NATURE-BASED CREDIT SCIENCE DECODER SERIES

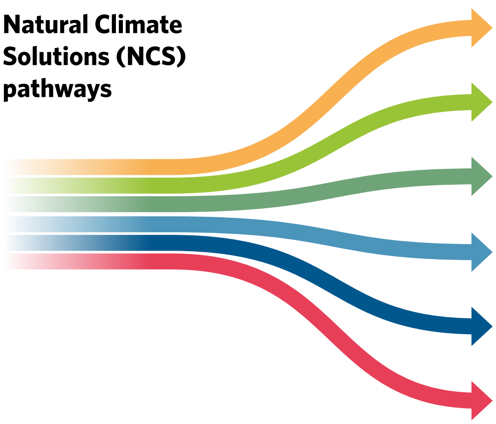
Improved Forest Management

The Nature Conservancy

Carbon accounting methods that center on scientific best practices are the backbone of high-quality carbon projects. However, while scientific advancements have markedly improved carbon accounting to date, the continuous evolution of practices can make it difficult for buyers to understand which practices are high-quality when purchasing credits. The Nature-based Credit Science Decoders are a series of explainers on innovative best practices and existing scientific gaps for carbon projects developed in six common Natural Climate Solutions (NCS) pathways:

This guide (1) provides an overview of the scientific approaches that Improved Forest Management (IFM) projects use and (2) highlights the best practices among them. We cover the ways in which IFM projects achieve durability, robust baselines, and accurate accounting of emissions reductions and/or removals. With this summary, buyers of high-quality carbon credits can better evaluate whether projects are effectively deploying rigorous scientific tools and approaches. They can also identify priority areas for research investment. Project developers may also benefit from this guide to ensure the incorporation of the latest science in their projects.

Natural Climate Solutions (NCS) pathways



1. Avoided Conversion of Grasslands and Shrublands (ACoGS)
2. Afforestation, Reforestation and Revegetation (ARR)
3. Agricultural Land Management (ALM)
4. Wetlands Restoration and Conservation (WRC): Blue Carbon
5. **Improved Forest Management (IFM)**
6. Reduced Emissions from Deforestation and Degradation (REDD)

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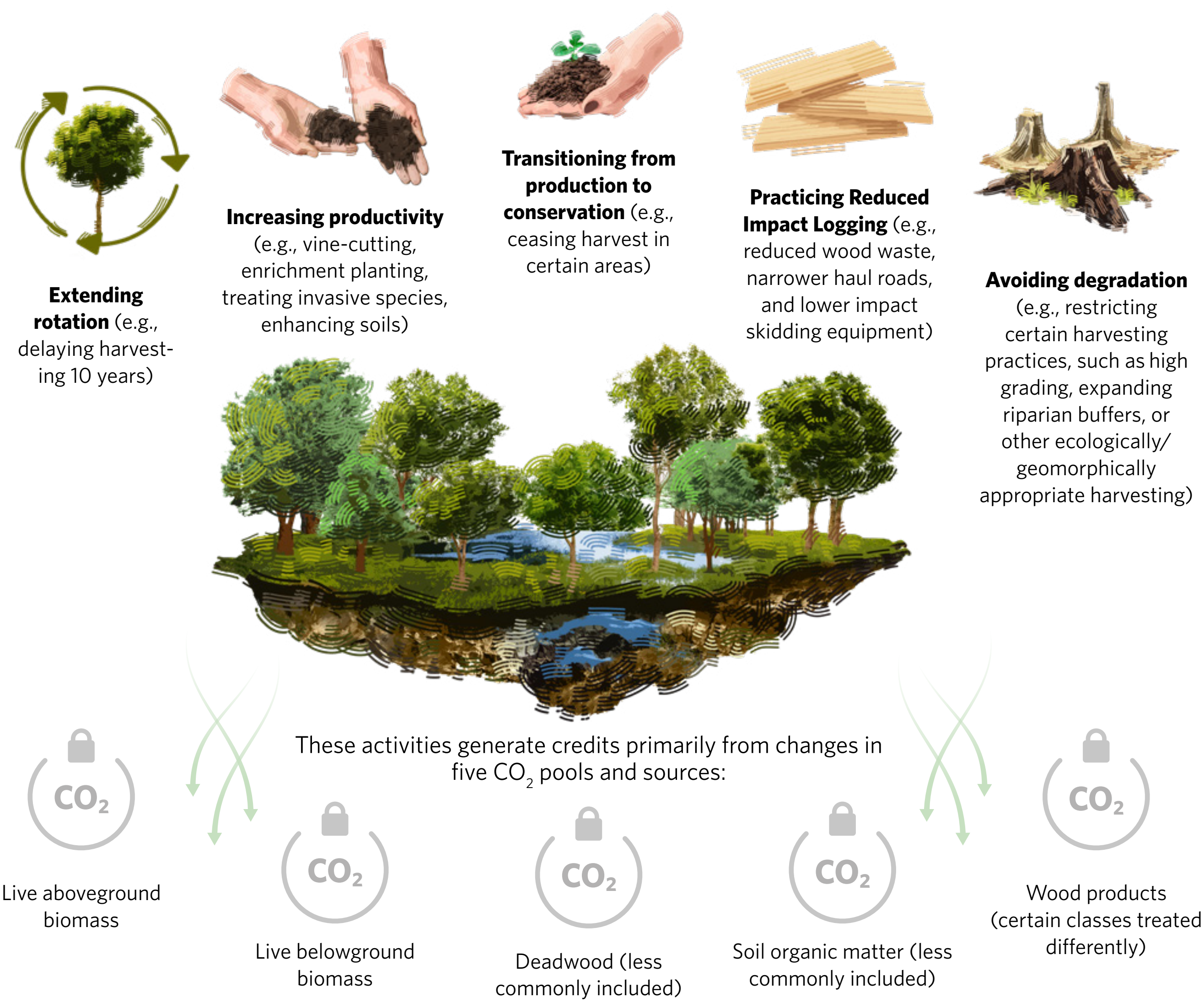
What are IFM Carbon Projects?

