



**Verified Carbon
Standard**

RIO BRAVO CLIMATE ACTION PROJECT MONITORING REPORT

Document Prepared by The Nature Conservancy, Programme for Belize, and
TerraCarbon LLC

Project Title	Rio Bravo Climate Action Project		
Version	3.0		
Report ID	Rio_Bravo_REDD_MR		
Date of Issue	24 May 2022		
Project ID	852		
Monitoring Period	01-January-2012 to 31-December-2021		
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Rio Bravo Climate Action Project is an Avoided Planned Deforestation project. The project activities began in January 1996 and is located in the Orange Walk District of north-western Belize. The project was one of the first Planned REDD+ projects globally and was registered under the VM0007 methodology retroactively in 2016. Therefore, the initial crediting period began on 1 January 2002. The project completed its initial crediting period on 31 December 2021 and will not be renewing its crediting period. This reporting period is the second period to monitored during the life of the project.

The project area contains 6,296 hectares of mature humid forest land and is a component of what is now the much larger, ~100,000 hectare Rio Bravo Conservation and Management Area (RCBMA). The area within the Project Boundary and the larger RCBMA was purchased creating a clear land title held by the Programme for Belize, in trust with the Belize government. The act of purchase removed the imminent threat of purchase by industrial scale agricultural farmers who would have proceeded to deforest the area and convert it to farmland. The land titles purchased covered areas both within and outside of the project boundary. The areas outside the Project Boundary contain Pine Savanna, an ecosystem type that was not under the threat of deforestation by agriculturalists, and it was, therefore, excluded from the project. During the 10-year monitoring period, 1 January 2012 to 31 December 2021, the project generated 130,629 t CO₂e emission removals.

During the reporting period, Programme for Belize continued to implement conservation activities across the project area by conducting regular patrols to prevent illegal poaching of wildlife and timber and to prevent damage from wildfire. Additionally, monitoring efforts were implemented to track the impact of sustainable selective logging and impacts of disturbance like hurricanes and wildfire. PfB also worked with community stakeholders to make sure that the boundaries of the reserve were protected and agricultural activities did not encroach on the forest. By maintaining forest cover in the project area during this period, PfB enabled the forest to sequester net positive carbon emissions from the atmosphere. Further details of project activities can be found in Section 3.1.

1.2 Sectoral Scope and Project Type

This project is within sectoral scope 14 “Agriculture Forestry and Other Land Use” of the VCS. It is a REDD+ Avoided Planned Deforestation project, established under methodology VM0007. It is not a grouped project.

1.3 Project Proponent

Organization name	Programme for Belize
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1.4 Other Entities Involved in the Project

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Role in the Project	Project development; Financial management; Verification lead
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1.5 Project Start Date

The project start date is 1 January 1996.

1.6 Project Crediting Period

The project crediting period is 1 January 2002 – 31 December 2021, totaling 20 years.

1.7 Project Location

The project is located in Orange Walk, Belize at -88.773375, 17.683477 decimal degrees. A kml of the project area is provided separately. A map of the project area is provided below (see Figure 1).

