Discussion Paper:

Integrated Farm and Land Management (IFLM) Method Framework

Prepared by:

CMI Integrated Farm and Land Management (IFLM) Taskforce

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Acknowledgments

Acknowledgement of Country

The Carbon Market Institute (CMI) Integrated Farm and Land Management (IFLM) Taskforce acknowledges the diversity of Australia's First Nations peoples as the Traditional Custodians of the lands and waterways across Australia. We pay our respects to Elders, past and present.

Other acknowledgements

CMI is a member-based institute accelerating the transition towards a negative emissions, nature positive world. We champion best practice in carbon markets and climate policy, with around 150 members including primary producers, carbon project developers, Indigenous organisations, legal, technology and advisory services, insurers, banks, investors, corporate entities and emission intensive industries.

For any additional information on the content of this discussion paper or to request a zip file of the referenced papers – please contact IFLM@carbonmarketinstitute.org.

Discussion Paper:

Integrated Farm and Land Management (IFLM) Method Framework

Section 1. Overview

This discussion paper has been prepared on behalf of CMI Integrated Farm and Land Management (IFLM) Taskforce. It builds on the original CMI ILFM Taskforce 'Blueprint' (2021) proposal for a more holistic carbon farming method, which was developed in collaboration with the carbon, agriculture, technology, resources and conservation sectors, along with inputs from Indigenous stakeholders, State and Federal Government and researchers.

The intent of the IFLM Method Framework is to combine a range of land sector carbon management activities and carbon pools into a single method. The IFLM Method Framework is designed to be 'modular' in that it could accommodate multiple, interoperable carbon management activities and technical schedules with requirements for modelling and measuring abatement. Project proponents could choose which modules are relevant to their context, with scope to add additional activity modules and technical schedules over time as they are approved by the Carbon Abatement Integrity Committee (CAIC).

The IFLM Method Framework represents a step change from existing single activity carbon farming methods, and the IFLM Method Framework is not intended to replace any specific carbon farming methods. Rather, the modular structure could mirror or cross reference aspects of existing or future single activity carbon farming methods or associated technical guidelines (including the Soil Carbon Method 2021 and the Environmental Plantings Method 2024 update that is underway, among others). Carbon farming is not a one-size-fits-all approach, and this approach provides optionality for land managers to either participate in single activity methods where appropriate for their circumstances or opt for the integrated and modular approach where they wish to undertake multiple carbon management activities on the one property. This paper summarises the scientific basis of key activities and concepts proposed for inclusion in the IFLM method. The objective of this paper is to stimulate discussion and build understanding around the core components of the proposed IFLM method, with intent to provide expert stakeholder input from a wide range of stakeholders as part of the Government-led design process that is currently underway.

The proposed IFLM Method Framework could enable generation of high integrity ACCUs based on scientific evidence and robust monitoring methods, while increasing participation across a broad range of ecosystems and land management activities. It draws on years of practical experience in implementing carbon farming projects and methods, with contributors having provided carbon services for 500+ land-based carbon projects. It applies lessons learned from pilots that have tested a more holistic approach to carbon farming. It aligns with contemporary accounting adopted by Australia as part of the Paris Agreement.

This paper outlines components of the IFLM Method Framework that are ready to be operationalised and provides details of the supporting science and method safeguards to ensure additionality and prevent leakage. Several further potential modules or components of the IFLM method are still in active discussion, although these are not described in this discussion paper. These include activities that avoid emissions, such as avoided clearing and enteric emission reduction activities. Further, the IFLM Method Framework builds upon the established principles of the *Carbon Farming Initiative Act (2011)* which provides foundational principles and method safeguards, such as the *Offsets Integrity Standards*, and requirements for *Free, Prior and Informed Consent (FPIC)*. These are relied upon in all Australian carbon farming methods and are not reproduced in this paper. Additionally, detailed transition rules for any existing projects registered under a relevant land sector method are not covered in this discussion paper. Development of transition rules from the array of existing land sector carbon farming methods will be an important next step in parallel with finalisation of the technical and legislative method drafting.

The CMI IFLM Taskforce and its subcommittees, including the Technical Working Group and Stakeholder Engagement Working Group, recognise the collective benefit of a more holistic, integrated land sector carbon method, and have worked collaboratively since November 2019 to support the co-design of the IFLM Method Framework. The work of the CMI IFLM Taskforce has included active engagement in a co-design process that commenced with the Clean Energy Regulator (CER) in 2022, and then with the Department of Climate Change, Energy, Environment and Water (DCCEEW) in 2023. During this time, multiple iterations of technical drafts of method have been prepared and revised by the CER and DCCEEW. This discussion paper advances a number of concepts described in the non-legal preliminary technical consultation draft version of the IFLM method shared by DCCEEW as part of targeted technical consultations in October 2023. This discussion paper has been collectively developed by the CMI IFLM Taskforce Technical Working Group during regular meetings held since October 2023, incorporating feedback from the broader CMI IFLM Taskforce provided in May 2024.

1.1 What is the rationale for the IFLM method?

To limit warming to 1.5 degrees, this is the 'decade that matters'. The land sector, primarily via photosynthesis, is critical for immediate CO_2e removal at scale. Storage of carbon in woody biomass and soil is currently the only proven technology to drawdown carbon from the atmosphere at scale. A comprehensive carbon farming method that is well matched to the broad range of carbon management activities implemented on land in Australia, is needed to unlock the substantial abatement potential of the land sector, and make a meaningful contribution to a net zero Australia by 2050.

While its primary purpose is to provide a high-integrity carbon farming method under the ACCU Scheme, the IFLM method can contribute to the delivery of three major Australian Government policies, including:

- Australia's National Net Zero Plan for the Agriculture and Forestry Sectors (currently under development), that is designed to support land sector decarbonisation (including via the ACCU Scheme) as an important input to Australia's national, whole-of-economy net zero strategy;
- Australia's 30x2030 biodiversity goal and longer-term nature positive aspirations, by interfacing with the emerging Nature Repair Act methodologies; and
- Australia's sustainable agricultural production and food security goals, providing long term market access for Australia's agricultural commodities, aligned with increasing market requirements for low emission, sustainable agricultural produce (including by supporting ACCU-based insetting approaches).

The IFLM method was announced by the Australian Government in October 2021 as a priority method for development.[1] This commitment was reaffirmed by The Hon Chris Bowen on 22 May 2023,[2] and again in March 2024. The modular approach to the IFLM method was endorsed in the 2022 Chubb Review, which was accepted by the Government.

[1] New ERF Method and 2022 priorities announced. Available at: https://www.minister.industry.gov.au/ministers/taylor/media-releases/new-erf-method-and-2022-priorities-announced

[2] Minister Chris Bowen Speech to the 7th Carbon Farming Industry Forum. Available at: Speech to the 7th Carbon Farming Industry Forum | Ministers (dcceew.gov.au)

The scale of abatement that could be delivered under the IFLM method is substantial. Recent analysis by CSIRO identified an economically viable potential for woody and soil based carbon removals of up to 84 million tonnes of CO_2e per annum[3]. To date, abatement delivered from native forest restoration, soil carbon and environmental planting activities under the ACCU Scheme (and its preceding programs) have well below the technical and economic potential estimated by CSIRO - about 5 million tonnes per annum since inception. A practical, high-integrity carbon farming method would address many of the key barriers to participation in carbon farming, including low commercial viability in some areas, and narrow scope of methods.[4]

[3] CSIRO has estimated that regeneration of native plant species, soil carbon sequestration activities, and environmental plantings, and can make a substantial contribution to Australia's emission reduction goals, with a technical sequestration potential of 60.1 million tonnes, 115 million tonnes, and 33 – 478 Mt of CO2e respectively per annum over 25 years. At a carbon price of $30, the economic sequestration potential of the activities could be up to 39 million tonnes, 29 million tonnes, and 16 million of CO2e per annum, respectively. Source: Fitch P, Bataglia M, Lenton A, Feron P, Gao L, Mei Y, Hortle A, Macdonald L, Pearce M, Occhipinti; S, Roxburgh S, Steven A, (2022). Australia's sequestration potential, CSIRO. A report to the Climate Change Authority. Available at: h+ps://www.csiro.au/en/research/environmental-impacts/emissions/carbon-sequestration-potenital

[4] Macintosh, A. Roberts, G. and S. Buchan (2019). Improving Carbon Markets to Increase Farmer Participation. June 2019 -Report to Agrifutures. Available at:
h+ps://agrifutures.com.au/wp-content/uploads/2019/07/19-026-Digital.pdf

1.2 Five key innovations proposed under the IFLM method

The proposed IFLM method presents an opportunity to learn from experience implementing carbon farming projects to date and provide solutions to past concerns raised about the accuracy, additionality, flexibility, or transparency of some carbon farming methods. In this discussion paper we outline how this could be achieved via five major innovations under the proposed IFLM method:

1. **Modular**: The IFLM method could enable reporting of multiple carbon pools and carbon management activities as part of a single project. This could better align with on-ground realities for many land managers and increase commercial viability per project, and in doing so diversify the spectrum of properties that can participate in carbon farming;
2. **Model matches measurements**: Expanding on the existing measure-model approach for soil, the IFLM method could introduce a model validation component for woody biomass, where model estimates would be matched to high accuracy field data. The IFLM method could require model adjustments if model predictions do not match measured outcomes;
3. **Material gap analysis for woody biomass:** to provide high-confidence in the additionality of projects that undertake woody biomass regeneration activities, a statistical gap analysis could be applied, where the Carbon Estimation Area (CEA) could be compared to ecosystem benchmarks, such as carbon stocks or ecosystem structure. This provides an early datapoint to assess whether the CEA likely has potential for increased woody carbon stocks. When triangulated with third party evidence of barriers to ecosystem restoration (i.e. suppression agents inhibiting regeneration), the gap analysis can provide an evidentiary linkage between the proposed carbon management change and ecosystem carbon stock outcomes;
4. **Monitoring of leakage**: To ensure that the IFLM method accounts for all material sources of emissions that can be demonstrably linked to undertaking the project. This ensures that carbon farming activities have safeguards to protect against leakage, particularly related to displacement of land clearing;
5. **Multi-ecosystem applicability:** The IFLM Method could have expanded applicability across the broader range of Australian ecosystems. This innovation strengthens alignment of the method level accounting principles with the Paris Agreement landscape accounting approach. Eligibility criteria in past methods were linked to Kyoto era thresholds of forest and non-forest and the transition between these land classifications. This has significantly constrained the ability of carbon farming to occur in the broadest range of ecosystems, including ecosystems located in Australia's vast Indigenous estate. High-integrity model validation processes enable new combinations of carbon management activities to be undertaken in many different ecosystems, where each unique ecosystem has its own robustly validated model.

1.4 About this discussion paper

This document is an input to the co-design process for the IFLM method that is under development by DCCEEW. The suggested IFLM Method Framework and components have been developed by the CMI IFLM Technical Working Group, based on the collective review of more than 100 peer reviewed journal papers and scientific reports, following months of intensive discussions. The IFLM method components outlined in the discussion paper represent a genuine attempt build on lessons from ten years of carbon farming, respond to public or academic concerns or reviews that highlighted areas for improvement with past or current carbon farming methods, and align with a vision for a more modular future approach to carbon farming that has widespread support from the broadest possible range of stakeholders.

The discussion paper and components have been put forward as options to stimulate thought and discussion and support timely finalisation and adoption of a new IFLM method. The public release of this paper is to ensure open dialogue and critical review can occur, and to build expert consensus. This will enable us, collectively, to work toward scaling up land sector decarbonisation, while continuing to build on the framework and add additional components as they are science and implementation-ready. We welcome feedback on the components and additional ideas to continue to strengthen all its aspects as part of the co-design process.

Section 2 of this discussion paper provides a summary of the five key innovations under the proposed IFLM Method Framework.

Section 3 conducts an overview of the IFLM Method Framework, outlining a five-step process from project registration through to project reporting.

Section 4 addresses each of the key components that together form part of a standard carbon farming methodology determination structure. These components typically include:

- Project data collection requirements
- Mapping requirements
- Net abatement calculations
- Record keeping requirements
- Auditing requirements
- Regulatory approvals

Section 4 provides a brief summary of each of the key components, together with the scientific foundations underpinning the proposed method approach. It demonstrates how the proposed approach includes integrity safeguards and meets the Offsets Integrity Standards which must be considered by CAIC in reviewing the IFLM method and preparing a recommendation to the Minister.

Section 2: Five key innovations proposed under the IFLM method

This part of the discussion paper describes the five major innovations that form the foundation of this next-generation carbon farming method.

2.1 Modular approach: Integration of carbon management activities, integration of the woody biomass and soil organic carbon pools, with ability to add science-ready modules in future

The IFLM Method Framework is 'modular' in that it could accommodate multiple, interoperable carbon management activities or technical schedules to model and measure abatement. Project proponents could choose which modules are relevant to their context (e.g. location, land use, expertise and any complementary or competing issues). The modular design of the IFLM Method Framework includes some overriding principles that would apply across multiple components, while also allowing for flexibility to apply specific components to ensure all elements are fit for purpose.

This discussion paper outlines carbon management activities that sequester carbon in soil and/or woody biomass in the initial version of the IFLM method. The integration of eligible woody biomass and soil organic carbon activities in a single project increases the range of ecosystems that could participate in the ACCU Scheme. The proposed modularity can provide a high level of method stability, and also a platform for incorporation of new activities and innovations over time. For example, while emissions from enteric fermentation remain challenging to address, particularly in grazing livestock, there are emerging technologies and management practice changes that are showing early promise. Similarly, modules are needed to address existing forests at risk of clearing, both in private lands and native forests. These modules could be progressively included into the IFLM Method Framework via the new Expression of Interest (EOI) and co-design/ proposer led process.

Similarly, the modular structure of the IFLM Method Framework would allow for mirroring or cross references to aspects of existing single activity carbon farming methods. One example would be mirroring and applying the '*Supplement to the Estimation of Soil Organic Carbon Sequestration using Measurement and Models Methodology Determination 2021*' in relation to the soil carbon measurement and modelling schedules in the IFLM method. This Supplement was legislated relatively recently following an extensive co-design process led by the Clean Energy Regulator and remains fit-for-purpose. Any updates to this Supplement in the future could then apply to both the Soil Carbon Method 2021 and the IFLM method soil carbon components, maintaining consistency across the ACCU Scheme.

The modular nature of the IFLM method is underpinned by the four universal carbon accounting architectures (Figure 1). These are: holding carbon stocks at baseline level (stable or storage), increasing carbon stocks (gain or sequestration), preventing emissions (loss or avoidance), or modifying the long-term average carbon stock (fluctuating). In the land sector carbon pools, all project or baseline scenarios follow one of these four carbon accounting architectures.

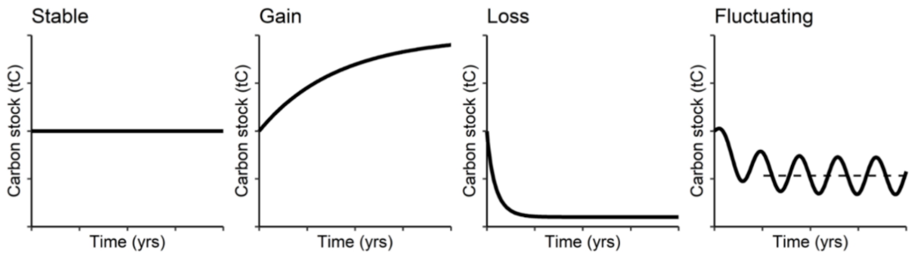

Figure 1 The four universal carbon accounting architectures: stable, gain, loss, and fluctuating.

This discussion paper focuses on carbon sequestration activities that increase woody biomass or soil organic carbon via a gain architecture in the project scenario. To execute the carbon accounting calculations applicable for each carbon pool, the soil and woody carbon pools would be treated as separate Carbon Estimation Areas (CEAs), even when they overlap. Changes across all carbon pools would be integrated (i.e. summed) using the net abatement calculation. This simple framework provides a project level balance of the gains and reversals of eligible carbon stock across all activities within the project boundaries.

In the first instance, the estimation of GHGe from livestock, fertilisers, soil ameliorants, cultivation, fuels and electricity would be calculated using default emissions factors, mirroring the Soil Carbon Method 2021. Over time, the modular nature of the IFLM method framework could accommodate additional carbon pools and activities, including activities to avoid emissions such as avoided clearing and livestock management activities to reduce enteric emissions.

The package of activity modules, along with model and measurement schedules and guidelines, that together could make up the initial IFLM method framework is shown in Figure 2.

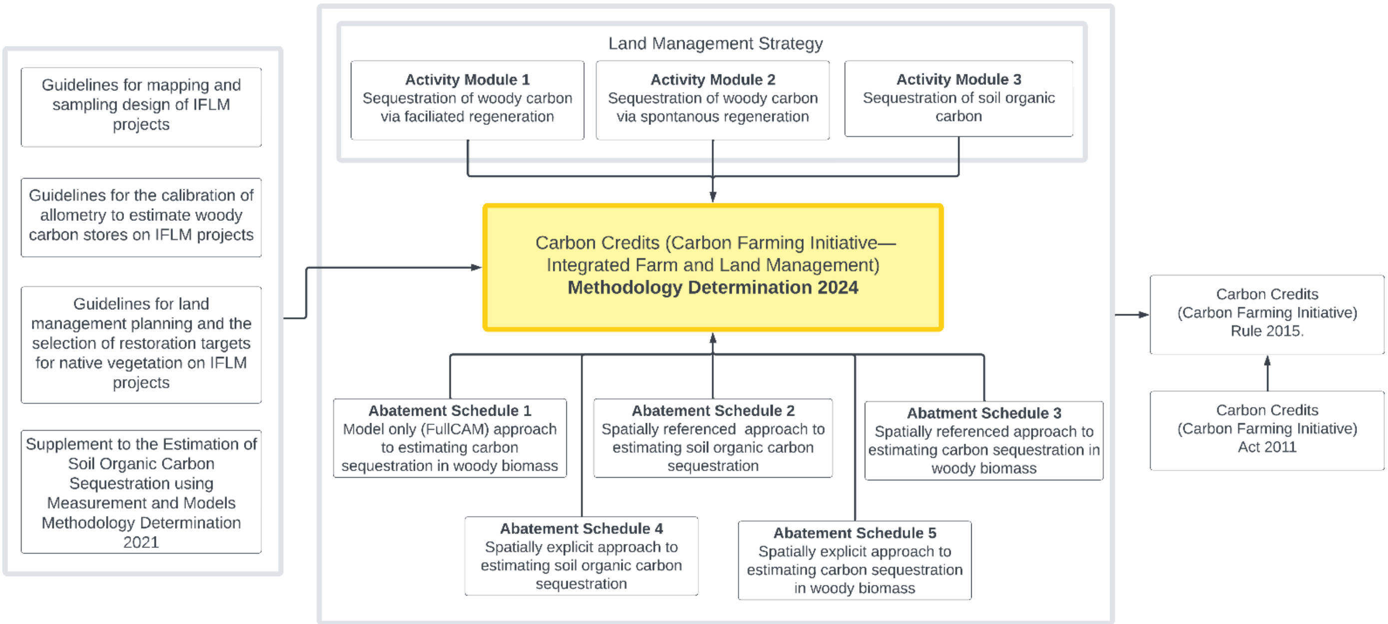

Figure 2: Overview of the possible initial package of IFLM method modules, guidelines and schedules

2.2 Model matches measurements: estimation of woody and soil organic carbon sequestration using measurement and validated models

The proposed IFLM Method Framework includes schedules covering five different approaches to estimate changes in carbon stocks, as shown in Figure 2. The application of these Abatement Schedules could be subject to different eligibility criteria and method safeguards. The five Abatement Schedules could include:

1. **National model – woody biomass:** Implementation of the national Full Carbon Accounting Model (FullCAM; or other approved national model), with supplementary project data (applicable for woody biomass carbon stocks, not soil); or
2. **Spatially referenced models - Soil:** Averaging of soil core data across uniform CEAs, mirroring Schedule 1 of the Soil Carbon Method 2021.
3. **Spatially referenced models – Woody biomass:** Averaging of woody biomass measurements across uniform CEAs, mirroring approaches in existing carbon farming methods that measure woody biomass carbon stocks, such as the avoided deforestation method, or the reforestation and afforestation methods.
4. **Spatially explicit models – Soil:** Extrapolation of soil carbon measurements over an area of land, based on a correlation with detectable characteristics in remotely sensed imagery or other spatially explicit covariates, mirroring elements of Schedule 2 of the Soil Carbon Method 2021;
5. **Spatially explicit models – Woody biomass:** Extrapolation of woody biomass measurements over an area of land, based on a correlation with detectable characteristics in remotely sensed imagery or other spatially explicit covariates.