In most managed forests, the primary objective is to produce high-quality timber. The "business-as-usual" practices used to achieve this objective are often incompatible with reducing greenhouse gas (GHG) emissions. For example, in the near term, maximizing the Net Present Value (NPV) of timber usually does not result in maximizing carbon stocks. In addition, exploitative harvesting practices such as "high grading" also generate near-term revenue but jeopardize the long-term viability of the ecosystem as a carbon stock. These are but two of the many examples of how "business-as-usual" forest management prioritizes objectives that stand in opposition to climate change mitigation. However, with the proper financial incentives, forest owners can afford to implement climate-smart practices that ensure productivity and positive climate impact. One way to deliver this finance is through carbon markets, where forest owners receive a payment for each additional tonne of carbon that is sequestered or remains stored in their forests due to the adoption of climate-smart forestry practices. These projects are often referred to as Improved Forest Management (IFM) projects.

Figure 1: Improved forest management activities and their associated carbon pools.



IFM projects generate carbon credits by implementing management practices that remove carbon or avoid carbon emissions compared to a defined baseline. See Figure 1 for an overview of activities most often used in IFM projects and the CO_2 fluxes associated with them (other GHGs are usually not included in project accounting). IFM projects can use one or a combination of these practices.[1]

High-quality IFM carbon projects should leverage scientific best practices to achieve three fundamental tasks:

1.

Assure climate additionality through the objective selection of a baseline

2.

Accurately quantify credits by considering what the relevant carbon stocks are; which measurement, estimation, and modeling approaches to use; and how to account for uncertainty

3.

Ensure project durability through proactive management against, monitoring for, and response to reversals

1.

Assure climate additionality through the objective selection of a baseline

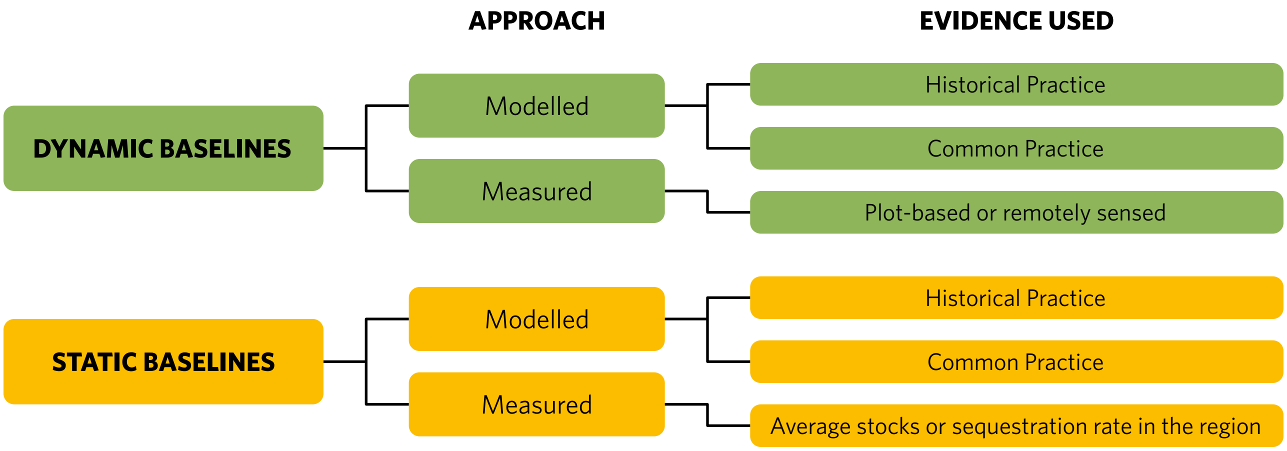
Project baselines establish the volume of carbon stocks that represent the "without-project scenario". That volume is compared against the actual project volume and the difference determines how many credits the project can issue. A robust baseline is also the main ingredient to prove additionality, or the critical concept that the project would not have occurred without climate finance. Within IFM projects, there are a range of approaches used to determine the baseline. However, two considerations never change: 1) the GHG pools and models considered in the baseline and project scenarios should be the same, and 2) the project activity should not be the same as the baseline activity.