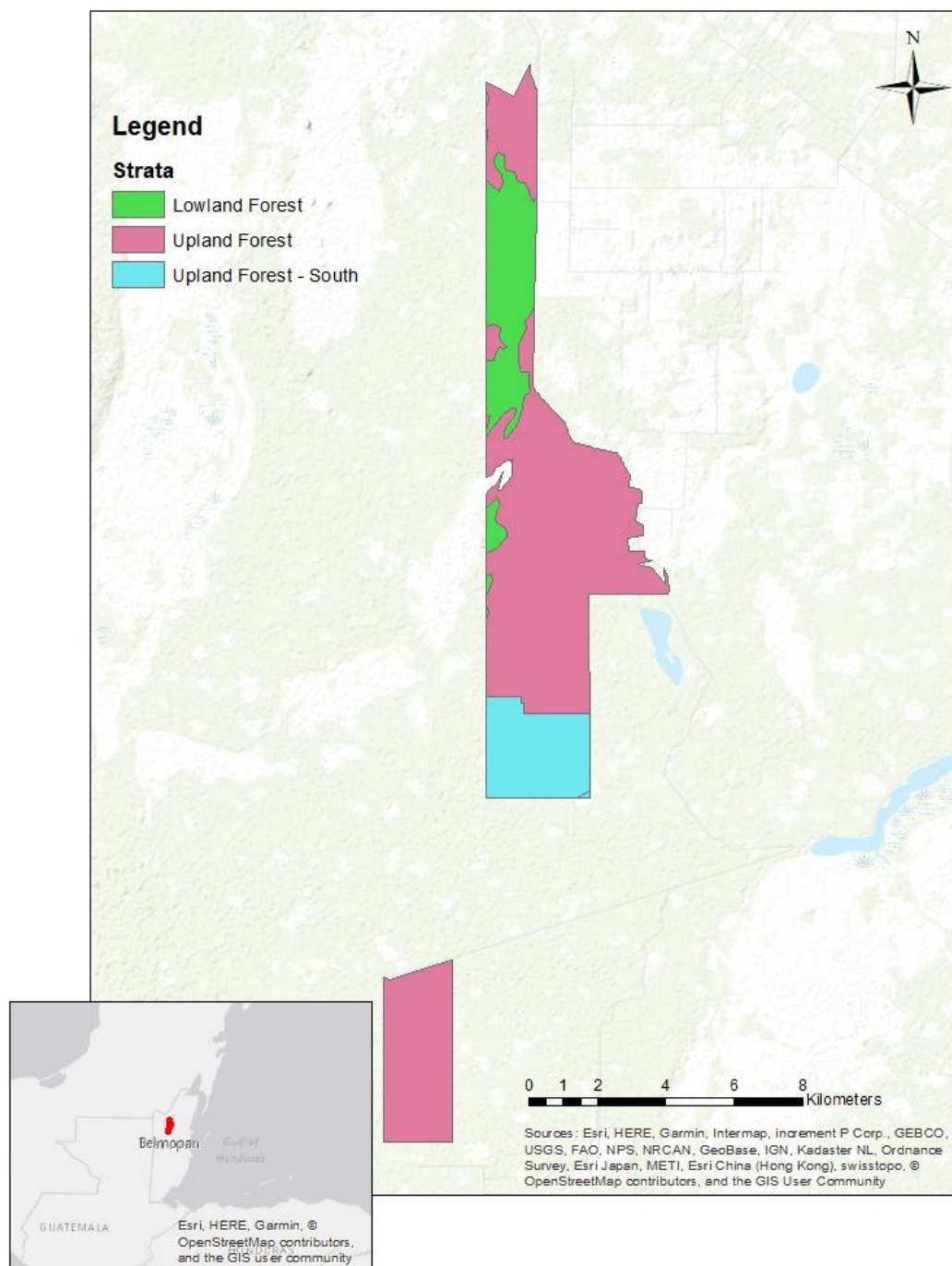


Figure 1. Map of the Rio Bravo REDD+ project area in north-central Belize.

1.8 Title and Reference of Methodology

Methodology:

Approved VCS Methodology VM0007 Version 1.6 REDD Methodology Modules.

Tools:

VMD0005 Estimation of carbon stocks in the long-term wood products pool (CP-W), v1.1

VMD0011 Estimation of emissions from market-effects (LK-ME) v1.1

VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning (E-EPB) v1.2

VMD0014 Estimation of emissions from fossil fuel combustion (E-FFC) v1.0

VMD0015 Methods for monitoring of greenhouse gas emissions and removals (M-REDD), v2.2

VMD0017 Estimation of Uncertainty for REDD+ Project Activities (X-UNC), v2.2

AFOLU Non-Permanence Risk Tool, v4.0

1.9 Participation under other GHG Programs

The project is not registered under any other GHG programs.

1.10 Other Forms of Credit

The project is not included in any other emissions trading programs or other forms of environmental credit.