The national model provides a lower cost estimation approach where suitable calibrations are available for the proposed project activities. Proposed applicability criteria for use of the national model are outlined in Section 4 to ensure that projects using the national model do so in a way that aligns with key model assumptions and calibration datasets. Use of the national model would be coupled with project specific data supplied by the project proponent, alongside a land management strategy. Initially, the national model would not be available for modelling soil organic carbon CEAs.

Projects applying the spatially-explicit approach would combine measurements with spatially explicit biomass or soil carbon maps for increased precision and statistical rigor. The method would include validation protocols that compare modelled estimates of carbon stock against measurement data to confirm the accuracy of modelled carbon stock changes in woody biomass and/or soils. This provides high confidence in the accuracy of abatement estimates. These models would be verified by independent third-party auditors at the time of each project audit, and could also be subject to scheme-wide compliance and gateway audits. This is described in more detail in Part 3 of this document.

The third option 'spatially-referenced models' involves averaging measurements taken from sample plots across a stratum, which is a simpler model and may be preferred for uniform CEAs. Similar approaches have been applied in Schedule 1 of the Soil Carbon Method 2021, or in various carbon farming methods that involve field-based tree measurement.

Both the spatially-explicit and spatially-referenced approaches would be suitable for all eligible woody biomass and soil organic carbon activities for smaller scale projects.

Measurements could be conducted using standardised protocols that would ensure consistency between projects. Aspects of measurement that might require standard protocols could include woody biomass inventories, soil core sampling, chemical analysis or spectroscopic techniques, map accuracy assessments, and gateway assessments. To accommodate rapid improvements in measurement technologies, measurement protocols could be articulated in more flexible policy instruments that can be updated, such as guidelines. Alternatively, measurement protocols from existing methods could be developed into a library of approved external measurement protocols.

A major advantage of a method that allows for comprehensive measurement and modelling would be the ability for carbon projects to collectively contribute data for the ongoing improvement of the national model (i.e. FullCAM, or other approved national model). This would build on existing data collection initiatives from the Australian Government, such as the Australian National Soil Information System,[5] and deliver on Independent ACCU Review Recommendation 4.2 to explore using a national platform to share information and data. Project proponents may provide verification data or seek to prioritise areas as part of the ongoing FullCAM calibration and validation process stewarded by DCCEEW and CSIRO. This positive feedback loop might broaden the applicability scope of the national default model, lowering the barrier to entry for small-scale participation in carbon farming.

[5] https://ansis.net/data/

2.3 Material gap analysis for woody biomass: additionality assessment for woody biomass activities using ecosystem benchmarks

In both the IFLM Method Framework and existing carbon farming methods (including Soil Carbon Method 2021), woody biomass and soil carbon CEAs must provide evidence of the factors limiting carbon stocks and preventing carbon stock gains. This discussion paper proposes that the IFLM Method Framework could include an additional requirement that would bolster confidence in the additionality of projects that include activities designed to increase carbon stocks in woody biomass. This step would involve demonstrating that there is a material gap in carbon stock between the current ecosystem state, and the biophysical potential of the site.

The purpose of the gap analysis would be to understand why ecosystem carbon stocks in the CEA are lower than they could be, and specifically how new or amended (additional) management activities could contribute to closing this gap. This is based on the premise that ecosystems carry the 'ecological fingerprint' of historical events. In other words, something must have occurred historically that caused the carbon stock to be below its maximum. The causal agent of the gap could be natural disturbance, anthropogenic land management (including active actions depleting or supressing carbon stocks and/or a lack of adequate management activity), or a combination of the two sets of factors. An example of a gap analysis applied to an existing human-induced regeneration (HIR) project and a nearby reference site is shown in Figure 3 below.

A deeper analysis of management history and ecosystem state as part of the gap analysis would also provide valuable insights into the biophysical parameters that should be measured to determine if the management change is successful. For example, if the gap analysis indicated a lack of a size cohort (Figure 3), which might occur if a historical management disturbance affected or removed a particular age or size class, then measuring a change in the size distribution of vegetation may be a key metric to be collected and monitored.

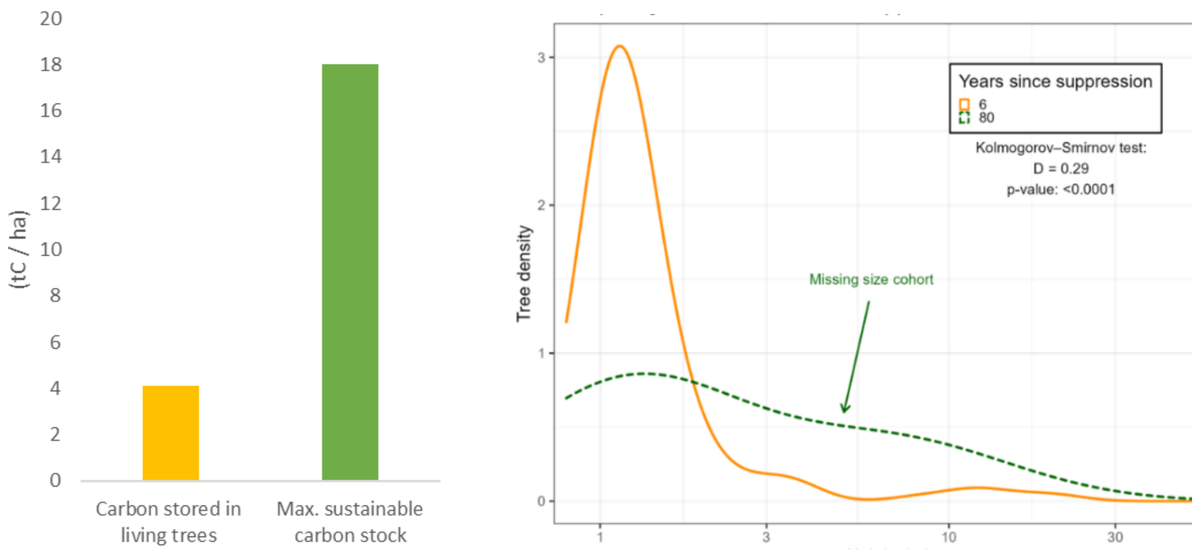

Figure 3: Gap analysis applied to an existing HIR project. The left panel shows woody carbon stocks the current CEA (yellow bar) against the FullCAM conceptual model describing maximum attainable biomass (green bar). The right panel uses ecosystem benchmarks of tree size and tree density to identify a missing size cohort, when compared to a nearby reference site. In both cases, statistical analysis can be applied to detect the significance of the gap.

The gap analysis could be applied across a broad range of ecosystems, drawing on ecological understanding of forest structural composition and successional dynamics in the wake of disturbance. In other words, there is general agreement on the broad structural characteristics of relatively intact ecosystems, and this could provide an indication of the biophysical structure and carbon storage potential of the CEA. It is proposed that the gap analysis be applied at the initial project stratification stage, described in Section 3.

2.4 Monitoring of leakage: increased rigor to account for leakage emissions from woody biomass and soil organic carbon activities.

The CFI Act (as part of its 'Offsets Integrity Standards') states that methodology determinations should account for project emissions as follows:

> "*a methodology determination …should provide that, in ascertaining the carbon dioxide equivalent net abatement amount for a project, there is to be a deduction of the carbon dioxide equivalent of any amounts of greenhouse gases that: (i) are emitted as a direct consequence of carrying out the project; and (ii) under the determination, are taken to be material amounts*"
> (Section 133(1)(e) of the CFI Act).

To date, carbon farming methods have accounted for emissions that can be directly linked to project activities implemented in the project area, such as fuel emissions. However, emissions due to leakage have not been accounted for within existing carbon farming methods, but have been left for broader sectoral policies to address. This has resulted in some concerns about the risk of displaced emissions. According to the Emissions Reduction Assurance Committee (ERAC) (2021) "*leakage refers to increases in emissions or reductions in removals that occur outside the project boundary as a consequence of the project activity*."[6] The Independent ACCU Review (Recommendation 7) also included the proposal that the ACCU Scheme could include mechanisms to better account for leakage emissions.

To address concerns about leakage potential, the proposed IFLM method could include a project-specific risk-based leakage assessment process. Leakage monitoring requirements could be commensurate with the likely risk of leakage to avoid unnecessarily increasing transaction costs for activities with low risk of leakage.

The CMI IFLM Taskforce Technical Working Group has developed a draft risk-based leakage assessment tool (Figure 5 below). It identifies activities with a greater risk of leakage. Criteria for evaluating the risk of leakage applied in the draft tool include considerations such as:

- the specific nature of the baseline activities, and the project activities to be implemented;
- whether the management change is likely to reduce agricultural productivity (which could cause the land manager to shift the activity elsewhere due to opportunity cost); and
- whether the management change involves a cessation of historical activities that carry a higher risk of continuing elsewhere (for example, avoided clearing).

To manage leakage, it is proposed that in the Land Management Strategy, project proponents could be required to articulate a leakage prevention plan or, if leakage is expected, to identify the potential leakage so that appropriate deductions can be made for any material leakage emissions prior to crediting of abatement.

Using the draft tool, the major leakage risk identified was the displacement of mechanical/chemical suppression activities (i.e. shifting of land clearing). Under the draft leakage assessment tool, it is proposed that leakage monitoring is consequently focused on mechanical/chemical suppression activities. It also proposed that leakage assessments are restricted to circumstances where the project proponent has operational control of land outside the CEA, and the legal right to conduct broadscale mechanical or chemical suppression of native forest. This would help ensure the tool is operationally and legally viable.

[6] Source: ERAC Information Paper on the Offsets Integrity Standards
https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.dcceew.gov.au%2Fsites%2Fdefault%2Ffiles%2Fdocuments%2Ferac-information-paper-offsets-integrity-standards.docx&wdOrigin=BROWSELINK

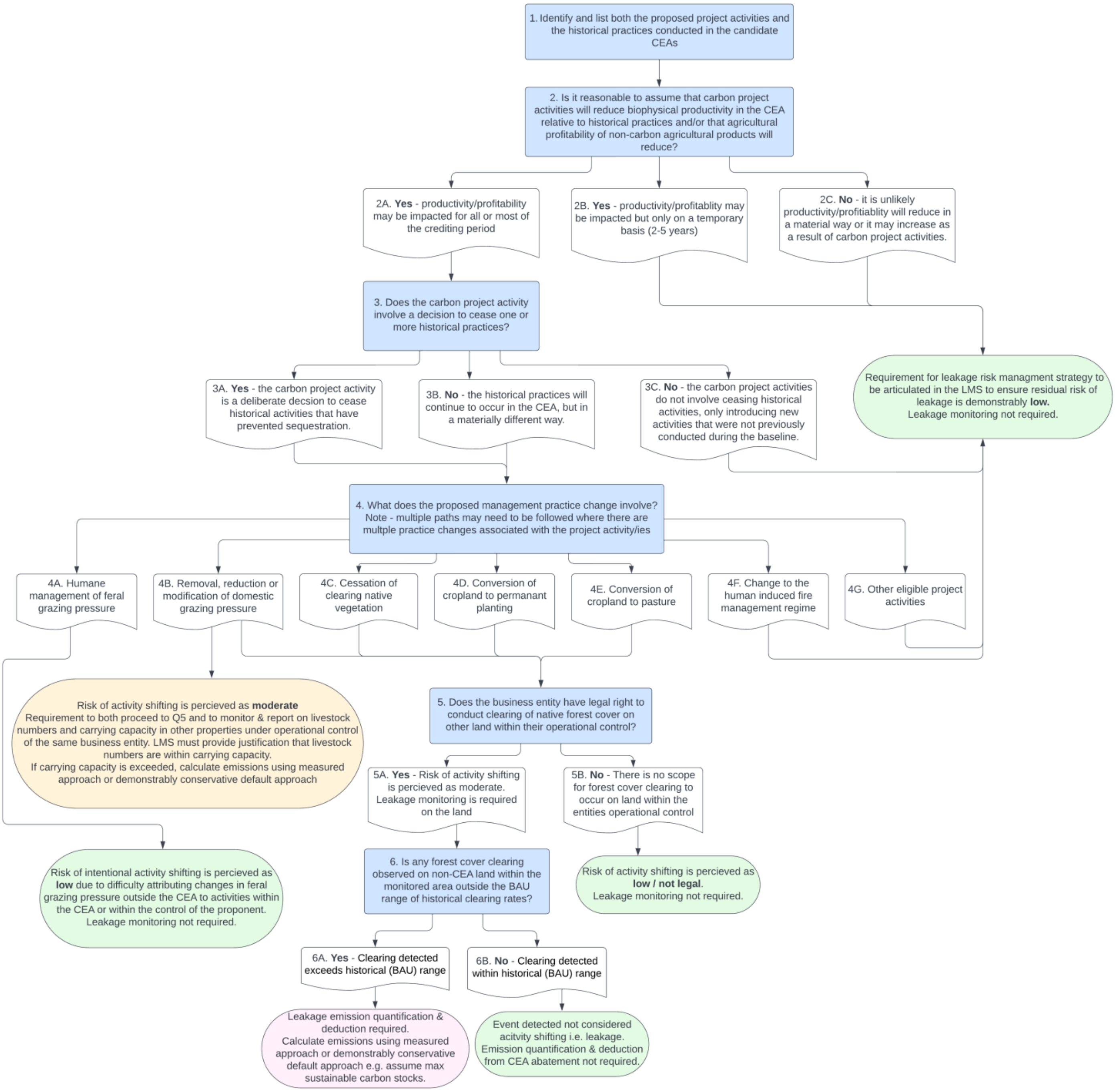

Figure 5: Risk-based leakage assessment tool developed by the CMI IFLM Technical Working Group (Draft)

2.5 Multi-ecosystem applicability: expanded application across a broader range of Australian ecosystems

For project proponents that opt to incorporate measurement into their monitoring and reporting program, the IFLM Method Framework proposes to allow crediting of abatement for any increase in woody biomass that is attributable to the management change. This would expand the categories of eligible vegetation beyond the approach in current carbon farming methods, which limit method eligibility to woody biomass that can pass from the non-forest or sparse woody class to above the “forest threshold” of 2m tall and 20% canopy (‘the forest transition requirement’). This narrowly defined requirement has excluded participation of many land managers in a wide variety of ecosystems around Australia that are otherwise keen to participate in carbon farming. This includes land managers right across Australia in both high rainfall pasture or cropping zones and semi-arid regions. The forest transition requirement has restricted land manager’s ability to manage and regenerate land across the full spectrum of vegetation canopy cover. It is not well-matched to the broader land sector reporting requirements under the Paris Agreement, which take a landscape accounting approach and depart from rigid thresholds applied under the Kyoto Protocol.

The expanded approach under the IFLM method would be designed to be applicable across the broader range of Australian ecosystems. This would broaden land manager participation in both rangeland and higher rainfall regions by:

- Enabling a broader range of management activities, such as fire management, including cultural fire, that until now have been excluded from existing carbon farming methods outside the savanna regions;
- For rangeland regions: Enabling crediting of abatement for management changes that store carbon in ‘sub-forest’ or shrubland and woodland forest areas that do not have forest potential, but where the gap analysis shows they are degraded and will sequester and store carbon over the life of projects and beyond.
- For higher rainfall regions: Enabling land managers to control their preferred tree cover/ pasture balance will enable agricultural producers and land managers to incorporate optimal levels of woody biomass in their pastures, and also to regenerate some forest areas to higher canopy thresholds.

Broadening applicability across the range of Australian ecosystems would be enabled by the introduction of a measure-model validation process, summarised in section 2.3. This means that each unique ecosystem could apply its own robust, high integrity validated model.

Projects applying the national model approach (i.e. FullCAM) for woody biomass would need to meet additional eligibility criteria to ensure that the project location and management activities fit the calibration of the available national model, and this might require retention of the forest transition requirement. In other words, the expanded range of ecosystems and management changes could only be applied to projects that adopt a measure-model approach.

Section 3: A five-step process from project registration through to reporting

The proposed IFLM Method Framework would attribute carbon sequestration to eligible management activities to ensure additionality requirements are met. This approach can be summarised into a five-step process from project registration through to reporting. It is underpinned by well-established ecological restoration science. This attribution process described in this Section 3 of the discussion paper is a key safeguard within the method framework to ensure that carbon abatement is only credited for a) eligible activities that deliver a carbon gain and b) where there is a direct evidentiary linkage to the human management practice changes. Eligible activities that don't result in carbon sequestration won't be credited. Additionally, abatement won't be credited where there isn't direct evidentiary linkage between the factors that have been limiting carbon stocks and the additional management activities undertaken to address this limitation. The five key steps are summarised in Figure 6 below and are described in more detail in the following Section.

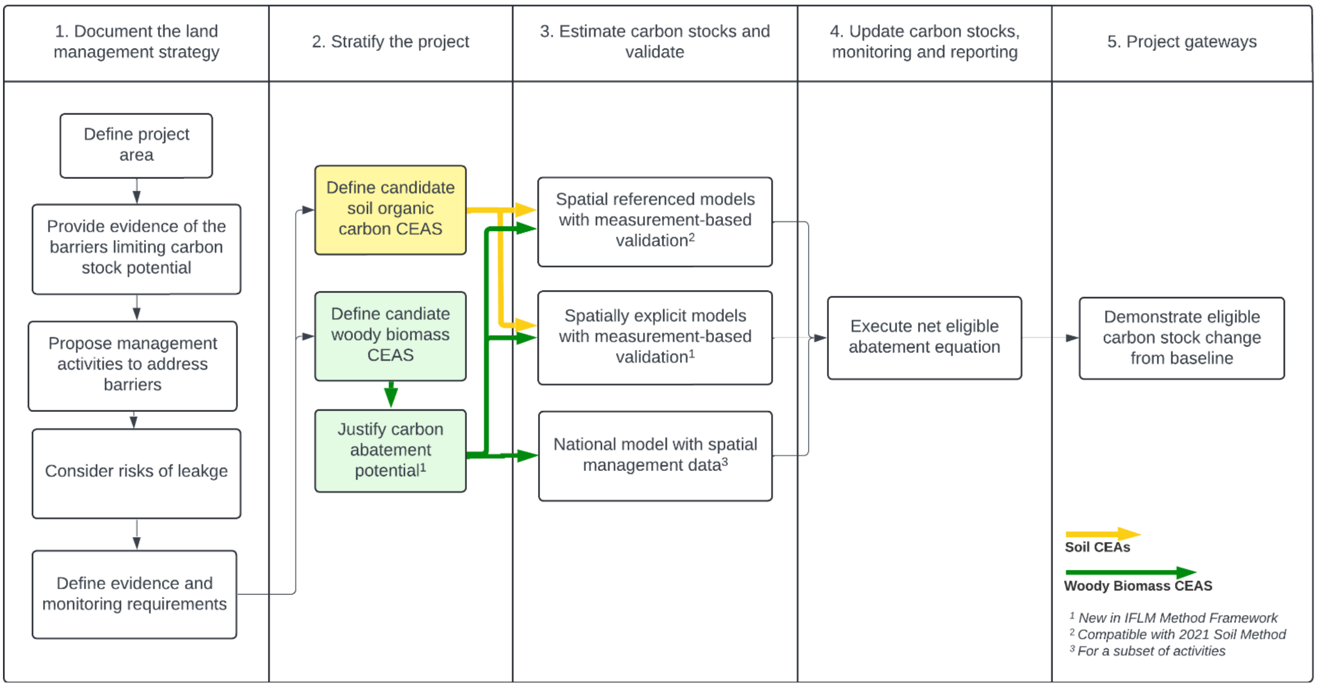

Figure 6: The key steps in an IFLM project. Yellow arrows indicate steps required for soil organic carbon CEAS (mirroring requirements in the Soil Carbon Method 2021) and green arrows denote steps required for woody biomass CEAs. Where arrows fork, only one selection is required. Arrows that combine indicate integrated steps that are conducted for the overall project.