BASELINE SELECTION

Baselines in IFM projects have used two primary approaches that involve either 1) *modelling* the baseline scenario (i.e. using reasonable and plausible assumptions to estimate the without-project scenario) or 2) *measuring* the baseline scenario (i.e. using observations from areas outside the project site to estimate the without-project scenario).

Robust modelled baselines should incorporate information about forest management behavior that would have happened in the absence of a project. For example, modelling of typical or expected management of a forest parcel based on current timber market conditions and presumptions about landowner objectives. This model of a baseline can be refined based on constraints that can be supported with data (e.g., national forest inventory trends in growth and harvest, access to markets, biophysical constraints on the parcel itself, and logistical constraints of work force availability).

Figure 2: Approaches to baseline-setting in IFM projects.



Both modelled and measured baselines can be either "dynamic" or "static", though dynamic baselines are more desirable because they can more reliably reflect the changing contexts of the project (Swinfield et al., 2024; Novick et al., 2024; Ellis et al., 2024).

Dynamic baselines are updated periodically, ideally every 5 years or less. In the case of dynamic *modelled* baselines, the updates could involve a re-evaluation of model parameters such as the capacity of local markets to process harvested material or other new information such as natural disturbance impacts. Dynamic measured baselines are developed by comparing ex-post (i.e. after the activity is performed) carbon stock measurements of a control area to the ex-post project carbon stock measurement in the treatment (project) area. Because they are ex-post, these baselines are repeatedly remeasured and updated at least at the end of each crediting period.

Carbon accounting standard Verra's approach to dynamic *measured* baselines is referenced in their VM0045 methodology for IFM projects. In this approach, the project area is statistically matched to a reference area using conditions and parameters common to both. Such statistical matching can provide advanced assurance of causal inference—that is, that the climate finance caused the project's climate benefit rather than simply that the project activity differed from the baseline activity. For example, the baseline and project areas would represent similar forest ownership classes, forest types, and starting timber volumes. Causal inference, and therefore additionality, is demonstrated by ex-post measurements that isolate the project activity as the variable that causes the difference in emissions between the project and the baseline.

BASELINE CONSIDERATIONS

High-quality IFM projects that use modelled baselines should consider the following:

- Who the landowner(s) in the project area is (e.g., length of ownership, private or public entity)
- How economic conditions might change throughout the baseline period, which would affect harvesting rates (e.g., the price of timber)
- When to update to the baseline (e.g., at the end of each crediting period or more frequently)

- Whether the selected baseline is ecologically, financially, operationally, and legally probable and plausible (e.g., considering if the site index allows for the level of productivity, if the harvesting areas are accessible, or if the benefits of harvesting outweigh the overhead)
- Whether the reference region for and characterization of harvesting practices are reasonable and supported by data

Note that, for measured baselines, many of the points above are inherently considered if the matching plots are thoughtfully selected. High-quality IFM projects that use measured baseline should consider the following:

- Whether sufficient data is available to match a given reference area to the project area
- Whether the criteria to match reference and project areas is objective and thorough (For example, do the matching criteria cover the relevant drivers of forest management behavior?)
- Whether the variables used to match them also should not change during the crediting period, which could allow for unrealistic levels of baseline harvesting

Projects that utilize dynamic measured baselines, such as those under Verra's VM0045 methodology, introduce new questions around project finance. Dynamic baselines acknowledge the risk that real forest management is truly dynamic, and thus, crediting can also be more complex to predict. An unexpectedly low level of crediting volume determined during ex-post evaluation might mean that less finance flows to the project than originally planned. Projects can develop ways to provide stable income to participating communities and landowners despite this dynamic crediting (e.g., through guaranteeing payments and taking on more risk), and buyers may need to be willing to work with projects to balance this risk as well through buyer contracting. The reward is best-in-class, evidence-based additionality and atmospheric integrity.

TAKEAWAYS FOR BUYERS: BASELINES

MINIMUM expectations for IFM projects:

- The GHG pools and models used to construct the baseline scenario should match with those used for the project scenario.
- The assumed baseline activity should differ from the project activity.
- The plausibility of any modelled baseline scenario should be considered prior to crediting, taking into account financial, operational, and ecological constraints.
- Projects with dynamic measured baselines should transparently report their approach to matching and be able to demonstrate that their matching criteria adequately captures the drivers of forest management behavior in the project area.
- Baselines should be regularly updated (at least every 5 years or less).

OPTIMAL practices for IFM projects:

- Dynamic measured baselines (e.g. VM0045's approach) should be the preferred baseline approach whenever there is sufficient data and availability of statistically similar reference areas.

2.