1.11 Sustainable Development Contributions

The project activities, described in Sections 1.1 and 3.1, all contribute to meeting several of the Sustainable Development Goals laid out by the UN as a metric to pursue global efforts that will reduce poverty and inequality while improving access to health care and education. These activities also contribute to the nationally stated sustainable development priorities documented as SDGs 8, 13, and 15¹. These SDGs were monitored throughout the reporting period both directly and indirectly through the carbo project. SDG 13 and 15 were tracked and reported through a combination of forest inventory, logging mill receipts, and remote sensing analysis to assess the amount of forest cover remaining in the project area and the amount of timber products sustainably sourced from the area. SDG 8 is tracked through PfB revenue and also through the Tourism Development Programme. The core management goal of the broader Rio Bravo Conservation and Management Area (RBCMA) is, “a model private protected area that maintains its biological integrity, regionally significant cultural and landscape features, and fosters a sense of civic appreciation, while providing a sustainable flow of ecological goods and services, and economic benefits to its stakeholders.” The Rio Bravo REDD+ Project has had

¹ <https://belize.un.org/en/sdgs>

many positive co-benefits over the last 10 years that achieved or are in the process of achieving many of the Sustainable Development Goals (SDGs):

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	8.9	8.9.1 Tourism direct GPD as a proportion of total GDP and in growth rate	Implemented activities increased local tourism.	By effectively protecting over 6,236 ha of tropical forest as a part of the larger RBCMA, Rio Bravo has employed locals and brought in revenue to the local and regional economy. Tourism is supported by the Tourism Development Programme based in Belize City. Tourism accounts for over 50% of annual income for PfB which is then used for conservation and maintenance activities across the project area and also the RBCMA. (See “PfB SFMP 2022-2016v_Final.pdf”)	The Programme for Belize oversees a robust eco-tourism program at the Rio Bravo Reserve that provides revenue to sustain conservation activities and benefits to the local community. The business is centered around La Milpa and Hill Bank Field Station, where tourists can partake in tours of an archaeological research site and natural features of the reserve. The ecolodge and other eco-tourism activities related to the reserve create economic opportunities for local communities who provide services to tourists and those who are employed by the Reserve.

2)	13.0	Tonnes of greenhouse gas emissions removed	Implemented activities to increase carbon stocks.	By conserving 6,236 ha of tropical forest, Rio Bravo has removed 130,629 tonnes of CO ₂ e from the atmosphere during the monitoring period. (See Summary "RioBravo_MR_Calcs_*.xlsx").	Tropical moist forest is one of the most important terrestrial carbon sinks, and the 20 years of management and protection provided by the reserve has had a positive climate impact. Over the 20-year project crediting period, the Rio Bravo Climate Action project has generated 1,790,889 tons of CO ₂ -equivalent emission reductions and removals.
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3)	15.2	15.2.1 Progress towards sustainable forest management	Implemented activities to increase sustainable forest management.	PfB harvests timber in 36% of the RBCMA following the principles of sustainable forestry. PfB carries out selective logging, and careful harvest planning and on-going monitoring help ensure minimal harvest impacts to soil, water, and biodiversity. PfB's operations are FSC Certified, which ensures protection of High Conservation Value areas and promotion of natural regeneration of the forest. The RBCMA is FSC certified, having undergone 2 certification cycles and 10 audits during this monitoring period. On average, 501 cubic-meters of selectively logged, high-quality timber is sustainably harvested from the project area each year to finance conservation activities and generate revenue for the reserve and local communities. (see Logging Data in "RioBravo_MR_Calcs_*.xlsx")	PfB sustainably manages the forests in Rio Bravo to produce valuable timber while conserving biodiversity that is unique to Belize and to the world. The RBCMA is home to on-going research and survey projects, and biodiversity surveys have found over 40 species of international conservation concern found in the forests of Rio Bravo. The reserve protects the tropical forests in perpetuity through an MoU with the government of Belize, and it is also a working forest. The RBCMA monitors harvesting practices as well to prevent and mitigate illegal activities like poaching and illegal logging. VCU's from the project generate additional revenue that contributes to the long-term conservation of the Reserve.
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4)	15.7	15.7.1 Proportion of traded wildlife that was poached or illicitly trafficked	The project activities reduced poaching and illegal logging activity.	Ongoing patrols by PfB have identified and taken actions to reduce illegal poaching and logging activities. Only 329 incidents of illegal logging occurred within the project area, amounting to 1,003 tCO2e or less than 0.06% of total emission reductions and removals achieved by the project. (See “IllegalLoggingData_2011_2020_OriginalAreav2.xlsx”).	Poaching and illegal logging in Rio Bravo and surrounding lands has been an ongoing issue throughout the project lifetime. Revenue from the project has allowed PfB to increase patrols and ultimately reduce illegal activities in the project area of the lifetime of the project.
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2 SAFEGUARDS

2.1 No Net Harm

The Rio Bravo project has had minimal, if any, socio-economic impacts since there were no communities or in-holdings in the project area. The project area has been privately owned for over a century, and thus the transfer of the land from one private property owner to another did not introduce any new limitations regarding access to resources from the project area. However, the project area, as a part of the larger Rio Bravo Conservation and Management Area (RBCMA) could have potentially negative impacts on the surrounding communities that PfB has taken measures to mitigate.