Step 1. Document the land management strategy

The purpose of the Land Management Strategy is to provide a strong technical and scientific justification for how new and varied (additional) management activities will sequester carbon in woody biomass or soil organic carbon. A Land Management Strategy should describe the current state of the ecosystem and the natural and human processes impacting on carbon storage in the ecosystem, including a list of barriers preventing the ecosystem moving to a higher carbon state.

In the case of a soil CEA, this list of barriers could include things like nutrient deficiencies, soil acidity, inappropriate grazing regimes, unproductive pastures, or poorly functioning hydrological systems (mirroring requirement in the Soil Carbon Method 2021). In the case of a woody biomass CEAs, the list of barriers could include the absence of critical elements or ecosystem functions, like fire, seed sources or organic inflows, hydrology / water availability, and threats or suppression agents such as inappropriate grazing regimes, mechanical/chemical suppression, feral animals; competition from weeds, or poor ecosystem conditions such as soil salinity or compaction.

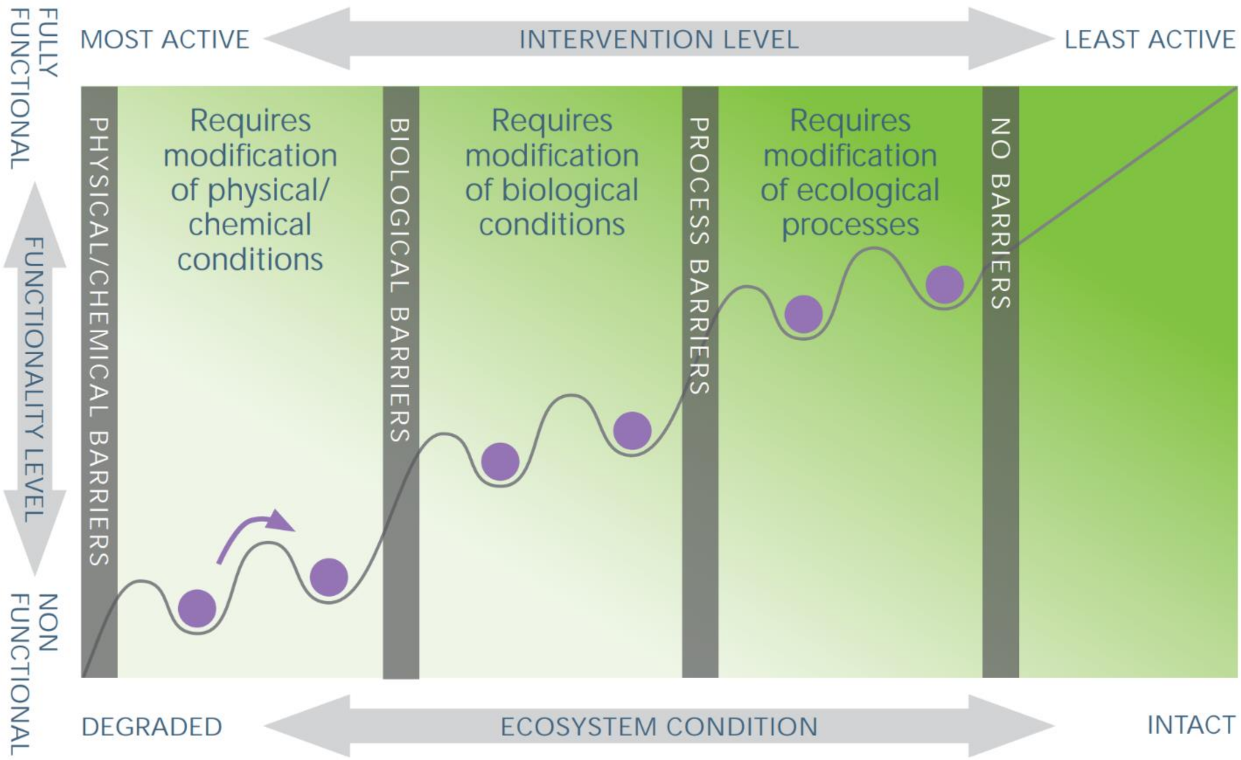

Figure 7: The [7] describe three broad types of barriers (physical, biological or ecosystem process) that prevent ecosystems moving to high functioning, advanced ecosystem states. Barriers may require a variety of interventions and ecosystem dynamics may be complex and non-linear. When barriers are removed, the ecosystem is expected to proceed toward a high carbon state. Note that barriers are not necessarily sequential, but physical, biological and process barriers may all exist at the same time and be addressed in parallel.

In addition to identification of barriers, the Land Management Strategy would articulate a plan for implementation of carbon management activities in the project that directly target the identified barriers that have been preventing increases in woody or soil carbon stocks. This plan is intended to be iterative and updated at regular intervals based on principles of adaptive management.

[7] Standards Reference Group SERA (2021) National Standards for the Practice of Ecological Restoration in Australia. Edition 2.2. Society for Ecological Restoration Australasia. Available from URL: Available from URL: http://www.seraustralasia.com/standards/home.html

In the case of more ecological complex management changes (such as changes to the fire regime), the Land Management Strategy could be required to be signed off by a qualified ecologist or person with Traditional Ecological Knowledge. As described above in Part 2.4, the Land Management Strategy would also articulate a leakage prevention and monitoring strategy. Further details of reporting requirements and types of acceptable information to demonstrate the direct evidentiary linkage are included in Section 4 of this discussion paper.

Step 2. Stratify the project

Stratification of the project area into CEAs is a feature of most, if not all, existing land-based carbon farming methods. This step would largely mirror stratification processes in existing carbon farming methods by grouping land across the project area that is expected to be eligible to generate ACCUs. This step is described below. For woody biomass CEAs, there could be an additional step (2b) to justify the carbon abatement potential of CEAs via the statistical gap analysis – a concept that was introduced in Section 2.3 and is described in more detail below.

Step 2a – Define candidate CEAs

Candidate CEAs may differ in their project activities, management history, or potential to increase woody or soil organic carbon stocks. Even where they overlap, the carbon stocks of woody biomass and soils would be treated separately. The eligibility of the candidate CEAs could be demonstrated in the land management strategy. For woody biomass CEAs, the accuracy of the CEA stratification process could be assessed via a map accuracy assessment process, which could be described in supporting guidelines, alongside targets for overall map accuracy requirements, including errors of omission and commission. For human-induced regeneration and native forest managed regrowth projects the accuracy threshold is currently 85%, and a similar accuracy threshold is proposed for the IFLM method.

Step 2cb– Justify abatement potential for woody biomass CEAs – Statistical gap analysis

The statistical gap analysis plays an important role in stratification of woody biomass CEAs. This step performs a statistical analysis to determine whether the candidate CEA has significant scope to grow toward its maximum sustainable carbon stock, in response to the proposed project activities. The presence of a carbon stock gap indicates that something must have occurred historically that caused the carbon stock to be below its maximum. The causal agent of the gap could be natural disturbance, anthropogenic land management (including active actions depleting or supressing carbon stocks and/or a lack of adequate management activity), or a combination of the two sets of factors. The existence (or not) of a carbon stock gap is demonstrated via data collected within the CEA, for example with measurements of woody carbon stocks, canopy height and area, or tree size classes. Evidence of the carbon stock gap is taken in conjunction with direct evidentiary information (including third-party documentation) of the factors preventing carbon stock gain, which must be addressed in the Land Management Strategy.

The statistical analysis would involve comparison of preliminary measurements taken in the CEA to ecosystem benchmarks representing a more ecologically advanced state. Ecosystem benchmarks can be derived from conceptual models or from comparable ecosystems (i.e. reference sites). One set of measurements that could be used for the statistical gap analysis could be woody carbon stocks. Alternatively, canopy area and vegetation height could be used to compare against benchmarks of forest cover. Another option could be demographic analysis of tree size data, or analysis of tree population dynamics. In this case, the absence of a specific woody cohort might suggest a historical event that caused the gap. The existence of a statistically significant carbon stock gap between the CEA and the ecosystem benchmark would suggest there is potential to store more carbon in the ecosystem, potentially via implementation of one or more of the eligible project management activities. Therefore, the gap analysis would result in a binary pass/fail process to delineate eligible CEAs that is fully de-coupled from eligible abatement calculations (although the same data could potentially be used to calculate project carbon stocks).

Ecosystem benchmarks used for gap analysis would be aligned with contemporary ecological restoration practices, where indicators of key ecosystem attributes are benchmarked against an ecologically comparable target state. Ecosystem benchmarks could be compiled from public datasets or data from ecologically comparable reference sites in regional proximity to the CEA; predictive models of forest growth; and/or relevant, project-specific data on existing vegetation structure. Generic, state-based benchmarks of ecosystem structure (i.e., ecosystem archetypes) may be available in state-based guidelines which could be used to inform the proponent's desired outcome. Two examples of conceptual models are presented in Figure 4. Benchmark ecosystem data could be shared on public platforms to ensure transparency.

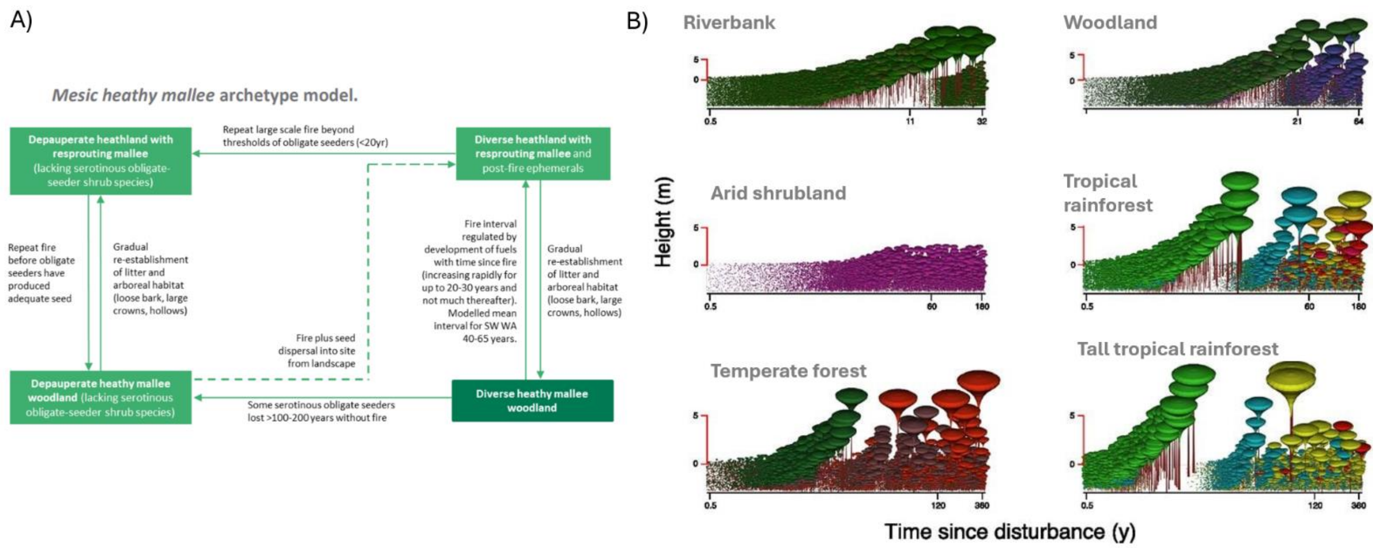

Figure 8: a) An example of an archetype model for mesic heathy mallee from the Australian Ecosystems Models Framework[8]. b) Predictive models of forest growth and successional dynamics across a range of forest ecosystems in the wake of a stand replacing disturbance.[9]

[8] Prober, S., Richards, A., Hodgson, J., Gosper, C., Sundholm, A. M., White, M. and Yates, C. (2023) The Australian Ecosystem Models Framework: Mallee woodlands and shrublands. Accessed May 2024 at https://publications.csiro.au/publications/publication/PIcsiro:EP208384. DOI: **10.25919/9kpp-xd43**

[9] Falster, D.S., Brännström, Å., Westoby, M., & Dieckmann, U. (2017). Multitrait successional forest dynamics enable diverse competitive coexistence. Proceedings of the National Academy of Sciences, 114, E2719 - E2728. Available at: https://www.pnas.org/doi/full/10.1073/pnas.1610206114

Working Definitions:

Maximum sustainable carbon stock: the estimated biophysical limit of land-based carbon sinks. Projects would be required to show progress towards the maximum sustainable carbon stock as project activities proceed to be issued credits. The maximum sustainable carbon stock could be conservative and could also be exceeded but may not be varied without varying historical eligibility claims based on gap analysis.

Ecosystem benchmarks: the attributes of a real or notional community of organisms, and their associated environment, used to guide land management planning. The ecosystem benchmarks could come from an actual site (i.e. reference site) or a conceptual model synthesised from numerous reference sites, field indicators and/or historical and predictive records. The ecosystem benchmarks would describe the specific ecosystem attributes (like soil type, species composition, land use and disturbance frequency) and provide the basis for monitoring and assessing outcomes attained by undertaking the project activities. An important ecosystem benchmark could include the maximum sustainable carbon stock under the nominated (planned) land use. Ecosystem benchmarks would represent a comparable ecosystem in a more ecologically advanced state, and may include either recovering or undisturbed (remnant) native ecosystems.

Reference site: a real community of organisms, and their associated environment.

Conceptual models: a notional community of organisms, and their associated environment. Readily available conceptual models that could be used for during the gap analysis could be nationally available data sources such as the maximum attainable aboveground biomass layer of FullCAM.

Step 3. Estimate carbon stocks

As described in Section 2.2, it is proposed there would be total of five Abatement Schedules for estimation of soil and woody carbon stocks. These include:

1. National model – woody biomass:
2. Spatially referenced models – Soil
3. Spatially referenced models – Woody biomass
4. Spatially explicit models – Soil
5. Spatially explicit models – Woody biomass

A more detailed explanation of all five approaches is described in Section 4. In all approaches, validation measurements and the applications of models would be audited by a third party.

In an environment of rapid innovation in modelling and measurement technologies, it is proposed the IFLM method could be 'technology agnostic'. This could allow proponents to adopt lower cost and more precise technologies over time, which would deliver increasing levels of certainty. In addition, providing a pathway for approval of new, high accuracy technologies would also send an important signal necessary for investment in new technologies as they emerge. A technology agnostic method could be achieved via the introduction of a qualification process, whereby the new modelling approach or measurement technology could either be:

- published in peer reviewed literature [3+ articles), with a stated accuracy above a certain threshold; or
- the new technology could demonstrate a high correlation with an existing approved high-accuracy technology via a one off upfront high-accuracy program, comparing the 'new' and the 'existing' technology.

The measurement or modelling validation processes would be subject to audit.

An additional integrity control has been proposed for calculation of woody biomass carbon stocks when using the measure-model approach. This is the concept of an 'eligible carbon stock ratio', where trees or land containing trees that are not affected by the management change would be excluded when calculating eligible abatement.[10] For example, trees that are too tall or are unlikely to be affected by grazing, or that cannot be cleared under State/Territory legislative requirements, would be excluded in this step. As a complement to the stratification of land into CEAs and exclusion area, this approach provides a fine resolution tool to ensure additionality of abatement in ecosystems with a matrix of tree sizes and species, where abatement will only be issued for sequestration that is affected by the management change.

Step 4. Update carbon stocks, monitoring and reporting

The carbon stocks of woody biomass and soil CEAs would be estimated at the start of the project. Changes in carbon stocks would be calculated at each reporting period by executing net abatement calculation. The carbon stocks of each CEA would be reported individually, from Step 3, and then aggregated. Project and leakage emissions could be deducted. Buffer deductions would be applied the net abatement amount at each reporting period.

[10] This concept was first proposed for inclusion in the IFLM method by the Clean Energy Regulator, in a draft version of the IFLM method in July 2022. The Avoided Deforestation method also has an example of an eligible carbon stock ratio, that is used to exclude biomass in trees that are not permitted to be cleared.

For the woody biomass CEA using the measure-model approach, the eligible carbon stock ratio would be applied to withhold any sequestration estimated to occur in ineligible carbon stocks. For all CEAs using the measure-model approach, like the Soil Carbon Method 2021, the IFLM method would require accounting for a range of uncertainties. Modelled carbon stock changes, as in the 2021 Soil Method, would be required to show that the magnitude of carbon stock change was material, after accounting for a range of uncertainties. The carbon stock at the end of the reporting period must be greater than the carbon stock at the start of the reporting period, and there can be no more than 40% overlap of the distribution of carbon stocks between the two time points. As carbon stocks continue to increase, or as uncertainties decrease with additional data collection, then any overlap with the initial carbon stock estimate will decrease to zero.

For woody biomass CEAs, this probability of exceedance threshold would be in addition to an overall 85% map accuracy requirement for spatial delineation of CEAs, as described in Step 2. The length of the reporting period would likely depend on the rate of increase and the precision of eligible carbon stock estimates. Reporting periods could vary from less than one to more than five years.

Step 5. Project Gateways

Projects would also encounter regular project gateways to assess whether the ecosystem is sequestering carbon and advancing toward its maximum sustainable carbon stock. Project gateways are a common feature of existing methods, and typically require meeting specific criteria indicating that the carbon management activities have been effective. Under the IFLM method, project gateways could be applied to woody biomass CEAs to assess whether the ecosystem is advancing toward its ecosystem benchmark or maximum sustainable carbon stock.

Woody carbon stocks estimated using FullCAM would be required to demonstrate progress in line with the modelled progression of woody carbon stocks, typically as a measure of % canopy cover similar to current regeneration gateway checks, but also using evidence of forest potential such as stem counts.

Woody carbon stocks using measure-model approaches could provide periodic verification that carbon stocks and other relevant biophysical variables are increasing towards the nominated ecosystem benchmarks, via a repeated gap analysis.

At this gateway, the accuracy of the eligible carbon stock ratio could be reviewed to ensure it is conservative. This would involve demonstrating that increases in net biomass stocks are attributable to the recruitment and growth eligible trees, deducting the growth that occurred in any ineligible cohort and demonstrating that the number of ineligible cohort remains constant. The eligible carbon stock ratio could be updated and any over or underestimated eligible carbon stock change would be reconciled before issuance.

Section 4. IFLM Method Framework by Component

This section provides a summary of each IFLM method component that would be required to finalise drafting of a standard carbon farming methodology determination for the proposed method. This is aligned with and builds on components set out for consultation in the non-legal preliminary technical consultation draft version of the IFLM method shared by DCCEEW as part of targeted technical consultations in October 2023. In addition to each component, we provide the scientific foundations underpinning the proposed method approach and how the proposed approach includes safeguards and meets the Offsets Integrity Standards which must be considered by CAIC in reviewing the IFLM method and preparing a recommendation to the Minister.