Accurately quantify credits by considering what the relevant carbon stocks are, which measurement, estimation, and modeling approaches to use, and how to account for uncertainty

DEFINING THE GHG BOUNDARY

The GHG boundary defines the GHG pools included in the project accounting. In forests, there are many forms of GHG sinks, some of which are accounted for in carbon crediting and some of which are not (see Figure 1). The line between these two categories depends on the relative size of the stock and its durability, as well as its relevance to the project activity. For example, leaf litter releases its carbon stock to the atmosphere or soil on a time scale of months, disqualifying it from most durability thresholds (Cao, 2019). Though forest soil stores a significant amount of carbon, IFM project activities may not significantly affect soil carbon stocks, in which case they can also be excluded with justification from the project (Nave et al., 2009; Schmid et al., 2005; Johnson and Curtis, 1999).

The forest carbon pools[2] that are typically accounted for in projects include:

- Live aboveground woody biomass (most often trees; herbaceous plants are usually non-significant)
- Live belowground woody biomass (most often trees; herbaceous plants are usually non-significant)
- Wood products (also accounting for decay)
- Standing deadwood (also accounting for decay)

Whether or not a pool is considered should depend on whether fluctuations are likely to make a significant difference in accounting estimates. Usually, projects will defer to the pools required in the methodology. Methodologies should determine the inclusion of a carbon pool based on the percentage of the total project stock that the pool represents and whether the project activities under the methodology could affect that pool. If the pool represents just a few percentage points of the total project volume, for example, it can be omitted from project accounting.

MEASUREMENT, QUANTIFICATION, AND MODELING

Once the relevant carbon stocks have been identified, the project must also choose robust approaches to measure them. Measurement of carbon stocks is required at regular intervals to determine the change in biomass due to project activities. At a high level, carbon stock data can be procured via field sampling (e.g., tree sampling plots, transects), remote sensing (e.g., LiDAR, spectral imaging), regional proxies (e.g., emissions factors), flux towers, static chambers, or some combination of these approaches. Currently, field sampling is the only approach permitted by accounting methodologies to quantify carbon in IFM projects, given that the accuracy of other approaches is either untested or proven to be significantly lower (Novick et al., 2022; Pachama, 2024). Remote sensing has emerged as a potentially robust alternative or complement to field sampling, though it has yet to be approved by accounting standards (Goetz et al., 2009).

Using the data collected, projects can then quantify biomass (and thus carbon stocks) across the entire project area. Projects may opt to do this through dynamic equations (e.g., allometric models) or static ratios (e.g., root-to-shoot ratios), depending on the quality of scientific literature available for the project site. See Table 1 for an overview of the best existing approaches to quantifying each of the core forest carbon stocks.

The most suitable measurement and quantification approach ultimately comes down to three factors:

- Type of carbon pool
- Data accessibility in the project area
- Quality of the data available in the project area

Carbon pool	Optimal measurement approach(es)	Optimal quantification approach(es)
Live aboveground woody biomass	High-frequency field measurements, stratified by management type, species composition, and forest structure	Region-specific allometric equations for each species
Live belowground woody biomass	Indirect measurement based on live above ground woody biomass measurements	Region-specific allometric equations for each species
Wood products	High-frequency field measurements of merchantable timber, stratified by management type, species composition, and forest structure (if the timber as not yet been harvested) OR Harvest slips and/or mill receipts (if the timber has been harvested)	Region-specific allometric equations for each species AND A factor to determine how much biomass will be converted to wood product
Standing deadwood	High-frequency field measurements of deadwood, stratified by management type, species composition, and forest structure	Region-specific allometric equations for each species AND Decay class (recorded in-field) AND Structural loss adjustment factor

Table 1: An overview of the optimal measurement and quantification approaches for each carbon pool, not considering data accessibility and availability.

Field sampling practices in carbon projects should be transparently documented, including information on which pools were measured, how the project area was stratified, what type of sampling method was used, how the sampling areas were selected, and where the plots are located. There are several other best practices concerning field sampling that the project should document, though it may be impractical for a credit buyer to fully review each practice. The most important consideration here is that the sampling protocol is unbiased, repeatable, and transparent.

When it comes to remote sensing, current tools are limited in their ability to estimate biomass unless the project area is a uniform plantation. For example, satellite remote sensing is not suitable for a project trying to quantify incremental growth in a closed canopy (Coffield, 2022). In this case, LiDAR (a remote sensing tool with extremely high spatial resolution) may drastically improve the estimation but can be cost-prohibitive. Remote sensing can still be useful in other contexts though, such as project monitoring or origination. Buyers should be especially wary of products (including LiDAR) that claim to quantify stocks in complex forest structures (Pachama, 2024). Biomass proxies such as NDVI (Normalized Difference Vegetation Index) should not be used to estimate stocks without corresponding ground truth data. NDVI should also be avoided in high biomass areas because it becomes saturated (Pachama, 2024). Future scientific advancements may allow for better biomass quantification with remote sensing.