There are two types of communities in broad proximity of the project area (Northern Belize) who may have been impacted by the project: Mennonite and Mestizo communities. It is important to note that as privately owned land, neither of these communities could claim legal access to any of the natural resources found in the project area. No new negative impacts on these communities occurred during the reporting period.

Potential negative impacts attributable to the project on Mennonite communities may have included:

- Increase in land prices due to the scarcity of available land.
- Inability for Mennonite communities to expand due to the lack of available land.
- Lost income from expanded agricultural production if they would have been allowed to purchase and develop the project area.
- Wildlife, such as jaguars, killing livestock near the reserve.

Potential negative impacts attributable to the project area on Mestizo communities could include:

- Hardship due to continued limited/ controlled access to resources for personal use: timber for fence posts, home building, or wood products; hunting for sustenance; medicinal or cultural resources.
- Loss of income due to continued lack of access to resources within the project area (timber, flora or fauna) or for sale.

Many of the potential negative impacts of the project are economic. To mitigate these potential negative impacts on local communities, PfB has undertaken initiatives to develop economic opportunities based on sustainable land use practices. For example, the RBCMA has been working with communities to establish sustainable chicle latex production, sales of seeds and nuts grown around villages, and sabal palm thatch production, among other initiatives². Additionally, the positive effects of the reserve such as clean and plentiful drinking water, a growing tourism industry, and increased biodiversity and forest

² Castillo, Gonzalo. 2021. Socioeconomic Assessment for Programme for Belize's Management Plan 2021-2026. GC Professional Consulting Services.

health likely offset any of the negative impacts of the project activities by generating an amenable environment in which to farm and to receive alternative sources of income.

Positive socio-economic impacts

The Programme for Belize has actively managed a community engagement program since it was founded in 1988. The timber operations in the Rio Bravo Conservation Management Area (which includes the carbon project area) has been certified under the FSC since 1997, which also requires monitoring and verification of the social impact of the project activities (land ownership and sustainable logging). Many of the potential negative impacts listed above are, in part, likely to be offset by the positive impacts of the project.

Some of the positive impacts on local communities have included:

- Increased tourism and related income for local communities.
- Environmental education at local schools
- Funding a dance group at local schools
- Hosting of school groups at the field stations in the Rio Bravo Conservation Management Area
- Providing training in alternative livelihoods, such as teaching locals how to make jewelry and other products for sale to tourists
- Granting special access to a traditional bush doctor to collect herbs and medicinal plants in the protected area
- Hiring locals as rangers, other field personnel, and short-term laborers
- Hiring Mennonite service providers for road maintenance, vehicle maintenance, sustainable logging services, and other specialized jobs.
- Road access between Mennonite lands and the northern communities has improved with annual road repairs administered by PfB.
- PfB ranger patrols have helped to reduce the occurrence of illegal activities such as illegal hunting and logging on Mennonite lands.
- PfB rangers assist with fire management and mitigation efforts near Mennonite lands.

Potential negative environmental impacts of the project would likely be due to logging activities which, if done improperly, can cause soil erosion, destruction of habitat, loss of biodiversity, among other consequences. However, through FSC certification and re-evaluation of a forest management plan every 5 years, PfB implements rigorous standards for timber harvest operations to mitigate these negative impacts. Detailed harvest plans are written prior to harvest operations. Detailed harvest data is tracked

and archived for every timber sale. Best management practices are followed to create buffers around important waterbodies and waterways to prevent soil erosion and pollution of water systems³.