IFLM method component	**Summary of scientific basis**	**Evidence basis – Key scientific papers**	**Options for method safeguards*** *Category of method safeguard shown with underline formatting. ***[Relevant Offsets Integrity Standard shown grey square brackets]***
1. Woody biomass activities: Ecological framework to identify barriers to ecosystem restoration, and proposed eligible management changes	A CSIRO report to the Climate Change Authority notes that regeneration of native forest is “readily scalable, with low fixed costs that are independent of project extent, and minimal costs associated with project establishment and maintenance.” Restoration of native forest is already making a meaningful contribution to Australia’s emission reduction targets, whereby ‘land converted to forest land’ is one of the top three ‘key categories’ in Australia’s latest national inventory report (alongside public electricity and road transportation), and the top sequestration contributor. The proposed IFLM method framework for sequestration in woody biomass is based on the principles of ecological restoration, where the goal is restoration of the ecosystem towards a more ecologically advanced ecosystem state. The Society for Ecological Restoration Australasia (SERA) ‘National Standard for Ecological Restoration’ recommend a three-step ecological restoration approach: 1. Assessing site condition to determine the appropriate ecological restoration approach, including assessing the potential for spontaneous regeneration by looking dormant in-situ propagules or seed from nearby sources, and identifying the barriers to restoration; 2. Removing the barriers to ecosystem restoration; and 3. Modifying the physical, chemical, biological conditions or ecosystem processes in favour of ecosystem restoration. Following these ecological restoration principles, the proposed IFLM method accounts for eligible abatement from four main categories of ecosystem restoration including:	Fitch P, Battaglia M, Lenton A, Feron P, Gao L, Mei Y, Hortle A, Macdonald L, Pearce M, Occhipinti S, Roxburgh S, Steven A. (2022). Australia’s sequestration potential, CSIRO Standards Reference Group SERA (2021) National Standards for the Practice of Ecological Restoration in Australia. Edition 2.2. Society for Ecological Restoration Australasia. Keenleyside, K.A., N. Dudley, S. Cairns, C.M. Hall, and S. Stolton (2012). IUCN Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices. Gland, Switzerland: IUCN. DCCEEW (n.d.). Key threatening processes under the EPBC Act. [13] Williams K, Hunter B, Schmidt B, Woodward E & Cresswell I (2021). Australia state of the environment 2021: land, independent report to the Australian Government Minister for the Environment, Commonwealth of Australia, Canberra. Richards AE, Dickson F, Williams KJ, Cook GD, Roxburgh S, Murphy H,	For sites with potential to recover via spontaneous regeneration following removal of barriers to regeneration, the foundational premise of the proposed IFLM method is a requirement to identify the dominant suppression agent(s); to test whether the suppression agent has had a material impact in supressing woody biomass stocks below its carrying capacity; and if so, implement a management change that removes the dominant suppression agents. ***[Additionality, Eligible carbon abatement, Measurable and verifiable]*** The presence of suppression agents, and an indication of their impact on the woody biomass, could be assessed using multiple evidence points which could include demonstration of the following: **CEA is below its maximum sustainable carbon stock** • If a CEA is below its maximum sustainable woody biomass carbon stock, something must have occurred historically that caused the carbon stock to be below its maximum. This is known as the ‘ecological fingerprint’ left by historical events, and it creates a carbon stock ‘gap’ that could potentially be filled by a management change. The causal agent of the gap could be natural disturbance, human-induced management, or a combination of the two. • Project data collection requirements: To determine if there is a gap between the current and maximum sustainable potential woody carbon stock in a CEA, the IFLM method could have a statistical test involving comparison of current carbon stock to the maximum sustainable carbon stock of the CEA. The

[13] Available at: https://www.dcceew.gov.au/environment/biodiversity/threatened/key-threatening-processes

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* <u>*Category of method safeguard shown with underline formatting.</u> *[Relevant Offsets Integrity Standard shown grey square brackets]*
	1. Spontaneous regeneration, where the main barrier to ecosystem restoration is the presence of suppression agents. In these cases, the site has existing in-situ seed or root stock. The management change involves removal of suppression agents that were preventing growth of existing regeneration, or new germination of seed stock; 2. Facilitated regeneration, for sites where the main barrier to ecosystem restoration is the absence of a seed or seedling bank, and/or competition from other species. The management change involves reintroduction of target species via planting or direct seeding, According to SERA, “reintroductions of species should only be carried out if and when potential for regeneration has been tested or is known to be not possible or sufficient”; 3. Combined regeneration/re-introduction, for sites where a combination of barriers to ecosystem restoration apply, such as barriers applying to some less resilient species and not others. The management change involves a combination of spontaneous and facilitated regeneration to restore species diversity on all parts of the site; and 4. Reconstruction, where the substrate (e.g. soil) may need to be re-introduced or modified prior to seeding or planting, to facilitate reintroduction of native woody species. The list of barriers to ecosystem restoration under the proposed IFLM method has a high level of alignment with key threatening processes[11] or pressures that are identified under the EPBC Act and/or in the State of Environmental Report. For example, there are 21 key threatening processes listed under the Australian EPBC Act, and the IFLM method addresses seven of these.[12] Australia’s State of the Environment (SOE) Report lists a number of pressures on the Australian environment that are also eligible suppression agents under the proposed IFLM method, including land clearing; overgrazing by introduced herbivores, and competition from weeds. The scientific basis for each of the eligible suppression agents under the proposed IFLM method is provided in the rows below. Given the high level of alignment with Australia’s biodiversity conservation frameworks, the IFLM method may form a complimentary tool with emerging methods under the Nature Repair market.	Doherty M, Warnick A, Metcalfe D, Prober SM (2020) The Australian Ecosystem Models Framework project: A conceptual framework. CSIRO Client Report EP1810177. Maschler et al. (2022) Links across ecological scales: Plant biomass responses to elevated CO2. *Global Change Biology* 28.21: 6115-6134.	maximum sustainable carbon stock is derived from ecologically appropriate benchmarks (e.g. the maximum biomass layer of FullCAM) or alternative ecosystem benchmarks from an ecologically comparable ecosystem. The ecosystem benchmarks provides an indication of the carbon stock that might be achievable if the management change is implemented successfully. *[Additionality, Measurable and verifiable]* • <u>Mapping requirements:</u> The existence of a statistically significant carbon stock gap, together with a direct evidentiary linkage to an eligible human suppression agent, provides evidence to suggest that the CEA has been suppressed, and that the CEA has potential to sequester carbon in response to an eligible management change. Only land that can meet these requirements could be mapped as eligible woody biomass CEAs. *[Additionality, Evidence-based, Measurable and verifiable]* **Direct evidentiary linkage between carbon stock gap and barriers to ecosystem restoration** • To determine if the existence of a carbon stock gap is caused by human management decisions that were in force during the baseline period, or whether they were caused purely by natural events, it is necessary to investigate whether a direct evidentiary linkage or correlation between the carbon stock gap and the management evidence. • <u>Record-keeping requirements:</u> The direct evidentiary linkage could be established via third party documentation showing the historical presence and density of the suppression agent (such as receipts, tax statements, sales records etc), and internal documentation such a time-stamped photographs, paddock books. *[Additionality, Evidence-based]* • <u>Project data collection requirements:</u> Direct evidentiary linkages could also be established via comparison of historical management practices in the CEA to ecosystem benchmarks, representing a comparable ecosystem in a higher carbon state. Differences in management practices that are correlated with differences in carbon stocks, canopy cover metrics or tree

[11] ‘Key threatening processes’ are processes that may threaten the survival, abundance, or evolutionary development of native species or ecological communities.

[12] The seven key threatening processes listed under the EPBC Act that are also addressed under the regeneration component of the IFLM method include: 1) Competition and land degradation by rabbits; 2) Competition and land degradation by unmanaged goats; 3) Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs; 4) Fire regimes that cause declines in biodiversity; 5) Land clearance; 6) Loss and degradation of native plant and animal habitat by invasion of escaped garden plants; and 7) Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting. *[Relevant Offsets Integrity Standard shown grey square brackets]*
			demographics can provide evidence of a direct evidentiary linkage to the impact of management. *[Evidence-based]* • Project data collection requirements Ancillary data sources such as historical imagery could also be used to demonstrate past suppression or negative changes in woody biomass cover. *[Evidence-based]* **Monitoring success of the ecological intervention** • Net abatement calculation: The success of the ecological intervention (i.e. removal of barriers to regeneration) should be monitored over time. Under approaches using measurements and models, ACCUs would only be issued when biomass has increased. Under the FullCAM approach, issuances would be paused if the projects do not meet certain gateway checks (FullCAM approach). *[Conservative, Additionality, Measurable & Verifiable]* **Adaptive management and responding to change** • Net abatement calculation: CO2 fertilisation is altering sequestration and cycling rates for natural carbon sinks, and has complex interactions with other ecological processes like population and disturbance dynamics. For both woody biomass and soil organic carbon CEAs, the framework determines eligibility and physical, biological and process barriers to carbon removals. Any changes in growth or turnover rates following the removal of barriers as part of implementing the project land management strategy will be captured via measurement & modelling approaches. *[Conservative, Additionality, Measurable & Verifiable]* **Third party auditing** • Auditing requirements: Under the Carbon Farming Initiative Act, all projects are subject to independent third-party audits, and projects are not issued until this has occurred. *[Measurable & Verifiable]*

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting. *[Relevant Offsets Integrity Standard shown grey square brackets]*
2. For sequestration in woody biomass CEAs: Framework to calculate abatement for eligible woody carbon sequestration activities – spatially-explicit & spatially-referenced approaches	**Measurements and models to estimate of abatement from woody biomass sequestration** The introduction of a model calibration and validation option for woody biomass builds on a similar feature that was introduced in the 2021 soil carbon method. This process involves using high precision data to test how accurate the model is at predicting carbon stock changes and making refinements to the model if required. Model calibration and validation is a well-accepted process that has been articulated in peer reviewed scientific literature for many decades. **A 'Gap analysis' and 'eligible carbon stock ratio' ensures that abatement is eligible** Approaches using measurement and models could include two main features to ensure that ACCUs are only issued for sequestration that is genuinely impacted by the eligible management change: 1) restriction of CEAs to land that is significantly below its maximum sustainable carbon stock (i.e. land that passes the carbon stock 'gap' analysis); and 2) application of an 'eligible carbon stock ratio'. Eligible carbons stock ratios would be estimated for each CEA, with the purpose of deducting sequestration from ineligible trees that are not affected by the management action. For example, in a CEA where grazing was the only eligible suppression agent, ineligible trees in a CEA might be those that are less palatable, that were above grazing height at project commencement, or that were not eligible to be cleared. The carbon sequestered in this cohort of ineligible trees would be monitored over time and deducted from total carbon sequestration in the CEA. Eligible carbon stock ratios could be estimated using repeated measurements of tree size (such as stem counts by size class or canopy height). For some project activities, such as facilitated regeneration (i.e environmental plantings) and where complete clearing is allowed, the eligible carbon stock ratio would be 1.0 (meaning all carbon sequestration would be eligible). **Averaging approaches and spatial models** It is possible to estimate carbon stocks of woody biomass by either 1) averaging of point-based estimates, or 2) spatial models. It is proposed that both types of estimates would be possible under the IFLM method. Point based estimates involve taking measurements such as tree diameter and height in sample plots, and then applying an allometric equation to convert these variables to biomass. The average carbon stock of all plots in	McRoberts, R. et al. (2022) Statistically rigorous, model-based inferences from maps. Remote Sensing of Environment 279: 113028. Duncanson, et al. (2021) Aboveground biomass. Satellite-Derived Land Product Validation: Land Product Validation Subgroup (WGCV/CEOS),[14] particularly: • Ch. 2.1 – Paul, K. et al: 2.1 Field Measurement Errors • Ch. 2.2 – Chave, J. et al: Allometric Errors • Ch 3.1 – Réjou-Méchain, M. et al: Spatio-Temporal Mismatches During Calibration/Validation Procedures • Ch 4 – Roxburgh, S & McRoberts, R: Characterization and Propagation of Error Labrière, N. et al. (2023) Toward a forest biomass reference measurement system for remote sensing applications. Global Change Biology 29.3: 827-840. Liao, Z, et al. (2020) Woody vegetation cover, height and biomass at 25-m resolution across Australia derived from multiple site, airborne and satellite observations. International Journal of Applied Earth Observation and Geoinformation 93: 102209. Goetz, S. et al (2022) Revisiting the status of forest carbon stock changes in the context of the measurement and monitoring needs, capabilities and potential for addressing reduced emissions from deforestation and forest degradation. Environmental Research Letters 17.11, 111003.	**Models outputs must be validated with measurements** • Net abatement calculations: The inclusion of a model calibration and validation approach in the IFLM method would provide increased confidence in the accuracy of modelled abatement estimates. It would also allow for increased flexibility of management, as modelled outcomes could be measured. *[Conservative, Measurable & Verifiable, Evidence-based]* **Reporting of uncertainty** • Net abatement calculations: Validated models would be required to report uncertainty, and would be required to demonstrate greater than 60% confidence that carbon stocks have increased in order to receive issuance *[Conservative, Measurable & Verifiable, Evidence-based]* • Auditing requirements: Reporting of model validation statistics would enable the Regulator, auditors and other stakeholders to assess how well a model predicts carbon sequestration, relative to high precision measurements. *[Measurable & Verifiable]* **Two overlapping processes to ensure additionality** • Project data collection requirements: The measurement based model validation approaches would include two separate processes to ensure that abatement is only issued for sequestration that is additional to business as usual: 1) delineation of CEAs into land that meets the statistical gap analysis (i.e. land that has been suppressed and has potential to grow in response to the management change); and 2) application of the eligible carbon stock ratio, to exclude trees or land within the CEA that after not affected by the management change. *[Additionality, Measurable & Verifiable, Evidence-based]* **Models to be applied within the validation scope** • Net abatement calculation: Because carbon stock estimates using models and measurement are precise enough to account for changes in net biomass, there is greater flexibility on what vegetation categories and management activities can be applied. Safeguards to ensure that models are used to predict

[14] Available at: https://lpvs.gsfc.nasa.gov/PDF/CEOS_WGCV_LPV_Biomass_Protocol_2021_V1.0.pdf

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting.* ***[Relevant Offsets Integrity Standard shown grey square brackets]***
	a strata is then applied across all land in the strata. In this case the 'model' is simply the average of all sample plots in a strata. Spatial models involve estimating carbon stock of woody biomass across more discrete areas of land (which could be as small as a single pixel), by correlating a feature observed in remotely sensed imagery (such as crown cover or tree height) with high accuracy sample measurements of carbon stock. In this case the 'model' is the estimate of carbon stock in each area of land, based on the allometric relationship between the proxy variable (such as tree height or crown cover), and carbon stock. **Model validation processes** Validation requirements would aim to quantify the accuracy of woody carbon estimates. Validation processes would be transparent and objective to allow independent auditors to verify that each step has been completed appropriately and the validation results are credible. Where spatial models are used to estimate carbon stocks, the map calibration and validation data could be collected using a probability sampling design to ensure that the full range of carbon stock values (low, medium & high) and geographic conditions are covered. Sample data may need to be collected outside the carbon estimation areas to obtain a representative sample. Sample plot locations could be pre-registered with the CER to prevent gaming, and could include back-up sample locations in case of access limitations. **Validation metrics** Recommended validation metrics include systematic deviation, precision and carbon stock uncertainty. Sample size must be sufficient to summarise errors by woody carbon class (e.g. low, medium, high) and by geographic stratum to identify specific regions or forest types with lower accuracy or greater bias. A probability of exceedance test could be applied to incorporate uncertainty. **Timing of model validation** Model validation would be conducted at project registration and at subsequent gateways. The woody carbon stock map would be updated at the end of reporting period and the net carbon stock change would be estimated as the total carbon stock within the CEA boundaries as T(i+1) – T(i). Total carbon stock could be calculated by integrating over the map, within CEA boundaries (also commonly referred to as zonal statistics).	Xiao, J, et al. (2019) Remote sensing of the terrestrial carbon cycle: A review of advances over 50 years. Remote Sensing of Environment 233: 111383. Draws from measurement based model validation approaches to estimating soil organic carbon sequestration; *Carbon Credits (Carbon Farming Initiative—Estimation of Soil Organic Carbon Sequestration using Measurement and Models) Methodology Determination 2021* (DCCEEW).	abatement in circumstances where the model has been validated include: - Third party auditing of model validation assumptions; - Phased requirements to take measurements across the full range of ecosystem conditions and management regimes where the model is applied; - Inherent disincentives to apply the model outside the validation scope, as this risks the model failing its statistical compliance tests; - The model can only be applied on CEAs that have passed the gap analysis, which shows that land can support sustainable carbon stock increases in sub-forest or mixed age cohorts, not represented in the national model. - The eligible carbon stock ratio ensures woody biomass increases are only being reported in the eligible cohort. ***[Additionality, Measurable & Verifiable, Evidence-based]*** **Ongoing monitoring incorporates ecosystem benchmarks** • Data collection requirements: The inclusion of a repeat statistical gap analysis would provide a tangible, transparent and standardised way to benchmark progress towards a more ecologically advanced, higher carbon storing ecosystem. Other features of measurement based model validation approaches that build integrity of the abatement estimates could include: • Pseudo-randomly generated sampling design for model validation pre-registered with the CER. • Collection of sample reference carbon stock measurements at model validation sites. • Data processing and quality assurance / quality control protocols. • Documented rationale for model choice and demonstration of applicability; model calibration and evaluation. • Summary of model verification and analysis of model precision. • Auditable chain of evidence. • Maintenance of an estimated ineligible carbon stock reserve and only those that pass the gap progression test have the ineligible reserve revised downwards, leading to a windfall in creditable abatement if the eligible carbon stock ratio is shown to be conservative.

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* <u>*Category of method safeguard shown with underline formatting.</u> ***[Relevant Offsets Integrity Standard shown grey square brackets]***
	Monitoring growth of woody biomass via repeat statistical gap tests Gap progression tests could be conducted at regular gateways to confirm that ecosystem condition has improved and that the net carbon stocks have responded in line with the nominated project activities. Projects that pass the progression gateway could revise the eligible carbon stock ratio with each monitoring event. This is because the expected contribution of larger ineligible trees to net sequestration might be expected to diminish over time, as the carbon sequestration rate of larger trees declines as they approach maturity. The eligible carbon stock ratio is revised by repeating measurements of tree size within the CEA and deducting the same number of the largest trees (or area of canopy) that were above the size threshold at project registration. This is conservative because it assumes that carbon sequestration from remnant trees is deducted indefinitely, regardless of the true mortality rate. **Expansion of eligible vegetation categories** One opportunity created by the introduction of a measurement based model validation approaches for woody biomass, is the expanded scope of eligible woody biomass categories to include sequestration in land that has significant potential to progress towards a more advance ecosystem state and store carbon as a result of human management changes, but that does not necessarily have potential to transition from non-forests to forest according to the threshold definition in Australia. This approach also provides more flexibility to model woody carbon stock increases in vegetation with mixed age cohorts. This represents a step-change from the existing suite of carbon farming methods, which have very limited eligibility criteria, and generally require woody biomass to transition from below the forest cover threshold to above (or the reverse) and CEA to be delineated into even-aged cohorts. This requirement is not well suited to Australia's agricultural and Indigenous estate, and has significantly constrained participation in carbon farming. Introducing the measurement based model validation approaches for woody biomass would align with existing approaches for the estimation soil organic carbon and broaden participation across a diverse range of ecosystems and land management regimes.		• Monitoring and notification of disturbance events within a 90 day window.