Once measured and quantified, project carbon stocks should be modeled over time. These models are used to determine the baseline scenario (if *ex-ante*) and optimal activities to achieve the project's objectives. See the earlier section on additionality for guidance on selecting the best baseline scenario.

The most suitable modeling approach ultimately comes down to three factors:

- Which growth simulation tool is used
- The assumptions added to the model (see Table 2)
- The uncertainty of the approach

Model assumption type	Optimal input(s) for the baseline scenario	Optimal input(s) for the project scenario
Harvesting practices *The management actions taken and their frequency, which may vary within the project area*	The practices that reflect the assumptions in the baseline scenario	The scenario that optimizes carbon storage and forest health and resilience, considering financial, legal, operational, and other constraints
Growth *The rate of biomass accumulation in the project area*	Corresponds to the site index	Corresponds to the site index
Mortality *The rate of biomass death in relevant carbon stocks*	Based on forest inventory	Based on forest inventory
Decomposition/defect *The natural rate of emissions released by relevant carbon stocks or that should be omitted due to biomass deformity*	Separate rates for standing deadwood and wood products, derived from scientific literature	Separate rates for standing deadwood and wood products, derived from scientific literature
Natural disturbance *The frequency and impact of natural reversals in the project area*	Incorporates natural reversals identified in the risk assessment at the most likely intervals *These risks may differ between the baseline and project scenarios.	Incorporates natural reversals identified in the risk assessment at the most likely intervals

Table 2: An overview of the key modeling assumptions and considerations for projects to determine the best input. Note that projects using dynamic baselines do not need to model (because the baseline is set using empirical observation) but may choose to model in order to select the optimal harvesting practice in the project scenario.

Forest growth simulators model biomass flux in forest stands or individual trees. Often, the most suitable models in the context of carbon markets are geography-dependent. In the United States, the Forest Vegetation Simulator (FVS) is a common, well-respected program available for use, offered to the public for free by the national government. Growth simulation tools to avoid would generally be black-box, proprietary products. It is difficult to trust results if the user cannot see how they were calculated or if you are unable to override defaults with local knowledge.

Projects should be prepared to justify the growth simulation tool they select as well as the assumptions they put into their models such that they could be independently repeated. Both should already be publicly reported in the Project Design Document listed on the registry.

UNCERTAINTY

Uncertainty is an inevitable aspect of carbon crediting, regardless of the project type. Within IFM projects, three key areas of uncertainty should be considered to minimize the risk of over-crediting: model prediction error, sampling error, and measurement error.

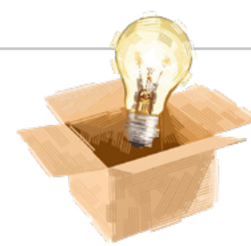
To minimize the sampling error, stratification of the project area into relatively homogenous units and increasing sampling intensity is a common practice. Beyond that, technical training for field crews to reduce measurement error as well as model optimization (where applicable) can also help minimize the uncertainty of the crediting volume. Despite these measures, some amount of uncertainty will remain. Where that uncertainty is significant, projects should discount their credits to protect against over-crediting.

Discounts for uncertainty, also commonly referred to as confidence deductions, are a percentage that is removed from the total estimate of credits. They help ensure that the project isn't over-crediting due to errors. In high-quality IFM projects, sampling errors should be considered when determining the right deduction percentage. If the total error exceeds 20%, then the project should take a 100% deduction (i.e., it should not be eligible for crediting). Conversely, a low error percentage (e.g., 0-5%) should not require a confidence deduction. For any percentage in between this range, the deduction should be proportional to the uncertainty. Confidence deductions should be adjusted at the end of each crediting period if the error rate has changed (whether increased or decreased). Lastly, model and measurement errors should be transparently reported.

TAKEAWAYS FOR BUYERS: ACCOUNTING

MINIMUM expectations for IFM projects:

- All significantly large carbon pools should be included in project accounting if they are impacted by project activities. Where relevant, projects should justify their choice to exclude soil organic carbon from accounting.
- Projects should be able to justify the most suitable carbon measurement and quantification approaches by demonstrating the following considerations:
  - The type of carbon pool
  - Data accessibility in the project area
  - The quality of the data available in the project area
- Projects should be able to justify the most suitable carbon modeling approach by demonstrating the following considerations:
  - Which growth simulation tool is used
  - The assumptions added to the model
  - The uncertainty of the approach
- An uncertainty deduction should be applied if uncertainty is above ~5% but if it is greater than ~20%, the project is non-viable.
- The uncertainty deduction should be re-evaluated after each crediting period.
- The uncertainty deduction should be proportional to the uncertainty.
- All accounting methods should be transparently reported.



OPTIMAL practices for IFM projects:

- Implementation of the following: (1) employs increased sampling intensity, (2) provides regular technical training to reduce measurement error, or (3) promotes model optimization to help minimize uncertainty of the credit volume.

3.