2.2 Local Stakeholder Consultation

During the project monitoring period, Pfb communicated regularly with local stakeholders through annual meetings. Documented stakeholder meetings took place alongside development of forest management plans to assess stakeholder understanding of the management activities that are taking place within the RBCMA and to have an opportunity to air grievances about these activities. Pfb has four overarching management strategies, one of which is stakeholder outreach, education, and advocacy.

As an ongoing effort to maintain FSC certification, socio-economic impacts must be assessed. The 2013 Socio-economic assessment of Pfb's activities on the primary buffering communities of the RBCMA (Socio-economic_Assessment_Final_ReportvRP.pdf) details that 295 interviews of local communities were conducted. This assessment's goals were to determine the impact of Pfb's impacts on stakeholders, including employees and buffering communities. The assessment provides recommendations for Pfb to improve upon the socio-economic wellbeing of the stakeholder communities.

In 2021, a consultancy report was published that assessed the socio-economic contributions of the RBCMA. This document informs the forest management plan through 2026. As in the 2013 assessment, communities were interviewed to determine Pfb's impact on the socio-economic wellbeing of the stakeholders. Annex A of the 2021 report includes focus group meetings' agenda and results summary. Annex B contains a link to recorded video conference interviews.

The results of the meetings and associated surveys are published in the socioeconomic assessments (see, "Socio-economic_Assessment_Final_ReportvRP.pdf" and "Pfb_RBCMA_mgmt_plan_final_Volume I_Socioeconomic_Section_Consultancy_Report_July_12_2021.pdf"). Based on these reports, stakeholders, which largely include people who live adjacent to the RBCMA, understand the benefits of conserving the forest and limiting resource extraction, and experience few negative effects as a result of these activities. Neighbors of the property benefit from clean drinking water, clean air, and increased biodiversity that draws tourist revenue to the region, among other benefits. Video and audio recordings of these stakeholder meetings are also available for review (see "Stakeholder Consultation 2021").

The FSC assessment process also included stakeholder consultations annually or semi-annually which reviewed all management practices in the RBCMA including the ongoing carbon project implementation. Details of stakeholder consultations including meeting timelines and outcomes of stakeholder communications are available in the FSC Forest Management Certification Reassessment Reports in the "Pfb FSC FM Certification Reports" folder. Regular and on-going communication with local stakeholders takes place, at minimum, during FSC certification periods where all management

³ Pacheco, Ramon. 2021. The Rio Bravo Conservation and Management Area, Orange Walk.

objectives and activities are discussed and every 5 years when the new forest management plan is drafted, which includes activities related to REDD project implementation and monitoring.

During this monitoring period there have been no changes to risks, costs, or benefits associated with the project that may have affected local stakeholders. Additionally, there have been no relevant changes to laws or regulations that affect stakeholders of the project. Ongoing efforts to coordinate and work with local stakeholders are described in more detail in the most recent forest management plan (see “PFB SMP 2022-2026vFinal.docx”).

During the verification site visit, the verifier will have full access to the project site and to PFB staff members and local stakeholders to assess the accuracy of reported outcomes in the monitoring report.

2.3 AFOLU-Specific Safeguards

The RBCMA is owned in perpetuity by the Programme for Belize in trust for the people of Belize based on the MoU signed by the Belize government. There are no current disputes over land use rights in the project area. The main source of potential conflict with local stakeholders is due to illegal logging and poaching in the Reserve. These conflicts are being addressed through both policy and education and awareness campaigns to reduce illegal activities. PFB works with the community to identify poachers and illegal logging activity. Efforts to combat illegal activities and also efforts to work with local stakeholders to address project impacts are described in greater detail in the most recent forest management plan (see “PFB SMP 2022-2026vFinal.docx”).

PfB has initiated and/or partnered several initiatives aimed at mitigating resource use changes through conflict resolution, enabling communities to develop substitute livelihoods, and raising community awareness of the conservation values that are maintained by the conservation management of the RBCMA. These efforts on the part of PFB are a work in progress and some measure of success is evidenced by the creation of alternative tourism linked alternative livelihood opportunities in these communities and the creation of a community managed protected area.