IFLM method component	**Summary of scientific basis**	**Evidence basis – Key scientific papers**	**Options for method safeguards*** <u>*Category of method safeguard shown with underline formatting.</u> *[Relevant Offsets Integrity Standard shown grey square brackets]*
3. Woody biomass activities: Framework to calculate abatement for eligible woody biomass sequestration activities – national model (ie. FullCAM) approach	**Summary of FullCAM for estimation of woody biomass carbon sequestration** FullCAM is a process-based model that simulates the effect of photosynthesis and respiration in a broad range of forest and woodland ecosystems across Australia. FullCAM models the growth and decay of woody biomass, coarse woody debris, soil organic carbon, and atmospheric emissions of CO_2, CH_4 & NO_2 from woody carbon pools. Growth and productivity are driven by local climate variables and the event queue is used to model management activities and disturbances. Carbon sequestration estimates using FullCAM are controlled by two main variables: 1) maximum aboveground biomass, which is the assumed carbon storage capacity of woody biomass on the site at maturity, or 'MaxBio'; and 2) the rate of carbon sequestration over time, or the 'Tree Yield Formula'. **Calibration of FullCAM** When FullCAM was first built in the early 2000's by the then Australian Greenhouse Office, the asymptotic MaxBio values were developed using a database of ~5,700 mature, undisturbed forest stands. These values are interpolated over the Australian continent using bioclimatic covariates (e.g. vegetation community, temperature, water availability and elevation). The Tree Yield Formula has been fitted to the recruitment of trees with the potential to exceed >2 m tall. Most of the original growth curve calibration dataset was from forest inventory data at sites in the early stages of regeneration, with low total biomass, with some competition from preexisting (remnant) trees of an older age. **Calibration of FullCAM for operation in regenerating ecosystems** The carbon stock change in FullCAM is represented as a single, even aged cohort. While FullCAM does not explicitly model competition from remnant trees, it was calibrated in regenerating ecosystems with a mixture of age classes. Canopy area is strongly correlated with both light and water availability and sparse canopies indicates that the effect of competition from remnant trees is low. For this reason, projects using FullCAM must stratify the landscape into areas with less than < 20% canopy area above 2m tall and uniform potential for a regenerating age/size class to sequester additional woody carbon. Regenerating ecosystems can have a blend of existing mature trees alongside a smaller regenerating cohort. To test the appropriateness of	Paul, K. & Roxburgh S. (2020) Predicting carbon sequestration of woody biomass following land restoration. Forest ecology and management 460: 117838. Roxburgh, S., et al. (2019) A revised above-ground maximum biomass layer for the Australian continent. Forest Ecology and Management 432: 264-275. Paul, K, & Roxburgh, S. (2022) Verification of FullCAM's Tree Yield Formula for Regenerating Systems. CSIRO, Australia. FullCAM Guidelines: Requirements for using the Full Carbon Accounting Model (FullCAM) in the Emissions Reduction Fund (ERF) methodology determination: *Carbon Credits (Carbon Farming Initiative) (Human Induced Regeneration of a Permanent Even Aged Native Forest—1.1) Methodology Determination 2013* (2020) DISER, v3.0 FullCAM Guidelines Requirements for using the Full Carbon Accounting Model (FullCAM) in the Emissions Reduction Fund (ERF) methodology determination: *Carbon Credits (Carbon Farming Initiative) (Reforestation by Environmental or Mallee Plantings—FullCAM) Methodology Determination 2014* (2020) DISER, v3.0 Guidelines on stratification, evidence and records or projects under the Human-Induced Regeneration of a Permanent Even-Aged Native Forest and Native Forest from Managed Regrowth methods (2019) Clean Energy Regulator. HIR Gateway Audit Requirements (2023) Clean Energy Regulator. Forrester, D. (2014) The spatial and temporal dynamics of species	**Criteria for when national model (FullCAM) may be applied** <u>Project data collection requirements, Mapping requirements:</u> To strengthen confidence that FullCAM is being applied in circumstances that fit the model assumptions, projects, there could be priority funding allocated to research in areas where additional calibration or validation is required. In addition, projects using FullCAM could be required to: • Be located in a ecosystem and applying an activity for which FullCAM has been validated (for regeneration activities) and/or is considered to be demonstrably conservative (for environmental planting activities); • Contain CEAs that are below the forest cover thresholds at the time of project commencement and for the entirety of the baseline; • Contain CEAs that transition to forest cover, to be checked at project gateways; • To be clear – the existing (Kyoto era) forest and non-forest eligibility thresholds are maintained under the FullCAM approach. *[Measurable & Verifiable, Evidence-based, Conservative]* **Strengthened evidence of forest potential** <u>Project data collection requirements, Mapping requirements: Building on requirements comprehensively implemented following the Independent ACCU Review,</u> the proposed IFLM method could strengthen evidence of forest potential using a combination of options like: • The CEA must have contained forest cover at some point in the past (there is no time limit on when). This could be evidenced via satellite imagery, aerial photography, photos, or other evidence; or • The CEA must contain an ecosystem that is likely to form forest cover, as per available state-based pre-clearing extent layers, or national pre-clearing extent layers; or • An independent qualified ecologist has provided an opinion that the CEA is likely to form forest cover following removal of the suppression agent. *[Conservative, Additionality, Evidence-based]* **More prescriptive map accuracy assessment requirements**

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	using FullCAM in regenerating ecosystems where there may be competition between existing trees and the younger regenerating cohort, in recent years CSIRO has undertaken a range of FullCAM calibration and validation studies. This work builds on the initial model calibration with a 1.6-fold increase in the number of calibration sites available (with a total of 573 sites contributing to the calibration dataset in NSW and QLD). The study design involved specific validation of the suitability of the FullCAM model for calculating abatement in regenerating ecosystems where there is already a proportion of existing biomass (i.e. the model was tested in an environment where there was potential for competition between the regenerating cohort and existing trees). Following validation of the model using observations from 41 sites across a total of 14 carbon projects across NSW and QLD, the researchers found that "overall bias of the model was negligible" and concluded that "these results provide verification that over multiple stands of regeneration in the study area, there is minimal risk of bias resulting in a divergence between the modelled and actual rates of carbon sequestration." However, the findings from the FullCAM validation study also noted that "further work is required to verify Tree Yield Function (TYF) predictions of above ground biomass for other regions where regeneration is also common, and that were outside our study region." It should also be noted that the validation study examined regenerating cohorts over a time period that approximates the first half of the crediting period for sequestration projects under the ACCU scheme. How competition from existing mature vegetation affects FullCAM model accuracy beyond the 25-year crediting period of the ACCU scheme is less well understood. Projects using FullCAM have a restricted set of eligible project activities aligned with the core processes of FullCAM. The requirement for all areas to be represented by a single model (i.e. have condition and potential uniform) means that there are strict guidelines for mapping and stratification that must be followed. Multiple, independent data sources are required to show that the mapping is accurate, that the FullCAM model is applicable, and that the ecosystem condition of the CEA is improving in line with the nominated project activities.	interactions in mixed-species forests: from pattern to process. Forest Ecology and Management 312: 282-292.	<u>Project data collection requirements, Mapping requirements:</u> Building on lessons learned from existing carbon farming methods, the IFLM method could standardise the map accuracy assessment process to ensure consistent quality across all projects. Specifically, the map accuracy assessment could provide guidance on: • Acceptable data sources to be used for ground truthing; • Representativeness of ground truth points across all vegetation classes across the project area; • Whether more granular statistical accuracy thresholds (such as required producers or users' accuracy for each class) might be more appropriate; and • Processes for removal of baseline forest cover. [Conservative, Measurable and verifiable, Evidence-based] **More prescriptive guidelines on setting modelling commencement dates and growth pauses** • Model commencement dates and growth pauses in FullCAM have a significant impact on a number of variables in the abatement estimate for regeneration projects, including initial carbon stocks; forest cover assessment dates; sequestration rates throughout the crediting period. • <u>Net abatement calculations:</u> FullCAM Guidelines to accompany the IFLM method could be updated to include clear and standardisd processes to set model commencement dates and growth pauses, aligned with ecological conditions on the ground. *[Conservative, Measurable and verifiable, Evidence-based]* **Ongoing monitoring and gateway checks** • <u>Project data collection requirements:</u> Monitoring of project success would be conducted using five yearly gateway checks. These could be strengthened with an assessment of change detected since the previous gateway, based on repeat ground-based sampling (either high resolution drone assessments or in-field measurements). These ground-based change detection assessments could incorporate additional forest potential characteristics such as height. *[Conservative, Measurable and verifiable, Additionality, Evidence-based]* Other features of an IFLM method that would ensure project integrity under a model-only approach (FullCAM) could include:

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			• A gap analysis is used to confirm that the CEAs has capacity to sequester additional woody carbon in response to project activities. • In addition to the gap analysis, stem counts indicating the recruitment of woody species with forest potential can be used to apportion the relative contributions of current canopy cover (< 20%) to regenerating and remnant cohorts, ensuring that competition between cohorts is in line with the FullCAM calibration. • Monitoring and notification of disturbance events within a 90-day window.
4. Woody biomass activities: Framework to demonstrate suppression by domestic grazing animals	**Summary of grazing impacts:** In certain ecosystems and climatic conditions, domestic grazing animals can suppress palatable woody biomass in three different ways: 1) prevention of growth through frequent defoliation of existing stems, resulting in reduced tree size relative to mature, unsuppressed stems; 2) death of individuals that are sensitive to frequent defoliation, resulting in reduced tree density relative to the restoration target; and 3) prevention of germination by alteration of ecosystem conditions that favour recruitment, or by the grazing of fruits and seeds, resulting in reduced tree density relative to unsuppressed sites. In some Australian ecosystems, over-grazing can also act as a stimulation agent creating conditions suitable for germination and proliferation of shrub species, often referred to as 'woody thickening'. This process has been described to occur because of reduced competition from pasture species, leading to increased resources for shrub recruitment in turn, leading to a reduction in fire frequency and intensity. This means it is possible that grazing can be both a stimulant of germination, and at the same time, a suppressor of regeneration once it occurs. The main conditions in which grazing can have a material impact on woody biomass are described below. **Conditions where grazing can have a material impact on woody biomass** Palatability: Sheep and cattle display preferential grazing and will actively select the most palatable and nutritious feed on offer at any point in time. In general, after good rains and in pasture types where grasses and forbs are present, preferred forage species will be grazed preferentially until depleted. In addition, some tree and shrub species contain a range of essential nutrients and proteins (the latter in legume species) meaning that	Fernando T. Maestre et al. (2022). Grazing and ecosystem service delivery in global drylands. *Science* 378,915-920. DOI:10.1126/science.abq4062 Witt, G.B., M. V. Noël, M. I. Bird, R.J.S. Beeton, N.l W. Menzies (2011). Carbon sequestration and biodiversity restoration potential of semi-arid mulga lands of Australia interpreted from long-term grazing exclosures. *Agriculture, Ecosystems & Environment*, Volume 141, Issues 1–2, pp 108-118. Dean et al. (2015) Optimising carbon sequestration in arid and semiarid rangelands. *Ecological Engineering* 74, 148-163. DOI: 10.1016/j.ecoleng.2014.09.125. Bowen & Chudleigh (2021). Mulga Lands production systems Preparing for, responding to, and recovering from drought. Queensland Department of Agriculture and Fisheries. May 2021 Brown, R. F. (1985). The growth and survival of young mulga (Acacia aneura F. Muell) trees under different levels of grazing. *The Rangeland Journal*, 7(2), 143-148. Fensham, R.J. Silcock, J.L and Dwyer, J.M (2011). Plant species richness responses	It is important for the IFLM method to set out the conditions where grazing has a material impact on woody biomass, and where it does not. The method safeguards options are designed to ensure that ACCUs are only issued in circumstances where the ecosystem, tree size and environmental conditions indicate a material impact of grazing on suppression of woody biomass in the baseline period, and where sequestration is likely to occur following a change in grazing management, are described below. **CEA should be below its maximum sustainable carbon stock** • <u>Project data collection requirements:</u> As described above, the existence of a statistically significant carbon stock gap, together with a direct evidentiary linkage to an eligible human management suppression agent, provides evidence to suggest that the CEA has the potential to sequester carbon in response to an eligible management change. *[Conservative, Additionality, Measurable & Verifiable]* **CEAs should show suppression of palatable species** • <u>Mapping requirements, Record-keeping requirements:</u> Species that are generally eaten by grazing must have capacity to support increased carbon stocks in woody biomass. Species palatability and the feed preferences of grazers should be considered when delineating CEAs. Evidence could be provided in the form of species lists, photographs showing evidence of defoliation, manure samples etc. *[Additionality, Eligible Carbon Abatement, Evidence-based]* **Only sequestration from land with trees at or below grazing height should be eligible**

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	domestic livestock instinctively seek them out to supplement their diet, even during times when pasture is available. Feed preferences are not fixed, but change (i) over time, (ii) between locations, (iii) in responses to change in the content of nutrients and secondary compounds in the plants, and (iv) in response to animal experiences and their capacity to vary the composition of their diet. Some woody species are not palatable to domestic livestock, and these are generally not suppressed by grazing. Some species are only palatable at certain stages of their life cycle. Many species are vulnerable to grazing as young regenerating saplings or seedings, but not as mature tree species. Some species are well-eaten by livestock throughout their life cycle. The fresh growth of many species is more palatable following a significant rainfall event. This can result in a series of defoliation events through time. Tree height: The tree leaves of palatable species can only be eaten at or below the grazing height of the animal (although cattle will snap off taller tree branches to reach the foliage). Once trees have grown above grazing height, the dominant suppression impact of grazing is via alteration of ecosystem conditions that favour recruitment. In other words, the grazing generally does not impact existing trees above grazing height, but it can impact overall tree density in the ecosystem. Climatic conditions, over-grazing: As palatable pasture becomes scarce during dry times, or in the event of overstocking, domestic stock can subsist entirely on palatable tree and shrub forage. If this occurs, livestock can remove a substantial proportion of tree leaves from palatable vegetation at and below grazing height. If the tree survives this grazing event, it will have significantly reduced photosynthetic capacity for a period of time. This has the effect of constraining palatable woody species to a sapling size. Many species have a physiological intolerance of frequent defoliation, and these species may ultimately die due to heavy grazing. **Impact of changes to grazing management** In ecosystems containing palatable woody biomass, that is below the theoretical biomass potential of the site, and where livestock numbers or total grazing pressure exceeds the carrying capacity of the site, if grazing levels are reduced, or if the grazing management regime is modified to include rest periods, this can release the suppression of existing trees and shrubs. When coupled with suitable rainfall conditions, this can allow germination of new seedlings, and growth of existing suppressed plants to above the grazing height of domestic stock, ideally to reach maturity.	to grazing protection and degradation history in a low productivity landscape. *Journal of Vegetation Science* 22 (2011) 997-1008. Long, X., Guan, H., Sinclair, R., Batelaan, O., Facelli, J.M., Andrew, R.L. and Bestland, E., (2019). Response of vegetation cover to climate variability in protected and grazed arid rangelands of South Australia. *Journal of Arid Environments* 161 (2019), 64-71 P.J. Peeters and D.W. Butler (2014) Mulga: regrowth benefits management guideline. QLD Dept. of Science, Information Technology, Innovation and the Arts. Casburn, G. & Atkinson, T. (2016) Using mulga as a forage supplement for livestock in droughts NSW Dept. Primary Industries; Primefact 1487. Crisp, M.D. (1978). Demography and survival under grazing of three semi-desert shrubs. *Oikos* (30): 520-528. Crisp, M.D and Lange, R.T. (1976). Age structure, distribution and survival under grazing of the arid-zone shrub Acacia burkitti. *Oikos* (27) 86-92. Fischer J, Stott J, Zerger A, Warren G, Sherren K, Forrester RI. (2009). Reversing a tree regeneration crisis in an endangered ecoregion. Proc Natl Acad Sci U S A. Jun 23;106(25):10386-91. D.A. Saunders, G.T. Smith, J.A. Ingram, R.I. Forrester (2003). Changes in a remnant of salmon gum Eucalyptus salmonophloia and York gum E. loxophleba woodland, 1978 to 1997. Implications for woodland conservation in the wheat–sheep regions of Australia,	• <u>Net abatement calculations, Project data collection requirements:</u> *Measurement based model validation approaches:* Only land with trees at or below grazing height should be eligible to be included in the abatement calculations. Sequestration in trees on eligible land that are above grazing height would be excluded from abatement calculations via the eligible carbon stock ratio. This would involve collecting data to estimate the conservative proportion of eligible trees (by count or canopy area) of a CEA at project commencement. The biomass in all trees would be monitored over and the estimated eligible proportion would continue to be refined throughout the project lifetime. *[Additionality, Eligible Carbon Abatement, Conservative, Evidence-based]* • <u>Mapping requirements, Project data collection requirements:</u> *FullCAM approach:* The IFLM method could retain the approach adopted in the HIR method, where areas of baseline forest cover are excluded from the CEA. This means that all CEAs using FullCAM must be below the forest cover threshold at the time of project commencement. This excludes areas of land where the overstorey trees are generally above grazing height. Additionally, data should be collected to demonstrate that a regenerating cohort of trees contributes to the existing canopy area of eligible areas, below the forest cover threshold, and that the regenerating cohort has the potential to increase in size and number. **Impact of suppression to consider climatic conditions, livestock numbers relative to carrying capacity:** • <u>Project data collection requirements:</u> Third-party evidence of livestock numbers, and benchmarking of livestock numbers relative to a 'safe' utilisation rate or long-term carrying capacity can be used to determine if livestock levels have exceeded carrying capacity and are likely to have caused a suppression impact. The proponent would need to show that livestock numbers have exceeded safe levels during the baseline period; or that prior to the baseline period there was historical exceedance of 'safe' utilisation rates and that livestock numbers during the baseline period were sufficient to maintain the historical suppression. *[Additionality, Evidence-based]* **Monitoring success of changes to grazing management**

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	Carbon is removed from the atmosphere during this growth process and is stored in the tree components. **Grazing as both a stimulation agent and a suppression agent** In cases where over-grazing has created the conditions for germination of woody species, the growth of these native tree species can be desirable from both biodiversity and ecosystem function perspectives. For example, in ecosystems that formed woodland or open woodland communities prior to European settlement, where structural composition has changed through historic clearing and over-grazing. Following a change in grazing management, the carbon sequestration from the recruitment of native tree species in recovering woodlands can be considered additional if it would otherwise have been suppressed by continuous over-grazing, irrespective of whether over-grazing created the conditions for germination in the first place. From a biodiversity perspective, it is generally undesirable to encourage regeneration of woody species into areas naturally lacking tree and shrub species (i.e. natural grasslands). **Economic incentive for over-grazing of woody biomass** Decisions to suppress palatable woody biomass are often quite intentional in areas where spontaneous regeneration of woody biomass occurs in grazing ecosystems. Graziers receive numerous benefits for doing so, including increased stocking rate (particularly during dry times), reduced shading of pasture, and increased land value. Conversely, in the absence of a carbon project or timber plantation, land managers generally receive few cash benefits from having expansive tree cover across their property.	*Biological Conservation*, Volume 110, Issue 2, 2003, Pages 245-256 Allcock, Kimberly G., and David S. Hik. Survival, growth, and escape from herbivory are determined by habitat and herbivore species for three Australian woodland plants. *Oecologia* 138 (2004): 231-241. Briggs, S. et al. (2008) Condition of fenced and unfenced remnant vegetation in inland catchments in south-eastern *Australia. Australian Journal of Botany* 56.7: 590-599. Weinberg, A. et al. (2011) The extent and pattern of Eucalyptus regeneration in an agricultural landscape. *Biological Conservation* 144.1: 227-233. Stone G., Zhang B., Carter J., Fraser G., Whish G., Paton C., McKeon G. (2021) An online system for calculating and delivering long-term carrying capacity information for Queensland grazing properties. Part 1: background and development. *The Rangeland Journal* 43, 143-157. Bowen et al. (2022) Opportunities to build resilience of beef cattle properties in the mulga lands of south-western Queensland, Australia. *The Rangeland Journal* 44.2: 115-128. Walpole, S. C. (2019) Assessment of the economic and ecological impacts of remnant vegetation on pasture productivity. *Pacific Conservation Biology* 5.1 (1999): 28-35. Gowen Rebecca, Bray Steven G. (2016) Bioeconomic modelling of woody regrowth carbon offset options in productive grazing systems. *The*	• =Project data collection requirements, Net abatement calculations: Ongoing gateway checks would be required to ensure that regeneration is occurring. Crediting would be paused if these gateway checks are not met. Areas that never meet gateway criteria should be removed from the project and any issued credits must be reconciled with net abatement. Failure to meet these gateway checks would indicate that the management change was not successful in those locations, or that the barrier to ecosystem restoration was mis-diagnosed. *[Additionality, Eligible Carbon Abatement, Conservative, Evidence-based]* **Grazing as both a stimulation agent and a suppression agent** • In cases where grazing may have created the circumstances for germination of woody species in the first place, the project could be eligible under the IFLM method if the grazing has also had a demonstrable suppression impact on growth or mortality of the woody biomass. That the grazing may have been a stimulation agent for the germination in the first place does not invalidate the additionality of a decision to allow the palatable woody biomass to grow, if the normal management decision would have been to continue to suppress the woody biomass. • Regulatory approval: The EPBC Act prevents introduction of tree species into natural grasslands and protects against perverse biodiversity outcomes of woody biomass regeneration activities occurring in threatened ecosystems.