Ensure project durability through proactive management, monitoring, and accounting

Durability in IFM carbon projects refers to the length of time the project proponent guarantees that any GHGs counted as carbon credits will remain sequestered. This concept is critical to ensuring that the climate impact of the credit is not reversed shortly after the credit is issued. Forests are dynamic environments where events such as wildfire or disease could release the emissions sequestered, causing a "reversal" of emissions. Human activity can also cause a reversal, whether that means non-compliance by project participants or unauthorized activities by actors not involved in the project. Regardless of the cause of the reversal, it must be addressed for the project to maintain its durability.

REVERSAL DETECTION

To detect a reversal event, high-quality IFM projects should actively monitor changes in the project area's carbon stocks from the project start date through to the end of the monitoring period. The duration of that period should be at least 40 years, as required in the Integrity Council for Voluntary Carbon Market's Core Carbon Principles (v1.1). Projects should monitor for reversals as often as feasible, ideally annually, to ensure timely identification and mitigation of reversals.

Several parameters should be clearly defined and regularly tracked for IFM project monitoring, including the project area boundaries, location of the sample plots, species composition, live and dead biomass, and wood production volume. Any carbon pool included in project accounting should be monitored (see page 8 for an overview of best practices in carbon pool inclusion). It is also critical to monitor and document significant events throughout the project's lifetime that could impact carbon stocks, including natural disturbances and human activities. Methods applied to measure stocks during the monitoring period should be consistent with the methods used to measure initial carbon stocks. If carbon stock methods change during the project lifetime, they should be well-documented and approved by the standard. How carbon stock changes are tracked and ultimately quantified in project accounting should be clearly and consistently laid out in the project's Monitoring Plan.

If the project uses remote sensing to monitor, see The Nature Conservancy's Remote Sensing Decoder for an overview of best practices. Remote sensing can be deployed for much more than monitoring purposes in carbon projects. This Decoder provides an overview of other appropriate applications for these tools.

REVERSAL PREVENTION AND COMPENSATION

Reversal events within IFM projects are typically addressed using buffer pools, a bundle of credits that can only be used to compensate for reversals. These credits are kept in reserve and canceled in the event of a reversal. Key elements that define high-quality buffer pools in IFM projects are:

- **Aggregation:** The project's registry should aggregate buffer credits across projects to reduce the risk of buffer pool undersupply. The aggregated buffer pool should represent a diverse set of project locations and contain credits generated by projects of similar quality. This approach is especially critical in project regions with high reversal risk.
- **Estimating reversal risk:** The percentage of credits allocated to the buffer pool should be based on a non-permanence risk rating instead of a static percentage. The full list of reversal risks to be considered for the buffer pool depends on the project and should be determined using a complete risk assessment. Both avoidable (under the project's control) and unavoidable (*not* under the project's control) reversals should play into the buffer pool's size.
- **Changing risks:** Buffer pool sizes should grow if the project demonstrates increased risk during each monitoring period. Conversely, a percentage of the project's buffer pool can be released if the project materially decreases its reversal risk score.
- **Clear protocols:** The project's standard should have clear rules in place for the use of and replenishing of buffer pools when reversals are addressed.
- **Future risks:** Standards should require that all buffer pool credits left after the end of the monitoring period be cancelled as compensation of potential future reversals.

Alternatives to reversal compensation exist, such as the cancellation of future credits issued or the replacement of credits lost with credits from another project, though this approach is more typical for avoidable reversals. Additionally, promising new tools are developing in carbon markets to further improve methods of addressing reversal risk. For example, carbon project insurance providers are offering policies with credit-based or dollar-based compensation for credit reversals. Permanence funds are also being tested in which projects set aside a portion of credit revenue at the point of sale to be used proactively for reversal prevention, monitoring, and compensation with credits that may retire the durability liability altogether. These funds can also be pooled and targeted toward places with the greatest risk of reversal. No empirical comparison of reversal compensation mechanisms (i.e., buffer pools, insurance, permanence funds) has yet been conducted, making it difficult to gauge which is the most effective. However, buffer pools are the most applied tools in the market.

While buffer pools and other mechanisms to compensate for reversals are essential to durability, projects must also implement safeguards that prevent reversal in the first place. For example, the project may want to establish an easement or help local landowners secure land tenure, which provides some legal assurance for the project. Many other risk mitigation options exist for projects to pick from. IFM projects should always conduct a comprehensive evaluation of reversal risks and prepare a risk mitigation plan in addition to using a buffer pool (or some other compensation mechanism). Robust monitoring, reporting, and verification of reversals ensures that they are accurately identified and addressed. See the section above on reversal detection for further best practices.

LEAKAGE

Improved forest management activities reduce the rate of CO_2 emissions within the project area. However, carbon projects must also account for the potential displacement of those emissions, also known as leakage.[3] Leakage in IFM projects can occur when the activities that would have taken place within the project area are simply moved outside the project area (activity leakage) or when decreased production of timber affects the dynamics of the broader market, ultimately increasing or maintaining emissions (market leakage). Some examples of these market dynamic shifts are the price of timber (output market leakage) or the value of standing forests (land market leakage). High-quality IFM projects account for each of these leakage risks through a discount that corresponds to the expected leakage rate.

