the North East. The project team used the latest (2020) version of the Centre of Ecology and Hydrology's Land Cover Map to estimate the coverage of key land cover types across the North East, and within each local authority area. The Land Cover Map is the only dataset of land cover with full coverage of Great Britain at high spatial resolution (pixels are 25m x 25m), and therefore represented the only means of mapping carbon across the whole North East region. 'Ballpark' estimates of total stock and sequestration with the North East were derived by matching these land cover types to Natural England's estimates of carbon storage and sequestration by habitat (Gregg et al. 2021).

These estimates suggest that the North East contains 143 Megatonnes of Carbon (MtC, range 110 to 177), with coniferous woodland (28.3 MtC, range 28.0 to 28.6 MtC), improved grassland (32 MtC, range 18 to 51 MtC), bog (27 MtC, range 22 to 32 MtC), arable and horticulture (23 MtC, no range available) and broadleaf woodland (22, range 9 to 32 MtC) the five cover types with the highest carbon stock in the region. Yet these numbers come with wide uncertainty ranges- e.g. the amount of carbon stored in the North East's broadleaf woodlands could be as high as 32 MtC, or as low as 9 MtC- a three-fold difference- emphasising the urgent need for better data and/or more localised estimates of carbon storage for this key habitat type. You can see the full table of estimates of carbon stocks and fluxes by cover type on page 3.

Data on carbon flux by cover type are more limited, and in many cases uncertainty ranges overlap zero, further emphasising the need for better, more context-specific information. The only three cover types where we can be certain sequestration is taking place are broadleaf woodland, coniferous woodland and saltmarsh, which in the North East are responsible for the removal of 0.44 (range 0.13 to 0.82), 0.35 (range 0.17 to 0.61) and 0.003 (range 0.001 to 0.005) Mt CO2 equivalent from the atmosphere per year, respectively. Looking forward, more data on the condition of the region's bogs, such as those being collected by the Northumberland Peat Partnership, will improve our understanding of which bog habitats are acting as sources and sinks of carbon (and other greenhouse gases).

The estimates for stock and flux in both woodland types have been selected to best represent the long-term behaviour of the habitat over 100 years. In the case of broadleaf, estimates for a 100 year old mixed woodland were chosen, while for coniferous, estimates were derived from field measurements at long-term >50 year plots of Sitka spruce forestry. Specifically on flux, although the central estimate in broadleaf is higher than coniferous, it is likely that the highest sequestration rates in North East England are achievable in coniferous- particularly Sitka spruce of higher yield classes (e.g. YC16) in the full-vigour phase (Gregg et al. 2021)- although sequestration rates will always depend on site-specific soil and climatic conditions.

It is also important to highlight that there are several important cover types for which estimates of carbon stock and flux were unavailable, namely: urban and semi-urban areas, domestic gardens and freshwater habitats (lakes and ponds). Equally there were other habitats that were not mapped by the Land Cover Map at sufficient precision to be included in this analysis, specifically blue carbon habitats (seagrass, kelp, sub-tidal sediment), hedgerows and floodplains. Given that urban and semi-urban areas in the North East cover 812 km^2 (9.5% of the land area), obtaining some estimate of their carbon stock is a particularly high priority.

Dr Andrew Suggitt, Assistant Professor at Northumbria University, said: “As the biodiversity and climate crises worsen, we are increasingly looking to incentivise land management that meets environmental criteria, and the carbon stock of each land use type is probably one of the most important things to take into account. Although- as our pilot project showed- we need a much better idea of where carbon is locked up in our landscapes in order to make better decisions, and quickly- because we are running out of time to get this right”.

Gaby McKay-Jones, RoE Research and Monitoring Project Assistant at Groundwork North East and Cumbria, said: “Understanding the gaps in our knowledge is essential when considering how as region we will undertake initiatives to tackle the climate and environmental emergency we are facing. This pilot project gives an insight into the carbon stock and flux of the North East’s habitat types and is an interesting step towards how land use can be managed to keep carbon stored.”

NEECCo is a cross-sector initiative bringing the North-East England region together to tackle climate emergency, reverse ecological collapse and deliver an urgent and just transition. The group is coalition of scientists, policy professionals, and non-governmental organisations including the Forestry Commission, Natural England, and the Environment Agency.

References

Centre of Ecology and Hydrology 2020. The UKCEH Land Cover Map for 2020, version 1.0. (10/09/2021). CEH Wallingford.
Gregg, R. et al. 2021. Carbon storage and sequestration by habitat: a review of the evidence (second edition). Natural England Research Report NERR094, ISBN 978-1-78354-732-6.

Table 1 Carbon stock and flux in the land cover types of the North East. Unless otherwise stated, estimates include carbon in the vegetation and soil to 1m depth. Positive carbon flux values indicate that carbon is being sequestered from the atmosphere. Types with coverages of less than 5km^2 are omitted. An expanded version of this table is available online with a full breakdown by local authority.

Land cover type (CEH 2020)	Coverage in North East England (km^2)	Carbon stock in MtC (range in brackets)	Carbon flux in ±Mt CO_2 equivalent per year (range in brackets)
Broadleaf woodland[1]	627	22.2 (9.3 to 32.4)	+0.44 (+0.13 to +0.82)
Coniferous woodland[2]	663	28.3 (28.0 to 28.6)	+0.35 (+0.17 to +0.61)
Heather grassland	359	3.6 (3.2 to 4.0)	-0.002 (no range available)
Acid grassland[3]	753	6.5 (no range available)	No data available
Calcareous grassland	12	0.08 (no range available)	
Neutral grassland	9	0.05 (0.03 to 0.06)	
Arable and horticulture[4]	1896	23 (no range available)	-0.19 (no range available)
Improved grassland	2503	32 (18 to 51)	+0.09 (-0.23 to +0.32)
Bog[5]	328	27 (22 to 32)	No central estimate available (range -0.43 to +0.0007)
Saltmarsh	6	0.035 (0.00006 to 0.06)	+0.003 (+0.001 to +0.005)

1 Broadleaf woodland estimates for stock and flux assume a mixed native woodland of 100 year old trees on mineral soil.
2 Coniferous woodland estimates were not reported by Gregg et al. 2021. Stock estimates assume Sitka Spruce forestry with a yield class of 12. Estimates for flux also assume Sitka Spruce forestry and are calculated across two rotations (Vanguelova et al. 2019- Forestry).
3 Acid grassland estimates for stock are to 15cm soil depth and do not account for vegetation.
4 Arable estimates for flux assume tillage of the soil.
5 Bog estimates for stock assume a 99:1 split of blanket and raised bog (as per the Priority Habitats Inventory data for North East England), and do not extend beyond a depth of 380cm. The range in flux estimates is largely driven by variations in soil condition and management history.

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