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		Rangeland Journal 38, 307-317. https://doi.org/10.1071/RJ15084 Rolfe John (2002) Economics of vegetation clearing in Queensland. *The Rangeland Journal* 24, 152-169. https://doi.org/10.1071/RJ02008 Stefani Daryanto, Bojie Fu, Wenwu Zhao, Lixin Wang, One-hundred years after shrub encroachment: Policy directions towards sustainable rangeland-use, Land Use Policy, Volume 84, 2019, https://doi.org/10.1016/j.landusepol.2019.03.008.	
5. For woody biomass CEAs: Framework to demonstrate suppression from total grazing pressure including feral animals	**Summary of total grazing pressure including feral (non-commercial) animal impact on woody biomass** Feral animals can contribute to total grazing pressure on woody biomass either directly, by consuming the leaves, seeds, fruit and other parts of woody biomass which results in either tree death or reduced ability to reproduce; and/or indirectly, by consuming grasses and herbs, which in combination with grazing pressure from domestic livestock, can lead to increased grazing pressure on woody biomass. The grazing habits of two example feral animals are summarised as follows: • Goats eat about 3-4% of their body weight in vegetation material per day and eat most plant types, and can eat woody species that are generally not palatable to domestic livestock. They have a high tolerance for plants with high tannin content. They often get up on their hind legs to eat from higher branches. They favour eating the highly nutritious parts of woody biomass such as fruit and nuts, which can affect the ability of the woody species to regenerate. • Rabbits eat the outer bark of woody species, which can result in tree death. They also each seeds and seedlings, which can reduce the ability of woody species to regenerate **History and prevalence of feral animals in Australia's agricultural landscape** European farming practises have led to the provision of permanent water points across the Australian landscape where previously there were none. In parallel, an entirely novel set of grazing and browsing animals were introduced into those landscapes. The release of feral animals into the	Fisher, A., Hunt, L., James, C., Landsberg, J., Phelps, D., Smyth, A., Watson, I. 2004. Review of total grazing pressure management issues and priorities for biodiversity conservation in rangelands: A resource to aid NRM planning. Desert Knowledge CRC Project Report No. 3 (August 2004); Desert Knowledge CRC and Tropical Savannas Management CRC, Alice Springs. Hacker R., Sinclair K., Waters C. 2019. Total grazing pressure – a defining concept for extensive pastoral systems in the southern rangelands of Australia. The Rangeland Journal, 2019, 41, 457–460 Prowse T., O'Connor P., Collard S., Rogers., D. 2019. Eating away at protected areas: Total grazing pressure is undermining public land conservation. Volume 20, https://doi.org/10.1016/j.gecco.2019.e00754 Mills C., Waudby H., Finlayson G., pArker D., Cameron M., Letnic M., 2020. Grazing by over-abundant native	The evidence basis and method safeguards for feral grazing pressure are similar to those for domestic grazing animals, with the exception that there is more uncertainty around the total numbers of grazing animals on a particular property at a given time. The types of evidence to demonstrate the presence of feral animals typically includes photographs, receipts showing harvest or sale numbers; consultation with NRM bodies, regional studies on total grazing pressure, annual pastoral returns, third-party landholder surveys, and also statutory declarations.

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	landscape often occurred around the time of European settlement of a region, and as a consequence there can be a very long history of feral grazing pressure long before commercial stock numbers were significant. Introduced and non-commercially managed grazers and browsers such as rabbits, donkeys, horses, camels, goats and pigs persist across the Australian landscape as a consequence of freely accessible waters, along with limited efforts to control them over space and time. Some feral animals have large ranges and relatively high population densities even in the absence of permanent artificial water points. **Control of feral animals** Control of feral animals can be managed by activities such as fencing, humane culling, or capture and removal for commercial sale. These control methods can be expensive and difficult to implement at scale. For example, 'exclusion' fences that prevent ingress of feral animals are typically taller than fencing for domestic animals, and are often constructed of ringlock (rather than single wire). In some cases, the commercial value of feral animals (such as goats) can incentivise feral animal control programs, but market prices tend to fluctuate resulting in ad-hoc control programs that generally only result in temporary reductions in numbers, at best. If total grazing pressure is reduced to a sufficient level to materially reduce grazing pressure on woody biomass, germination of new seedlings, and growth of existing suppressed plants can occur when coupled with suitable rainfall conditions. Carbon is removed from the atmosphere during this growth process and is stored in the tree components. Carbon projects have provided an incentive for the removal and in some cases near exclusion of feral animals. An IFLM method that incentivises control of feral animals is necessary to continue and expand the control of feral animals.	herbivores jeopardizes conservation goals in semi-arid reserves. https://doi.org/10.1016/j.gecco.2020.e01384 O'Bryan C., Patton N., Hone J., Lewis J., Berdejo-Espinola V., Risch D., Holden M., McDonald-Madden M., 2021.Unrecognized threat to global soil carbon by a widespread invasive species. Global Change Biology https://doi.org/10.1111/gcb.15769 Munro, Nicola T., Katherine E. Moseby, and John L. Read.The effects of browsing by feral and re-introduced native herbivores on seedling survivorship in the Australian rangelands The Rangeland Journal 31.4 (2009): 417-426. Zimmer, Heidi C., et al. Rainfall and grazing: not the only barriers to arid-zone conifer recruitment Australian Journal of Botany 65.2 (2017): 109-119. Braden J, Mills CH, Cornwell WK, Waudby HP, Letnic M (2021), Impacts of grazing by kangaroos and rabbits on vegetation and soils in a semi-arid conservation reserve Journal of Arid Environments, Volume 190, Dongen R, Huntley B, Keighery G, Brundett MC (2019) Monitoring vegetation recovery in the early stages of the Dirk Hartog Island Restoration Programme using high temporal frequency Landsat imagery Fisher AG, Mills CH, Lyons M, Cornwell WK, Letnic M (2021), Remote sensing of trophic cascades: multi-temporal landsat imagery reveals vegetation change driven by the removal of an	

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		apex predator Landscape Ecology, Volume 36, pages 1341-1358 (2021) Mahammed et. al. (2020) Grazing behavior, dietary value and performance of sheep, goats, cattle and camels co-grazing range with mixed species of grazing and browsing plants Veterinary and Animal Science 10, September 2020 Sinclair, R. (2005). Long-term changes in vegetation, gradual and episodic, on the TGB Osborn Vegetation Reserve, Koonamore, South Australia (1926-2002). Australian Journal of Botany, 2005, 283-296 Eldridge DJ, Oliver I, Val J, Travers SK (2020), Limited evidence for the use of livestock for the conservation management of exotic plant cover. Australian Journal of Botany 68(2) 137-145 https://doi.org/10.1071/BT19183 Auld, TD et al (2015), Saving arid and semi-arid southern Australia after over 150 years of exotic grazing pressure: Have we got the time and the will? Australasian Plant Conservation 24(2):2015 Edwards et al (2009), Evaluation of the impacts of feral camels The Rangeland Journal 32(1) 43-54 Mutze, G (2016), Barking up the wrong tree? Are livestock or rabbits the greater threat to rangeland biodiversity in southern Australia? The Rangeland Journal 38(6) 523-531 https://doi.org/10.1071/RJ16047 Russel, BG, M Letnic and PJS Fleming. 2011."Managing feral goat impacts by manipulating their access to water in	

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting. *[Relevant Offsets Integrity Standard shown grey square brackets]*
		the rangeland'', The Rangeland Journal, 2011,33: 143(152). Department of Climate Change, Energy and Water (n.d.) 'The Feral Goat'. Key threatening process -factsheet. Available at: https://www.dcceew.gov.au/sites/default/files/documents/feral-goat.pdf Department of Primary Industries and Regional Development, WA. (n.d.) Feral Camel. Available at: https://www.agric.wa.gov.au/pest-mammals/feral-camel	
6. Woody biomass activities: Framework to demonstrate suppression by human induced fire	**Summary of fire impacts on woody biomass** The Australian Government has recognized inappropriate fire regimes as a key threatening process under the EPBC Act. There has been a general shortening of the fire return interval in Australia's forests. Over the past four decades, there have been consecutive decreases, while the frequency of forest fires larger than 1 million hectares has risen since 2000. Changes to fire management has significant potential to increase sequestration or avoid emissions in woody biomass carbon stocks in a variety of different ways including: 1. Cessation of fire as a chemical suppression agent. In this case, the management change would involve cessation of a prescribed burning regime to promote woody thickening (sequestration); 2. Ecological burning in ecosystems where absence of fire is the suppression agent. In this case the management change would be the introduction of a prescribed burning regime to facilitate regeneration of species (sequestration), 3. Avoided wildfire. In this case, the management change would involve the exclusion or reduction of wildfire via enhanced prevention and suppression capability (avoided emissions & sequestration); 4. Burning to lower fire risk: In this case the management change would be application of strategic prescribed burning to transition to lower-emitting fire regimes (as in savanna fire management). (avoided emissions & sequestration) This discussion paper focuses on the first, second and third of these fire management regimes:	Ruscalleda-Alvarez, Jaume, et al. "Right-way fire in Australia's spinifex deserts: An approach for measuring management success when fire activity varies substantially through space and time." Journal of environmental management 331 (2023): 117234. Bowman, D. M., Murphy, B. P., Neyland, D. L., Williamson, G. J., & Prior, L. D. (2014). Abrupt fire regime change may cause landscape-wide loss of mature obligate seeder forests. Global change biology, 20(3), 1008–1015 https://doi.org/10.1111/gcb.12433 Kirkpatrick, J., Gilfedder, L., Duncan, F., & Wapstra, M. (2020). Frequent planned fire can prevent succession to woody plant dominance in montane temperate grasslands. Austral ecology, 45(7), 872-879. Ruscalleda-Alvarez, J., Moro, D., & Van Dongen, R. (2021). A multi-scale assessment of fire scar mapping in the Great Victoria Desert of Western Australia. International Journal of Wildland Fire, 30(11), 886-898	Sequestration associated with fire management modalities 1 (cessation of prescribed fire), 2 (ecological burning to stimulate regeneration) and 3 (avoided wildfire) could readily be accommodated using the same equation architecture as other woody biomass sequestration activities. To accommodate the broadest possible range of fire regimes in the method at a future time, for those fire management regimes not included in the initial method, the high-level equation architecture could include factors that would allow fire management modules to be included in the method at a future time. Given the complex interactions between fire and woody ecosystems, inclusion of fire management in the proposed IFLM method could be restricted to projects using measurement based model validation approaches only. *[Measurable and verifiable]* The inclusion of fire in the IFLM method should have a low level of crossover with the existing savanna burning method, to avoid confusion in the market. Regionally specific baseline/ecosystem benchmarks (e.g. major vegetation type fire frequency and intensity measures) could be established to allow a model only approach. Another option could be to consider dynamic (i.e. real-time) baselines across reference regions for ecosystems where infrequent but nonetheless destructive fires occur. Similar approaches are being considered by CSIRO in the Greater Western Woodlands. *[Evidence based, Additionality]* The IFLM method could require that the Land Management Strategy is signed off by an independent third-party qualified ecologist, and/or

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting. *[Relevant Offsets Integrity Standard shown grey square brackets]*
	Cessation of fire as a chemical suppression agent: Throughout northern Australia, fire is commonly used to suppress growth of woody biomass. In many cases, fire is the cheapest and easiest form of chemical suppression, particularly in cases where the woody biomass is not preferred feed for livestock. While fire is often used alongside grazing management, it is likely that fire is the dominant suppression agent in some forest and woodland ecosystems in northern Australia. When planned or prescribed burning is applied at excessive frequency in natural woodland ecosystems, this can suppress growth of woody biomass. Frequent burning results in death of younger trees as they have thinner bark and their leaves are closer to the ground. Often the mature vegetation typically survives the fire, although growth of surviving trees can be slowed. For example, in a series of experiments conducted in the Northern Territory, Murphy et al (2013) found that "plots that were subject to one or more severe fires in a 5-year period experienced declines in tree and woody understorey carbon stocks." Frequent burning not only suppresses growth of woody biomass - it can also result in loss of species from the ecosystem. Where prescribed fire can be demonstrated to be a suppression agent during the baseline period, the IFLM management change would involve alteration to the frequency of prescribed (planned) fire, to advance the site towards a more natural structure and species assemblage. The improved management of fire will enable woody biomass to grow and sequester carbon. The appropriate fire regime might vary between ecosystems, and could be developed in consultation with local NRM bodies and/or ecologists, as well as Traditional Owner groups and local fire authorities. **Ecological burning to stimulate regeneration** In some fire-adapted ecosystems, a lack of fire could be the dominant suppression agent. Ecological burning could be required to stimulate regeneration in a number of ways, for example: creating a fertile seed bed; removal of weed competition, cracking of hard seed coats, and stimulating fire-induced seed production. Ecological burning has been used by Indigenous land managers for thousands of years to stimulate regeneration of native species. **Avoided Wildfire** Outside Australia's tropical savannas large destructive fires can have long term impacts on carbon sequestered in forests. Fire return intervals in old growth woodlands can be very large. Prober et al in partnership with the	Canadell, J.G., Meyer, C.P.(., Cook, G.D. et al. Multi-decadal increase of forest burned area in Australia is linked to climate change. Nat Commun 12, 6921 (2021). https://doi.org/10.1038/s41467-021-27225-4 Clarke PJ, Lawes MJ, Murphy BP, Russell-Smith J, Nano CE, Bradstock R, Enright NJ, Fontaine JB, Gosper CR, Radford I, Midgley JJ, Gunton RM. A synthesis of postfire recovery traits of woody plants in Australian ecosystems. Sci Total Environ. 2015 Nov 15;534:31-42. doi: 10.1016/j.scitotenv.2015.04.002. Fire after a mast year triggers mass recruitment of slender mulga (Acacia aptaneura), a desert shrub with heat-stimulated germination. Boyd R. Wright, Roderick J. Fensham 2017 https://doi.org/10.3732/ajb.1700008 Ladbrook M, J. B. van Etten E, D. Stock W. Contemporary Fire Regimes of the Arid Carnarvon Basin Region of Western Australia. Fire. 2018; 1(3):51. https://doi.org/10.3390/fire1030051 Jenkins, Bryan. (2020). Recovery assessment: the process needed after impacts have exceeded sustainability limits. International Journal of Environmental Impacts: Management, Mitigation and Recovery. 3. 272-283. 10.2495/EI-V3-N3-272-283. Prober, S.M., Yuen, E., O'Connor, M.H. and Schultz, L., 2016. Ngadju kala: Australian aboriginal fire knowledge in the Great Western Woodlands. Austral Ecology, 41(7), pp.716-732. van Etten Eddie J. B., Davis Robert A., Doherty Tim S. Fire in Semi-Arid Shrublands and Woodlands: Spatial and Temporal Patterns in an Australian	person with Traditional Ecological Knowledge. The Land Management Strategy should describe how transition of the fire management regime will manage risks of wildfire. The Land Management Strategy should describe a fire management regime in accordance with State or regional recommendations appropriate to the ecosystem. *[Evidence based]* The method could require evidence that the carbon stocks in above ground vegetation in the proposed project area have been impacted by fire during the baseline period, and that implementation of the proposed management change is likely to sequester carbon. *[Measurable and verifiable]* Sequestration with fire modality 3 (avoided wildfire) could only apply to vegetation communities which are known to be threatened by frequent fire during succession stages and only where frequent fire has been shown to prevent succession to a climax community with higher carbon stocks than the feral community.

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	Ngadju people of the Great Western Woodlands (2016) found that If burnt, these systems 'take hundreds or thousands of years to come back'. Fire does not naturally carry easily in these systems due to the sparse understorey and low fuel loads. If a fire does pass through, large scale germination is triggered. However, it can take 500 to 1000 years for growth to equal the carbon stock before the fire. Gosper et al. (2014) found that fire that passes through E. salubris woodlands has the potential to change the underlying fire regime. Regenerating and recruiting forests face a higher fire risk while maturing as individuals present a connected canopy once a certain size is reached, before natural thinning occurs. The closed canopy of maturing and recruiting vegetation burns more frequently than the target state and communities can take over 100 years to reach a fire-resilient state. Fairman et al (2015) demonstrated that repeat short-interval fires (i.e. occurring less than 10 years apart) can increase the risk that high carbon storing forest ecosystems shift to a lower carbon storing ecosystem. Such an 'ecosystem shift' might occur in fire-sensitive forests (such as E. regnans or E. delegatensis forests), as the mature individuals are typically killed in a hot fire. If another hot fire follows shortly after the first, there may be insufficient time between fires to restore canopy seed or to reach seedbearing age (Figure 12). In this case, the forest either needs to be re-planted manually (at significant cost, and the risk of planting failure), or the ecosystem will convert to a shrubby, fire-prone, non-eucalypt (i.e. low carbon) ecosystem. Fairman et al (2015) also found that ecosystem shift following repeat short-interval fires can occur in fire-tolerant forests (for example, forests containing E. Obliqua). This can occur despite the fact that the mature individuals typically survive the fire and then resprout. However, if three or more short-interval fires occur, this can exhaust the vegetative resprouting capacity of the forest, which results in conversion to a shrubby non-eucalypt (i.e. low carbon) ecosystem (Figure 13). In Victoria, the Department of Energy, Environment and Climate Action monitors the 'tolerable fire interval' status for all Ecological Vegetation Classes (EVCs) in Victoria. Tolerable fire interval is effectively the minimum or maximum time between fires that will maintain ecosystem health. As of August 2019, there was almost 4.6 million ha of land in Victoria that was below its' tolerable fire interval, meaning that historically, hot fires have occurred more frequently than is ecologically desirable. These ecosystems can be considered at risk of ecosystem shift to a lower carbon state, unless a high intensity bushfire can be prevented.	Landscape. Frontiers in Ecology and Evolution 2021. 9. DOI=10.3389/fevo.2021.653870 Ward, Bruce & Bragg, Tom & Hayes, Barbara. (2018). Effects of chaining and burning in Acacia ramulosa shrublands of the Peron Peninsula, Shark Bay, Western Australia. International Journal of Wildland Fire. 27. 10.1071/WF17129. Turner, D.S., Ostendorf, B., & Lewis, M.M. (2008). An introduction to patterns of fire in arid and semi-arid Australia, 1998-2004. Rangeland Journal, 30, 95-107. Cunningham, C. X., Williamson, G. J., Nolan, R. H., Teckentrup, L., Boer, M. M., & Bowman, D. M. J. S. (2024). Pyrogeography in flux: Reorganization of Australian fire regimes in a hotter world. Global Change Biology, 30, e17130. https://doi.org/10.1111/gcb.17130 Van Etten, Eddie & Burrows, Neil. (2018). On the Ecology of Australia's Arid Zone: 'Fire Regimes and Ecology of Arid Australia'. 10.1007/978-3-319-93943-8_10. Marsden-Smedley JB, Albrecht D, Allan GE, Brock C, Duguid A, Friedel M, Gill AM, King KJ, Morse J, Ostendorf B and Turner D. 2012. Vegetation–fire interactions in central arid Australia: towards a conceptual framework. Ninti One Research Report NR001. Ninti One Limited. Alice Springs Gosper, C.R., Prober, S.M. and Yates, C.J., 2013. Multi-century changes in vegetation structure and fuel availability in fire-sensitive eucalypt woodlands. Forest Ecology and Management, 310, pp.102-109.	

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		Wright, Boyd R. and Laffineur, Boris and Royé, Dominic and Armstrong, Graeme and Fensham, Roderick J.}. {Rainfall-Linked Megafires as Innate Fire Regime Elements in Arid Australian Spinifex (Triodia spp.) Grasslands}, Frontiers in Ecology and Evolution Volume 9–- 2021 Clarke,Michael F. Kelly,Luke T. Avitabile,Sarah C. Benshemesh,Joe et al., 2021. Fire and Its Interactions With Other Drivers Shape a Distinctive, Semi-Arid 'Mallee' Ecosystem.. Frontiers in Ecology and Evolution Fairman Thomas A., Nitschke Craig R., Bennett Lauren T. (2015) Too much, too soon? A review of the effects of increasing wildfire frequency on tree mortality and regeneration in temperate eucalypt forests. International Journal of Wildland Fire 25, 831-848.	
7. For woody biomass CEAs: Framework to demonstrate suppression by chemical or mechanical clearing	**Summary of mechanical and chemical suppression impact on woody biomass** Mechanical and/or chemical suppression of woody biomass (also known as 'clearing'), is both a significant contributor to Australia's greenhouse gas emissions and conversely, land can sequester carbon through vegetation regrowth when re-clearing ceases. The response of woody biomass to mechanical or chemical suppression depends on: • the species, where some species that regenerate from lignotuber or stem may grow back thicker in response to lower impact clearing methods; • age of woody biomass at the time of clearing, where younger stems are less lignified/more flexible ,and may not snap during mechanical suppression; • the clearing method applied, as described below; • applicable state-based legislation in relation to individual tree retention requirements, patch size, and maximum allowable clearing rates; and	WWF International (2020) Deforestation Fronts: Drivers and Responses in a Changing World. DCCEEW (2021) Australia State of the Environment. New South Wales State of the Environment 2021. Queensland State of the Environment 2020. Ward MS, Simmonds JS, Reside AE, et al. Lots of loss with little scrutiny: The attrition of habitat critical for threatened species in Australia. Conservation Science and Practice. 2019; 1:e117. https://doi.org/10.1111/csp2.117 Liao, et al (2020), Woody vegetation cover, height and biomass at 25-m resolution across Australia derived from	In addition to the method requirements outlined in the rows above that apply regardless of the specific suppression agent, there are several safeguards/requirements relating specifically to the activity of 'clearing' that should be considered within the draft method and Rule to ensure alignment with the offset integrity standards. **Defining clearing and thinning** Clearing in existing methods is defined as '*the conversion by people of forest to a land cover other than forest, including through the destruction of trees or saplings by intentional burning, mechanical or chemical means',* whereas thinning is defined as *'the removal of woody biomass (whether dead or alive) from the land (note the destruction of biomass is considered removal even if the residues are left on the land).'* Under these definitions, clearing of sparse woody vegetation that has not yet reached forest cover (>2m tall with >20% crown area) would therefore be classified as 'thinning', and reclearing of regrowth that has reached forest cover (which can be fast in high rainfall areas) is not distinguished from the clearing of primary (remnant or intact native) forest.