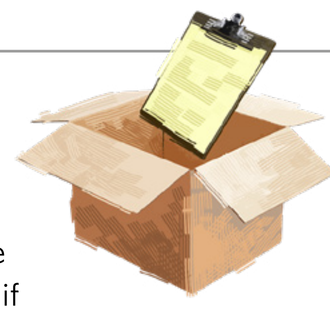
It is important to note the instances where leakage may or may not apply to projects. For example, in some cases, timber production in the project area may *not* decline after the project start date. These instances are rare, and buyers should request additional evidence from project developers who claim that harvesting levels either maintained or increased in the project scenario. Examples of mitigation activities that could result in maintained or increased wood production include reduced impact logging (RIL-C) or liana cutting. Additionally, leakage resulting from harvesting activities (e.g., use of fossil fuels by harvesting machinery) is assumed to be non-significant in project accounting. However, the buyer should ask whether those impacts have been considered by the project. Leakage accounting for IFM also conservatively does not account for "positive" leakage, that is, where the market signal from an IFM project encourages less harvest waste or encourages reforestation elsewhere, creating an additional climate benefit.

In the current market, there are limitations to leakage accounting and discount factors. For one, the sheer size and complexity of the global timber market means that projects cannot quantify the full market impact of the project. Existing IFM methodologies today intentionally omit material substitution or the potential that a loss in timber production will result in the increase in production of some substitutable good with a higher emissions factor (e.g., cement). The market allows this exclusion but acknowledges that it is a separate phenomenon from leakage and requires its own explicit accounting approach. Lastly, research studies from which leakage discount rates come are relatively dated. However, new research is underway to reduce leakage uncertainty.

Daigneault et al., 2023 present an updated leakage model, incorporating a more comprehensive list of drivers that can be used to improve leakage accounting. Based on empirical analysis, the main drivers of leakage in IFM projects are forest type and region, the time horizon used to measure leakage, regional enrollment in IFM carbon projects, and the project activity. Standards are working now to incorporate this new model into their programs.

In the interim, project proponents should mitigate leakage in three ways:

1. Discounting for expected regional market leakage and activity leakage (where applicable)
2. Ensuring that project participants do not increase timber production outside of the project area (e.g., by requiring harvest receipts).
3. Selecting project activities that maintain or increase timber production, wherever possible (e.g., by reducing harvest waste).



TAKEAWAYS FOR BUYERS: DURABILITY

MINIMUM expectations for IFM projects:

- Projects should conduct a reversal risk assessment and provide a detailed risk mitigation plan.
- Projects should provide a monitoring plan that transparently details how carbon stocks changes are tracked, accounted for, and reported.
- Projects should employ a mechanism to compensate for reversals and ensure that there is a robust protocol in place that guarantees a tonne-for-tonne compensation to cover the reversal.
- Buffer pool allocations should be based on the specific risk profile of the project.
- The project's risk profile should be adjusted over time, at least at each verification event.
- Projects should have clear protocols for the use, replenishment, and cancellation of buffer pools.
- Additional evidence should be provided if the project claims zero leakage.
- Projects should discount for expected regional market leakage and activity leakage (where relevant).

OPTIMAL practices for IFM projects:

- Reversal compensation in projects can be further assured through an aggregated buffer pool, sized based on both avoidable and unavoidable risks.
- Projects should demonstrate that activity of harvesting itself in the project scenario does not result in significant leakage (e.g., from logging vehicles).
- Leakage calculations should consider the duration of suppressed demand, type of harvesting activities, and forest type.

What's missing?

IFM PROJECTS REQUIRE MORE THAN JUST GOOD ACCOUNTING

Nature-based carbon projects are complex — they require a sophisticated understanding of finance, law, statistics, ecology, and many other domains to be well-designed. They also promise as much as 11 $GtCO_2e$ in emissions reductions or removals by 2030, making them a climate solution we cannot afford to ignore.

The guidance laid out in this Decoder defines some of the key scientific practices that make IFM projects high-quality. Additional resources to help buyers understand the full breadth of credit due diligence include:

- NCSA Buyer Procurement Guide (a broad overview of credit due diligence for NCS projects)
- Human Rights Guide for Working with Indigenous People and Local Communities (key approaches to ensure social safeguards in nature-related projects)
- Human Rights Screening Tool (a tool to identify and prioritize human rights risks in NCS projects)
- Healthy Forests for Our Future: A Management Guide to Increase Carbon Storage in Northeast Forests (details climate-smart forest management practices that also consider environmental safeguards)
- The Principles of Natural Climate Solutions (principles for high integrity natural climate solutions)
- Criteria for High-Quality Carbon Dioxide Removal (Microsoft's due diligence criteria for carbon dioxide removal credits)
- Catalyzing Forest Carbon Project Quality (an overview of recent innovations in IFM project accounting)