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whether the land manager's goal is complete conversion of land use (in which case the woody biomass may not grow back).
The NSW Local Land Services[15] categorises clearing methods as either 'low impact' or 'moderate impact', based on the extent to which soil and ground cover the soil is disturbed. A summary of clearing methods commonly applied on agricultural land in Australia is described below.
Mechanical suppression methods:
Chaining/pulling – Involves a large chain pulled between two bulldozers, can involve single or multiple passes (the more passes, the higher the tree mortality rate);
Stick-raking – Involves pushing of woody biomass using a heavy bar normally attached to a bulldozer;
Blade ploughing – This involves using a low, sharp plough on the front of a bulldozer to sever the tree stem at the base. This method is quite expensive and often only used on higher value land. Soil disturbance is high, and trees are generally slow to grow back after blade ploughing.
Chemical suppression methods:
Tordon herbicide[16] (active ingredient: 2,4-D and Picloram)
Graslan,[17] which is a long-acting herbicide (active ingredient: Tebuthiuron). Woody biomass generally takes a few years to regenerate after application of this herbicide.
Burning (see fire section above)
Mechanical/chemical suppression events can be years apart, and can result in full or partial regrowth. Often mechanical or chemical suppression events are reinforced using fire and/or livestock grazing to suppress woody vegetation regrowth[18] Detection of mechanical or chemical suppression of woody biomass can sometimes be difficult using satellite imagery only, particularly when re-clearing occurs when the woody biomass is quite young.
Historical clearing and re-clearing rates
Clearing and reclearing rates have fluctuated in Australia over the past decade at significant levels, with Eastern Australia remaining one of 24
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multiple site, airborne and satellite observations, International Journal of Applied Earth Observation and Geoinformation. Volume 93.
Heagney, Elizabeth & Falster, Daniel & Kovac, Mladen. (2021). Land clearing in south-eastern Australia: Drivers, policy effects and implications for the future. Land Use Policy. 102. https://doi.org/10.1016/j.landusepol.2020.105243
Simmons et al (2018), Spatial and temporal patterns of land clearing during policy change, Land Use Policy, Volume 75, Pages 399-410, .
Evans (2016) Deforestation in Australia: drivers, trends and policy responses. Pacific Conservation Biology 22, 130-150. https://doi.org/10.1071/PC15052
Hernande t al(et al (2024) 2024) 2024) 2024) 2024) 2024) Predicting the impacts of clearing on vegetation communities: a model-based approach for identifying conservation priorities in Queensland, Australia. Australasian Journal of Environmental Management, 1–24. https://doi.org/10.1080/14486563.2023.2298492
Busch & Ferretti-Gallon (2017) What Drives Deforestation and What Stops It? A Meta-Analysis. Review of Environmental Economics and Policy 2017 11:1, 3-23
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Additional or expanded definitions are necessary to enable specific exclusions, restrictions, etc. to be articulated throughout the method. Land subject to clearing of primary /remnant (intact native) forest during the 7 years preceding the project should be ineligible, whereas land subject to business-as-usual (BAU) reclearing of regrowth within the 7 years preceding the project start could be eligible. [Measurable and verifiable]
Baseline period length
The baseline period length establishes the period in which it is reasonable to assume activities are indicative of BAU. Additionality and baseline carbon stock levels are measured directly against what is captured by the baseline period. [Evidence-based]
It is important to select an appropriate baseline period length, so that:
barriers or ecological degradation drivers that are not constant but cyclical in nature (like clearing) are able to be captured, noting that reclearing frequency can vary regionally; and
baseline period activities and carbon stock calculations are not skewed by temporary climactic conditions.
Therefore, baseline periods may be tailored to different restoration targets or project activities to identify all possible barriers preventing a CEA from proceeding towards its maximum sustainable carbon stock. A fit-for-purpose baseline period creates a high level of confidence regarding the additionality of the carbon abatement claims.
BAU carbon stock assumptions
The BAU carbon stock assumption for 'constant' suppression drivers in a sequestration methods is typically taken to be a stable carbon stock, with a range of eligibility requirements associated with bolstering the validity of this assumption (e.g. requirement for a lack of forest cover throughout the baseline period), however for cyclical suppression drivers like clearing, the method requires the quantification of the long-term average baseline carbon stock and the initial carbon stock
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[15] NSW LLS Land Management Code – Invasive Native Species. Availabe at: https://www.lls.nsw.gov.au/__data/assets/pdf_file/0003/740586/Land-Management-Code-Invasive-Native-Species.pdf
[16] https://www.corteva.com.au/products-and-solutions/crop-protection/tordon-75-d.html
[17] https://ag.fmc.com/au/en/crops/crop-solution-type/graslan-herbicide
[18] Australia State of the Environment 2021 https://soe.dcceew.gov.au/land/pressures/land-use

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	global deforestation fronts in 2020 – the only developed nation location to remain on the list[19]. In 2019, NSW emissions from clearing of regrowth were estimated to be 7.6 Mt CO_2e[20]. In 2018, QLD net emissions from the land use, land use change and forestry (LULUCF) sector contributed 22.8 $MtCO_2e$, 13% of Queensland's total emissions[21]. Unlike most other Australian jurisdictions, Queensland is a net source of LULUCF emissions rather than a net 'sink'. Vegetation clearing is the main source of Queensland's LULUCF GHG emissions. Across the country, over the four year period between 2010-2014, nearly 200,000 hectares (ha) of primary forest was cleared and more than 800,000 ha of regrowth was recleared[22]. Between 2012 and 2020, more than 1.5 million hectares of remnant native vegetation was lost[23]. Extensive areas of sparse woody vegetation losses were also recorded between 2015 and 2019, averaging 2.27 million ha per year, a loss rate 8% greater than the previous 5 years.[24] **Impact on Australia's national greenhouse gas inventory** If this land is not re-cleared and instead allowed to grow and ideally form mature forest, there is significant potential to sequester carbon. CSIRO estimates the technical potential sequestration of land that has been cleared at least once since 1988 is 5.1 million tonnes CO_2e per annum.[25] CSIRO estimates the avoided emissions associated with cessation of clearing on land that has been twice-cleared is 9.21 million tonnes CO_2e per annum. **Regulatory controls on clearing** While regulatory controls around removal of native vegetation have tightened in many regions, some have been relaxed, with mixed outcomes. Of the 7.7 million hectares of land habitat cleared between 2000 and 2017 in Australia, 7.1 million hectares (93%) was not referred to the Australian		at crediting start to ensure correct project scenario delta crediting claims. The other difference between 'constant' and cyclical suppression drivers is the perceived certainty that the suppression driver would continue to impact the carbon stock in the absence of project activities. As the suppression driver is not always present but requires a decision to either continue, postpone or cease ahead of each instance, additional requirements within the method to ensure confidence in the additionality of the project activities could include one or more of: - the legal right to continue removing vegetation at a 'paddock scale' at project outset; - use of dynamic 'risk of clearing' Government map layers at project outset to identify eligible land and/or dictate discount factors applicable to the project scenario abatement; - trends of historical clearing throughout the baseline period; - use of dynamic baselining where credit generation is linked to observed clearing in real or modelled ecosystem benchmarks; - documented decision to implement project activities; and/or] - restrictions on what type of clearing and thinning during the baseline period is eligible for project activities. *[Additionality, Evidence-based]* Eliminating the risk of gaming (i.e. deliberately reducing carbon stock in the woody biomass pool prior to registration to maximise abatement potential of a project) is a necessary provision in the Method and/or Rule to ensure only real and additional abatement is credited.

[19] WWF International (2020) 'Deforestation Fronts – Drivers and Responses in a Changing World' accessed online at: https://wwfint.awsassets.panda.org/downloads/deforestation_fronts___drivers_and_responses_in_a_changing_world___full_report_1.pdf
[20] Department of Industry, Science, Energy and Resources. National Greenhouse Accounts (2019) https://www.dcceew.gov.au/climate-change/publications/state-and-territory-greenhouse-gas-inventories
[21] DES Queensland Government State of the Environment 2020. https://www.stateoftheenvironment.des.qld.gov.au/pollution/greenhouse-gas-emissions/land-use-land-use-change-and-forestry-sector-greenhouse-gas-emissions
[22] State of Environment (2016) – Land Chapter. Figure LAN5. https://soe.dcceew.gov.au/sites/default/files/2022-05/soe2016-land-final-web.pdf
[23] State of Environment (2021) – Land Chapter. Table 1. https://soe.dcceew.gov.au/sites/default/files/2022-07/soe2021-land.pdf
[24] State of Environment (2021) – Industry Chapter. https://soe.dcceew.gov.au/land/pressures/industry#SnippetTab
[25] Fitch P, Battaglia M, Lenton A, Feron P, Gao L, Mei Y, Hortle A, Macdonald L, Pearce M, Occhipinti S, Roxburgh S, Steven A, (2022). Australia's sequestration potential, CSIRO. A report to the Climate Change Authority. Available at: https://www.csiro.au/en/research/environmental-impacts/emissions/carbon-sequestration-potential

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* *Category of method safeguard shown with underline formatting. *[Relevant Offsets Integrity Standard shown grey square brackets]*
	Government for assessment under the *Environment Protection and Biodiversity Conservation Act 1999*[26]. **Drivers of clearing** Historically, the drivers for clearing in NSW and QLD have been the conversion of less agriculturally productive forest or secondary regrowth to more productive cropping or pasture production where clearing rates have been strongly related to commodity prices[27]. In NSW, clearing has generally been known to be repeated at higher frequency intervals for cropland development and lower frequency intervals for pastoralism, however, favourable market signals from the underlying agricultural sector in each region plays a significant role in driving the occurrence of clearing/reclearing. **Historical clearing** At the time of European settlement, significant areas of primary forest and woodland were cleared. This was typically a condition of the granting of farmland leaseholds or private land ownership. For example the NSW *Closer Settlement Act 1901* placed the following conditions on allocation of a 99 year farmland lease "the lessee shall confirm to any regulations relating to ..clearing of the farm of scrub and noxious weeds".[28] The Queensland 1907 Land Act contained the following requirement for granting of leases for 'scrub selections': "any country lands which are entirely or extensively overgrown by scrub may be proclaimed open for selection" and "during the period of the lease… he shall in every year clear a portion of the scrub… until the whole of the scrub has been cleared, and shall keep clear of scrub every part of the selection upon which the scrub has been previously cleared".[29] Once the primary clearing took place, the cleared areas were often maintained via re-clearing, and also by grazing and fires.		However, the combination of definitions and provisions within section 20AA the CFI Rule and the current draft of the method has the potential to overly restrict participation, due to a failure to accommodate standard approaches to BAU management of vegetation. The drafting of an additional definition of 'intact native forest' could be utilised by both the IFLM method and s20AA of the Rule to help to differentiate between land that is strictly ineligible and land that could instead have more nuanced restrictions applied. **Restrictions on thinning during the project period** In the higher rainfall, more productive agricultural zones of Australia, restrictions on the perceived opportunity cost associated with allocating land exclusively to trees, is much higher than in regions with lower land values. Similarly, most agricultural land valuers often perceive tight restrictions on vegetation management as a loss of 'option value' of the land, resulting in reduced land valuations. This can create problems for loan-to-value ratios for land subject to a mortgage, and can be a serious barrier to the bank eligible interest holder consent process required for carbon farming projects. Under the measurement based model validation approaches, consideration should be given for additional permitted thinning scenarios beyond what is anticipated in the current draft method, so that examples such thinning prior to complete canopy closure could be permitted - which would carry a lower perceived opportunity cost.

[26] Ward MS, Simmonds JS, Reside AE, et al. Lots of loss with little scrutiny: The attrition of habitat critical for threatened species in Australia. Conservation Science and Practice. 2019; 1:e117. https://doi.org/10.1111/csp2.117
[27] Heagney, Elizabeth & Falster, Daniel & Kovac, Mladen. (2021). Land clearing in south-eastern Australia: Drivers, policy effects and implications for the future. Land Use Policy. 102. https://doi.org/10.1016/j.landusepol.2020.105243
[28] NSW Closer Settlement Act 1901 available at: http://classic.austlii.edu.au/au/legis/nsw/num_act/csa19011902n7237/
[29] QLD Land Act 1897 available at: https://digitalcollections.qut.edu.au/4725/1/LandAct_61VIC_25.pdf

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8. For woody biomass CEAs: Framework to address risks associated with projects that sequester carbon from facilitated regeneration (planting, direct seeding, or infill planting)	This section assumes that the scientific fundamentals associated with sequestration from facilitated regeneration such as planting, direct seeding, or infill planting are well accepted. This section therefore focusses on the unique scientific aspects of integrating facilitated regeneration activities alongside soil. Pursuit of pure carbon objectives may not always align with biodiversity objectives and could inadvertently incentivise perverse outcomes if facilitated regeneration (i.e. environmental plantings) are not designed with both sets of objectives in mind. For example, the implementation of higher density plantings than was historically present, e.g. open grassy woodlands (<20% canopy cover) or temperate grasslands, would put further pressure on vegetation communities that have historically been highly altered by conversion to agricultural land uses (e.g. cropping and grazing). Land that is eligible for environmental planting and has not been historically cropped can contain extant native grass and forb species. Some site preparation and planting methods can have a negative impact on this remnant native vegetation, requiring careful planning, ongoing management and monitoring to ensure the impact is minimised. Access to native seed sources is a critical component of facilitated regeneration, and the services associated with collection, storage and propagation have historically been delivered by a small-scale industry due to lack of scaled demand. As a result of a growing interest in facilitated regeneration through planting, this industry is undergoing a rapid growth phase in order to meet the current and future demands in this space. As this industry scales up, the pressure on remnant vegetation as a source of high quality, genetically diverse native seed will increase, having the potential to negatively impact natural regeneration within these systems. Seed collection for sale from CEAs within permanent plantings is restricted, putting further emphasis on remnant populations as a source of seed. The ability to use a combination of tubestock planting and direct seeding within the same planting row would allow proponents to cost-effectively plant a diverse range of species while mitigating the risk of complete mortality areas within the project area. The uncertainty of seasonal and longer-term climatic conditions is a significant risk to the success of permanent planting projects. The compounding effect of highly altered soil conditions can result in areas of a	SA Native Vegetation Council - guidance on *Clearance associated with Ecological Purposes* (Management Plan approach)[30] Harrison, P.A., Vaillancourt, R.E., Harris, R.M.B. and Potts, B.M. (2017), *Integrating climate change and habitat fragmentation to identify candidate seed sources for ecological restoration.* Restor Ecol, 25: 524-531. https://doi.org/10.1111/rec.12488 Harrison, P.A. (2021), *Climate change and the suitability of local and non-local species for ecosystem restoration.* Ecol Manag Restor, 22: 75-91. https://doi.org/10.1111/emr.12520 Bailey, T.G., Harrison, P.A., Davidson, N.J., Weller-Wong, A., Tilyard, P., Steane, D.A., Vaillancourt, R.E. and Potts, B.M. (2021), *Embedding genetics experiments in restoration to guide plant choice for a degraded landscape with a changing climate.* Ecol Manag Restor, 22: 92-105. https://doi.org/10.1111/emr.12474	**Justification that planting, direct seeding, or infill planting is required** For sites where a lack of seed source is the main barrier to ecosystem restoration, and more active restoration methods such as planting or direct seeding are required, the proposed IFLM method should require evidence that there is low likelihood of ecosystem restoration in the absence of the facilitated regeneration project activity. This could be in the form of a non-forest cover requirement for a period of time prior to planting, potentially combined with a requirement to evidence a lack of native woody regeneration at project outset like under the existing EP method. Under the measurement based model validation approaches, if the land contained forest cover during the baseline period, it must be demonstrated that cover was provided from predominantly non-native species. This could be in the form of an expert opinion in the Land Management Strategy that the site had a lack of seed bank, and that native woody species were unlikely to spontaneously regenerate. *[Additionality, Evidence-based, Eligible carbon abatement]* **Incentivising the restoration of "sparse" vegetation communities (<20%)** The minimum stem density requirement of 200 stems under the FullCAM (model-only) approach is waived under the measurement based model validation approaches. This allows vegetation communities that have less than 20% canopy cover to be eligible as a facilitated regeneration project activity and expands applicability to more ecosystems. *[Measurable and verifiable, Evidence-based, Eligible carbon abatement]* **Impact on existing native vegetation** • State-based Regulatory Approvals – some States have an approval process for plantings that will impact extant native grass/understorey (e.g. native grasses). The EPBC Act provides controls on plantings in extant natural grassland ecosystems. **Ability to collect seed from CEAs for sale**

[30] Available at: 41_NVInfoSheet_NV Clearance for Ecological Purposes (environment.sa.gov.au)

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	project not meeting density objectives or completely failing to survive after initial germination or planting. The ability to conduct enrichment plantings will allow proponents to undertake subsequent planting and/or direct seeding events in these cases. The option to adjust seed mixes to ensure resilience in changing climatic conditions is also an important aspect of effective planning for environmental planting projects. However, there is a risk that new species or genetic variants will create new regional weed problems if a careful approach is not utilised.		Seed collection for sale could be removed as a restricted activity, provided the collection does not inhibit secondary recruitment, i.e. permanence. One way to address this risk is to require the seed be collected by a relevant state/territory certified and/or licensed seed collector. Certified and/or licensed seed collectors are generally required to leave sufficient seed to enable the forest to self-regenerate. There are also guidelines, such as the Flora Bank Guidelines that provides information on ethical collection practices. To enable this change, the definition of "permanent planting" would also need to be amended in the IFLM Method and the CFI Rule to allow for removal of seed for sale. **Blended planting + seeding approach** The method could allow for both planting and direct seeding within the same planting row. This activity might be required to use the most conservative calibration in FullCAM (i.e. direct seeding) if using specific calibration, or alternatively the measurement based model validation approaches. **Enrichment planting (FullCAM and measurement based model validation approaches)** For enrichment planting events on land that has achieved the stem density and/or survival thresholds consistent with forest potential / forest cover, the FullCAM guidelines for the IFLM method should allow the original planting date to be retained in the model. (Note: This would retain existing rules in the EP FullCAM Guidelines). If enrichment planting events are conducted within CEAs using the measurement based model validation approaches, where it is conservative to do so, the model being used to calculate abatement in between measurement events should remain on the same trajectory as before the infill event (unless the model has already been calibrated for this particular activity). Once re-sampling has occurred, the model can be adjusted accordingly. However, under both approaches, if a disturbance/reversal event has occurred and that is the reason enrichment planting is required, the affected CEA/s should be re-stratified accordingly, and the modelled yield curve reset for the new CEA/s with enrichment plantings. **Climate-adjusted seed mixes**

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			Land Management Strategies could include justification from a qualified person for climate-adjusted seed mixes that include a portion of genetic diversity from a broader provenance range than would have historically been expected. **Proliferation of potentially weedy species** To reduce the risk of potentially weedy species being planted via a facilitated regeneration project activity, the definition of "mixed-species environmental plantings" outlines the following guardrails: *1)…must consist of a mixture of tree and shrub species that:* *(a) are native to the local area of the planting;* *(b) are sourced from seeds:* *(i) from within the natural distribution of the species; and* *(ii) that are appropriate to the biophysical characteristics of the area of the planting;* *(c) may be a mix of trees, shrubs, and understorey species where the mix reflects the structure and composition of the local native vegetation community; and* *(d) are established through planting.* **Natural Resource Management / Landscape Plan alignment** Requirement to demonstrate alignment with NRM Plans – suggestion to include a text field in the registration application in addition to checkbox. NRM Plan alignment can also be outlined in the Offsets Reports in more detail, if needed. Land Management Strategies could be sent to applicable NRM bodies for noting.
9. For soil organic carbon CEAs: Framework to demonstrate sequestration from soil sequestration activities associated	**Evidence to support plantings projects (afforestation) as a soil carbon EMA:** There is evidence that that the incorporation of trees as part of an integrated management change that integrates woody biomass into pasture, cropping and degraded land systems increases soil organic carbon. Activities might include planting shelter belts, riparian restoration or facilitated regeneration to sustain scattered paddock trees. This can	Hobbs TJ., Neumann CR., Meyer WS., Moon T. and Bryan BA. (2016) 'Models of reforestation productivity and carbon sequestration for land use and climate change adaptation planning in South Australia'. *Journal of Environmental Management*, 181, 279-288.	Soil carbon stocks will be baselined prior to site preparation to account for any changes in soil mass and the consequential impacts on equivalent soil mass (ESM). Soil sampling depth will be to at least 10cm below the depth of (planned) soil disturbance of any planting event.