CARBON ACCOUNTING CONTINUES TO IMPROVE

The science behind IFM crediting continues to evolve, just as it does with any other crediting pathway. To increase the confidence in and quality of IFM credits going forward, buyers may consider supporting investment in one or more of the following research areas:

- Improving leakage estimates at the regional and global market levels and in short-term harvest deferral or restriction projects
- Long-term monitoring studies of the impact of IFM practices on soil organic carbon
- Quantifying the carbon lifecycle of wood products (specifically their role as a carbon sink)
- Increasing the local availability of allometric equations to estimate biomass accurately
- Expanding the availability of forest inventory data and remote sensing data for small biomass change detection globally to increase the feasibility of *ex-post* dynamic baselines
- Predictive durability maps to understand the risk of natural disturbance in IFM projects
- The effects of biophysical factors that affect top-of-atmosphere radiative forcing (e.g., black carbon deposited from particulate matter, changes in albedo resulting from changes in land cover, changes in water vapor)
- Fluxes in non-CO_2 gasses due to project activities

Appendix I

Methodology	Standard	Scope
U.S. Forest Protocol	California Air Resources Board	**Project activities:** Activities that increase and/or conserve forest carbon stocks, which include broadly: • Reforestation • Improved forest management (e.g. extension of rotation age, increasing stocking in understocked areas, thinning diseased and suppressed trees) • Avoided conversion **Geography:** Only applicable in the contiguous United States and eligible portions of Alaska **Forest type:** Forests consisting of at least 95% native species, unless species are introduced for climate adaptation
IFM on Non-federal U.S. Forestlands	American Carbon Registry	**Project activities:** Activities that increase forest carbon stocks **Geography:** Only applicable in the United States **Forest type:** Non-federally owned or managed forest which has not been converted to non-native forest within the last 10 years
U.S. Forest Protocol	Climate Action Reserve	**Project activities:** Activities that increase forest carbon stocks, including reforestation avoided conversion, and improved forest management. Examples of improved forest management activities are: • Extension of rotation age • Increasing stocking in understocked areas • Thinning diseased and suppressed trees **Geography:** Only applicable in the United States **Forest type:** All forest types
Mexico Forest Protocol	Climate Action Reserve	**Project activities:** Activities that increase forest carbon stocks. There are many eligible activities, for example: • Agroforestry • Silvopasture • Extension in rotation age • Enhanced fire resilience • Tree planting • Thinning for disease and infestation • Urban tree planting and management **Geography:** Only applicable in Mexico **Forest type:** All forest types
Conversion from Logged to Protected Forest (VM0010)	Verra	**Project activities:** Conversion from logged to protected forest **Geography:** There is no geographic limitation on the methodology **Forest type:** Any forest type except wetlands and peatlands
IFM in Temperate and Boreal Forests (VM0012)	Verra	**Project activities:** Conversion from logged to protected forest **Geography:** There is no geographic limitation on the methodology **Forest type:** Temperate and boreal forests (as defined by FAO), excluding peatland forests
Rotation Extension (VM0003)	Verra	**Project activities:** Extension in rotation age before harvesting **Geography:** There is no geographic limitation on the methodology **Forest type:** Managed forests, excluding peatland forests
Conversion of Low Productivity to High Productivity Forest (VM0005)	Verra	**Project activities:** Projects must perform one or both of the following activities on forests that have previously experienced logging: • Avoiding emissions from re-logging of already logged-over forest • Rehabilitation of previously logged-over forest by cutting climbers and vines, or liberation thinning, or enrichment planting, or a combination of these activities **Geography:** There is no geographic limitation on the methodology **Forest type:** Natural evergreen tropical rainforests (as defined by FAO) that do not contain peatland
IFM Using Dynamic Matched Baselines from National Forest Inventories (VM0045)	Verra	**Project activities:** A wide range of improved forest managements activities, including but not limited to: • Enrichment planting • Release of natural regeneration via management of competing vegetation • Stand irrigation and/or fertilization • Reducing timber harvest levels • Deferring harvest/extending rotations or cutting cycles • Designating reserves and altering fire severity via fuel load treatments **Geography:** There is no geographic limitation on the methodology **Forest type:** Any forest type except wetlands

Table 3: Summary of the most commonly used IFM crediting methodologies in the voluntary carbon market.

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ENDNOTES

1 Note that that IFM and REDD+ often involve similar mitigation activities. The UN defines 5 REDD+ activities: 1) reducing emissions from deforestation, 2) reducing emissions from forest degradation, 3) conservation of forest carbon stocks, 4) sustainable management of forests, and 5) enhancement of forest carbon stocks. Thus, IFM activities fall within the scope of REDD+ in certain cases. One key distinction is that REDD+ focuses in tropical forest countries, while IFM applies globally.

2 Note that CO_2 is typically the only GHG accounted for when quantifying credits.

3 The market may also refer to leakage as "secondary effects."