IFLM method component	Summary of scientific basis	Evidence basis – Key scientific papers	Options for method safeguards* <u>*Category of method safeguard shown with underline formatting.</u> ***[Relevant Offsets Integrity Standard shown grey square brackets]***
with facilitated restoration	increase SOC; total SOC stocks and distribution of SOC throughout the soil profile. As with many practice changes, literature indicates that changes in SOC stocks following the reintroduction of trees is affected by initial SOC, land condition, soil type, previous land use and climate. The primary drivers of increased SOC under plantings are attributed to increasing the amount of organic matter (OM) input through plant litter, roots and root exudates, as well as greater retention of soil OM through reduced soil disturbance (if previously under disturbance regimes, such as cultivation), increased soil aggregation and buffered soil temperature and moisture. These components assist in improving water infiltration and retention, an important component of soil carbon sequestration. Planting trees in pasture paddocks can reduce evapotranspiration and soil erosion by slowing surface water runoff, increasing surface roughness and reducing wind velocity across a site. Changes to plant biodiversity and root structure through afforestation also positively impacts soil microbial communities, supporting the growth of mycorrhizal fungi which in turn may increase soil carbon sequestration rates and improves carbon stability. The nature of land use change from continuously grazed pasture, continuous cropping and degraded land to rotational grazing with paddock trees, or forested cover aligns with permanent increases in SOC stocks in the medium-long term.	Paul KI., England JR., Baker TG., Cunningham SC., Perring MP., Polglase PJ., Wilson B., Cavagnaro TR., Lewis T., Read Z., Madhavan DB. and Herrmann T (2018) 'Using measured stocks of biomass and litter carbon to constrain modelled estimates of sequestration of soil organic carbon under contrasting mixed-species environmental plantings'. *Science of The Total Environment*, 615, 348-359. Wehr JB., Lewis T., Dalal RC., Menzies NW., Verstraten L., Swift S., Bryant P., Tindale N. and Smith TE. (2020) 'Soil carbon and nitrogen pools, their depth distribution and stocks following plantation establishment in south east Queensland, Australia'. *Forest Ecology and Management*, 457, 117708. Amarasinghe A., Knox OGG., Fyfe C., Lobry de Bruyn LA. and Wilson BR (2021). 'Response of soil microbial functionality and soil properties to environmental plantings across a chronosequence in south eastern Australia.' *Applied Soil Ecology*, 168, 104100. Barnes P., Wilson BR., Nadolny C. and Growns I (2009). 'The influence of individual native trees and grazing regime on soil properties and groundcover patterns in a temperate landscape of New South Wales, Australia'. *The Rangeland Journal* 31(4), 405-415. Lawrence, R., Ogilvy, S., O'Brien, D., Gardner, M. and McIntyre, S. 2023. Processes underpinning natural capital account compilation highlight the potential for low-input grazing to mitigate farm carbon emissions while also improving biodiversity outcomes.	Project GHGe, including site preparation, will be accounted for in net carbon abatement calculations, taking sure not to double-discount. It is recommended that for sampling rows and inter-rows are stratified separately to reduce variability in subsequent sampling rounds following the soil carbon baseline. Soil sample preparation and laboratory analysis in the current Soil Carbon Method 2021 ensures only soil organic carbon, not root carbon is counted in the soil carbon pool. That is, coarse roots (>2mm) are not included in the SOC pool. Monitoring and notification of disturbance events within a 90 day window. With a measurement only, and measurement based model validation approach then only increases in SOC are credited. The nature of land use change toward the incorporation of trees as part of an integrated permanent pasture grazing operation, or the conversion from cropping and/or degraded land to woodland or forested cover aligns with an EMA that is likely to result in permanent increase in SOC stocks.

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		The Rangeland Journal doi:10.1071/RJ22053 Paul, K. Polglase, P. Bauhus, J., Raison, J. and Khanna, P. (2004). Modelling Change in Litter and Soil Carbon Following Afforestation or Reforestation: Calibration of the FullCAM 'Beta' Model National Carbon Accounting System Technical Report No. 40[31]	
10. For soil organic carbon CEAs: Framework to calculate eligible abatement from soil sequestration activities	Soil organic carbon stocks are influenced by climate, soil type, land use and management. The Soil Carbon Method 2021 has identified 13 eligible management activities (EMAs) which have been demonstrated in the peer-reviewed literature to increase soil organic carbon in Australia. The extent to which these EMAs increase soil organic carbons stocks is influenced the soil carbon deficit (i.e. how far from attainable saturation the soil is based on clay content and mineralogy), the farming systems capacity to increase organic matter supply to the soil (i.e. increase plant production) and the soil and farming systems ability to protect and retain soil organic carbon. These EMAs can been categorised into management practices which increase organic matter supply to soil and reduce organic matter loss, for example by overcoming a soil constraint (such as addressing nutrient deficiency, acidity, sodicity or magnesic soils), increasing pasture production, function and composition (including in crop rotations and by altering the stocking rate, duration or intensity of grazing management), irrigation management and modifying the landscape to remediate land. In the Soil Carbon Method 2021 offset integrity standards are met by: • Measurable: only issuing credits for changes in soil organic carbon stocks. • Verifiable: Soil sampling plans (including randomisation approach) are submitted to the CER prior to sampling for approval. Third Party Soil Samplers collect soil cores and accredited laboratories analyse the samples with the approved dry combustion method (for Measure only approach). The Land Management Strategy is reviewed by a suitably qualified professional. Minimum of three audits per Project. • Conservative: applying a 25% temporary discount to first issuance of ACCUs for all Soil Carbon Projects. Additionally, there is a probability of exceedance measure in place. The Land Management Strategy	During the development of the Soil Carbon Method 2021 (and previous Soil Carbon Methods) literature was compiled by the Dept, particularly regarding the EMAs. Below are some more recent additional papers for consideration around potential for carbon sequestration in agricultural soils. Karunaratne S., Asanopoulos C., Jin H., Baldock J., Searle R., Macdonald B. and Macdonald LM. (2024). 'Estimating the attainable soil organic carbon deficit in the soil fine fraction to inform feasible storage targets and de-risk carbon farming decisions'. *Soil Research* 62, 1-16. Gray JM., Wang B., Waters CM., Orgill SE., Cowie AL. and Ng EL. (2022). 'Digital mapping of soil carbon sequestration potential with enhanced vegetation cover over New South Wales, Australia.' *Soil Use and Management*, 38, 229–247. Viscarra Rossel RA., Lee J., Behrens T., Luo Z., Baldock J., and Richards A. (2019). 'Continental-scale soil carbon composition and vulnerability modulated by regional environmental	Soil carbon stocks will be baselined prior to site preparation to account for any changes in soil mass and the consequential impacts on ESM. *[Conservative]* Soil sampling depth could be to at least 10cm below the depth of (planned) soil disturbance of any planting event. *[Conservative]* Project GHGe, including site preparation, would be accounted for in net carbon abatement calculations, taking sure not to double-discount. *[Project emissions, Measurable & Verifiable]* Sampling rows and inter-rows would stratified separately to reduce variability in subsequent sampling rounds following the soil carbon baseline. *[Measurable & Verifiable]* Soil sample preparation and laboratory analysis in the current Soil Carbon Method 2021 ensures only soil organic carbon, not root carbon is counted in the soil carbon pool. That is, coarse roots (>2mm) are not included in the SOC pool. *[Conservative, Measurable & Verifiable]* With measurement based model validation approaches then only increases in SOC are credited. *[Additionality, Measurable & Verifiable]* The nature of land use change from pasture, cropping and degraded land to forested cover aligns with EMA that is likely to result in permanent increase in SOC stocks. *[Evidence based, Measurable & Verifiable]*

[31] Available at: https://webarchive.nla.gov.au/awa/20050218013711/http://pandora.nla.gov.au/pan/23322/20050218-0000/www.greenhouse.gov.au/ncas/reports/tr40final.html

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[Relevant Offsets Integrity Standard shown grey square brackets]</th></tr>
<tr><td></td><td>outlines how any risks to the project and the carbon permanence will be managed.
• Clear and convincing evidence: all approved EMAs are based on peer reviewed literature. The Land Management Strategy includes a statement of how the EMA(s) are reasonably expected to increase soil organic carbon at the site. Accounts for material emissions due to project: projects are required to baseline and report GHGe for the CEAs. The calculation of net carbon abatement accounts for GHGe from the project implementation activities.

As part of the IFLM,
1. Include facilitated regeneration as an EMA for soil organic carbon, see relevant evidence above
2. Broaden the definition of designated waste stream so that biochar sourced from outside of the project area can be applied to the soil. (Currently, the biochar needs to be sourced or created from CEAs that are part of the project or organic matter that previously formed part of a designated waste-stream).

As per the Soil Carbon Method 2021, biochar means organic material (other than tyres or rubber products) that has undergone a pyrolysis or gasification process. Biochar is a multifunctional carbon material which when produced and used as a soil amendment can improve plant growth and thereby organic matter supply to soil through improving water holding capacity, plant available water, and nutrient retention and availability, as well as protect soil organic matter from decomposition by accelerating soil aggregate formation. Biochar can also reduce GHGe from soils, notably in our Australian context NOx. To meet conservativeness OIS, this would be a co-benefit and not accounted for when calculating Project Emissions. Converting on farm or station ‘waste’ materials (including thinning residues) to biochar offers an opportunity for broadscale soil amelioration and associated benefits of improved plant growth in a cost-effective. Expanding the designated waste stream definition to include farm organic materials that would have been otherwise been burned or left to decay. Projects are declared with a commitment to implement EMAs. Auditors are required to verify that at least one of 13 EMAs under the Method have been implemented at crediting.</td><td>controls’. Nature Geoscience 12, 547–552.

Viscarra Rossel RA., Zhang M., Behrens T. and Webster R. (2024). ’A warming climate will make Australian soil a net emitter of atmospheric CO_2’. npj Climate and Atmospheric Science, 7(79). Australian Biochar Road Map 2023 https://anzbig.org/biochar-industry-2030-roadmap/

Joseph S., Cowie AL., Van Zwieten L., Bolan N., Budai A., Buss W., Luz Cayuela M.,

Graber ER., Ippolito JA., Kuzyakov Y., Luo Y., Ok YS., Palansooriya KN., Shepherd J., Stephens S., Weng Z. and Lehmann J. (2021). ‘How biochar works, and when it doesn't: A review of mechanisms controlling soil and plant responses to biochar’. GCB Bioenergy, 13(11), 1731-1764.

Gross, A., Bromm, T. and Glaser, B. (2021). ‘Soil organic carbon sequestration after biochar application: A global meta-analysis’. Agronomy, 11(12): 2474.

Lehmann J., Cowie A., Masiello CA., Kamman C., Woolf D., Amonette JE., Cayuela ML., Camps-Arbestain M. and Whitman T. (2021). ‘Biochar in climate change mitigation’. Nature Geoscience, 14, 883–892.He Y., Zhou X., Jiang L., Li M., Du Z., Zhou G., Shao J., Wang X., Xu Z., Bai SH., Wallace H. and Xu C. (2017). ‘Effects of biochar application on soil greenhouse gas fluxes: a meta-analysis’. GCB Bioenergy, 9, 743–755.

Vijay V., Shreedhar S., Adlak K., Payyanad S., Sreedharan V., Gopi G., van der Voort TS., Malarvizhi P., Yi S., Gebert J. and Aravind PV. (2021). ‘Review of</td><td>Under the measurement approach, SOC stock is measured and the change in stock is considered sequestration. [Eligible carbon abatement]

Randomly assigned points are sampled and analysed, and these measures are extrapolated to the CEA. Method discounts for variability, permanence and a static baseline add conservativeness. [Conservative, Measurable & Verifiable]

The modelled option allows for crediting based on modelled soil carbon levels using remote sensing or any other technologies. The Method does require verification back to measured soil carbon stock to ground truth any modelled approach. [Measurable & Verifiable]</td></tr>
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		Large-Scale Biochar Field-Trials for Soil Amendment and the Observed Influences on Crop Yield Variations'. *Frontiers in Energy Research*, 9, 710766	
11. For woody biomass CEAs: Material sources of emissions are accounted for (i.e. leakage)	**Definition of leakage** The ERAC definition of direct leakage is: "Direct leakage, also known as activity shifting, refers to instances where the project proponent physically moves the emitting activity to another location, outside the project boundary, while claiming credits for the reduction in emissions inside the project boundary." Activity shifting leakage could occur for a number of reasons including: • An appetite to maintain agricultural productivity on other land, if implementation of the carbon project has reduced agricultural productivity in the CEA; or • Release of funding due to sale of ACCUs could enable agricultural activities to be shifted outside the CEA, where financial constraints prevented the activity from occurring in the absence of the carbon project.	Emissions Reduction Assurance Committee (2021) Information Paper: Committee considerations for interpreting the Emissions Reduction Fund's offsets integrity standards	**Reporting of direct, activity shifting leakage** In accordance with the recommendations of ERAC, reporting of leakage at the project level could be constrained to reporting of direct emissions due to activity-shifting leakage. To be clear, this would mean that leakage detection and reporting could be constrained to project activities that occur, or cease to occur in the CEA, that are displaced to and cause emissions on other land (see 2.4) within operational control of the land manager. **Leakage monitoring to be commensurate with risk** Reporting of leakage under IFLM could involve a tailored, project-specific assessment approach to ensure that effort on leakage monitoring is commensurate with the actual risk of leakage. For activities assessed as low risk of leakage, a less onerous process could be available, such as development of a preventative leakage management strategy in the Land Management Strategy (LMS). **Leakage monitoring for displacement of clearing** After applying a risk assessment framework, the IFLM related management changes that could cause material leakage emissions is displacement of mechanical or chemical suppression of native forest. This could be triggered by implementation of the following management changes in the CEA: • Cessation of mechanical or chemical suppression; and/or • Changes to grazing management which could result in changes to mechanical or chemical suppression on a non-project property (i.e. where reductions in grazing pressure in the project area could result in increases to mechanical or chemical suppression activities on other land to accommodate increased grazing on the alternate land). • Conversion of cropland or pasture to environmental planting which could result in changes to mechanical or chemical suppression on a non-project property to accommodate shifting cropping or grazing activities to alternate land (note the nature of the planting impacts the risk. For example, shelter belts or shade plantings with moderate canopy cover which improve agricultural productivity would be low risk, whereas block

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			planting conversions may be higher risk). Conversion of cropland to pasture which could result in changes to mechanical or chemical suppression on a non-project property to accommodate shifting crop activities to alternate land. When assessing leakage risks associated with cessation of clearing or conversion of cropland, the legal right of the project proponent clearing of native forest on their land under their operational control should be considered. Where there is potential for activity shifting to create leakage, non-CEA areas of the project may need to be monitored and where losses exceed the historical (BAU) range, leakage emission quantification and deduction is required. These additional monitoring requirements may be onerous and could possibly disincentivise some types of activities that have the potential to sequester material amounts of carbon. All other management changes implemented under the IFLM method are likely to have relatively low risk or immaterial changes in emissions due to leakage. Emissions associated with leakage from these activities could be handled via prevention and disclosure requirements in the Land Management Strategy. This could incorporate a 'duty of utmost good faith' declaration by project proponents, as recommended in the 2020 Grant King Review, and as currently applied in the insurance industry. **Leakage risk assessment approach** Leakage risk assessment could involve comparison of project activities to be implemented in the CEAs to identify possible reductions in biophysical productivity and/or profitability of non-carbon agricultural products generated from the CEA, relative to historical practices. This is based on the rationale that if productivity (such as yield or liveweight gain), or profitability of non-carbon agricultural products is reduced due to the implementation of the IFLM project, then the land manager will be more likely inclined to offset those losses by displacing historical activities to other land. CEAs where the profitability and/or productivity of non-carbon agricultural products in the CEA is unlikely to be impacted, or only temporarily impacted (e.g. 2 -5 years) by project activities, should be considered low risk. CEAs where project activities could possibly reduce the profitability or productivity of non-carbon agricultural products in the CEA for all or

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			most of the crediting period should be considered medium risk, and these risks could be addressed in the land management strategy. CEAs where project activities will reduce profitability/productivity may be impacted for all or most of the crediting period, which could drive the land manager to offset production losses elsewhere, could be considered high risk. Where carbon project activity involves a decision to cease one or more historical practices, such as complete de-stocking, or cessation of mechanical or chemical suppression, carry a higher risk of leakage. This is based on the rationale that a decision to cease historical activities may carry a temptation for the land manager to simply undertake the same activities outside the CEA, on other land owned by them. This is in contrast to situations where the carbon project activities have never been undertaken before (for example, facilitated regeneration), or where the historical activities are continued under the carbon project scenario, but in a materially different way (for example, transition from set stocking to rotational grazing). As historical activities are not ceased, productivity/profitability is therefore not likely to be affected and the risk of activity shifting is assumed to be low.
12. For soil organic carbon CEAs: Material sources of emissions are accounted for (i.e. leakage)	Soil carbon activities are included in the overall risk of leakage framework. In the Soil Carbon Method 2021 projects are required to baseline and report GHGe for the CEAs, and have Land Management Strategy (LMS) in place to reduce risks to soil carbon in the Project Area (which may include additional land that is not part of a CEA). The calculation of net carbon includes GHGe resulting from the project implementation activities. In addition, the Soil Carbon Method 2021 includes restricted and prohibited activities. To ensure a conservative approach and prevent leakage from EMAs to increase SOC, there are some suggested revisions the Soil Carbon Method 2021- Supplement. The preferred approach is that the entire property for any given project is included in the LMS, and that any risk of leakage addressed through specific management actions identified in that plan.	National Inventory Report Volume I, Australian Government (2023), Department of Climate Change, Energy, the Environment and Water	Potential updates to the Soil Carbon Method 2021 – Supplement to reduce risk of project leakage • Update default GHGe values. The GHGe defaults in the Soil Carbon Method 2021 Supplement have not been updated since July 2020. Default values could be based on the most recent National Inventory Report at the time of offsets report preparation and submission. • Update crop- and pasture-legume residue emissions. In the Soil Carbon Method 2021 Supplement crop residue defaults have broad categories that introduce inaccuracies into the emissions calculations e.g. one default for 'pulse' residue and no pasture-legume default values for crop residues (relevant if cover cropping or green manuring etc). • Include default values for poultry emissions. Currently, no emission values for poultry (e.g. chickens, ducks). • Need to include GHGe (e.g. NOx) from 'non-synthetic' fertilisers. • Similar to existing EMAs in the Soil Carbon Method 2021, Modify landscape or landform features to remediate land and use mechanical methods to add or redistribute soil, GHGe associated with soil disturbance from site preparation for facilitated regeneration activities could be included.

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			• Adding an audit parameter/opinion affirming that the risk of leakage is low (as productivity has generally increased). If this is not able to be affirmed, then estimation procedures could be proposed (if for example a non-crediting sacrificial area was identified. The possibility of this deduction could be an additional deterrence to practices that may cause this leakage. • It would however be a normal practice for soil carbon CEAs to focus on some areas of a property initially and expand the application of eligible activities over time to other registered project areas with new CEAs. Pasture renovation for example may also lead to temporary declines in SOC. Land managers are unlikely to renovate the whole project area at once. Outlining management to prevent leakage in the Land Management Strategy may also add some assurance to ensure leakage is adequately considered.