At each main location within the RBCMA PFB has a manager, one at Hill Bank Field Station and one at La Milpa Lodge. The manager of each site is the first contact with workers and community members from villages/settlements that are adjacent to the RBCMA. These managers receive any complaints and conduct the necessary investigations related to the issue and, documenting the information received and results of any investigations. If the complaint is something that the manager can address immediately, for example, a vehicle travelling too fast, then they would be responsible to address the matter so that the problem is not repeated. If the complaint is for something out of the manager’s mandate, for example, an issue regarding land tenure or resource rights, then the manager would record the complaint and forward it to the Executive Director of PFB, who would then decide to how to proceed. A decision may be made in coordination with the Manager, Admin & Planning and/or the Financial Controller. The issue would then be investigated, and possible solutions/remedial actions will be recommended and discussed with the aggrieved party. In some cases, legal advice/recourse may be necessary. The Executive Director also has an open-door policy, and any stakeholder can call for an

appointment to discuss any time. If the issue is of a national scale, the Executive Director will call upon the PfB Board of Directors for instructions on how to proceed.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

All project activities commenced before the start of this monitoring period and continued through the end of the crediting period on 31 December 2021. The main project activity was the acquisition and protection of forest lands threatened by agricultural conversion. This has been fully accomplished through the purchase of land that would have been sold to industrial scale agricultural farmers. The Programme for Belize has successfully continued to protect the land from deforestation and the threat of conversion to agriculture no longer exists.

The baseline reassessment for this monitoring period took place at the end of the last monitoring period. The drivers of deforestation, mainly agricultural land clearing, continued, as evidenced by the agricultural land that runs up against the RBCMA borders. Additionally, the above- and below-ground tree carbon stocks in the baseline were completely emitted in the first 10-year baseline period. Therefore, there were no carbon stocks left to emit in the most recent baseline period. Changes in the rates of deforestation are not relevant to baseline reassessment because no further deforestation would have taken place in this baseline period.

The forest carbon stocks have been protected from illegal logging, deforestation, and fires through ground surveys by forest rangers and ongoing communications with surrounding communities. Where incidents of disturbances like illegal logging, wildfire or storms, such as Hurricane Earl, have impacted carbon stocks in the project area, data has been collected to estimate the impact on GHG emission reductions and removals, and are described in more detail in Section 5. No loss events occurred due to these disturbances. Additionally, all potential impacts of leakage were accounted for in the previous reporting period and is not monitored during this period. Non-permanence risk was monitored using the VCS non-permanence risk tool. No significant loss of carbon stocks occurred during this period, and thus no reversals needed to be accounted for.

FSC Certified selective logging has taken place within some areas of the project boundary. Detailed surveys and logging plans have been created to minimize the impact of selective logging. No additional roads had been created. The selective logging areas have and will continue to be actively monitored and certified by FSC, and the GHG emissions reductions and removals associated with these activities are accounted for in Section 5.2.

The Rio Bravo Climate Action Project is within the larger boundary of the Rio Bravo Conservation Management Area (RBCMA) and benefits from the added protection that such an organization size and structure maintains. Therefore, the following protection activities take place both within the project boundary and the wider RBCMA. The protection work on the RBCMA is carried out by the team of rangers, based at Hill Bank station and responsible for manning the gates and mounting regular

patrols. This work is backed by regular over-flights to detect problems (use of trails, illicit agriculture) from the air. The rangers operate using a static and dynamic approach, with some operations constant and other patrols and actions taking place in response to information of illicit activity (such as illegal logging) as and when required.

The basic protection program is well-established with reliable funding from the national 'Debt-for-Nature' scheme, timber program and carbon funds. The following protection activities are implemented at all times:

- The gates are permanently manned, establishing a visible presence at the main entry points;
- The team is able to react to emergencies (including fire) at any time;
- Several overnight patrols are mounted per month and at least two surveillance over-flights are organized per year.
- Hundreds of land and water patrols are conducted annually.
- Infractions are pursued through the legal system as and when necessary.
- Regular training is undertaken in various topics related to the protection program, and one training was organized in conjunction with Police force and conferring Special Constable status.

Patrols per se then become supplementary, covering the areas where management programs are not providing regular ground presence. The target of one patrol per month, additional to involvement in forestry and savannah management work is maintained for the wet season and raised to two per month for the dry season, however there are typically many more patrols that take place throughout the year. Particular attention is drawn to mounting extra dry season patrols to the two savannahs in order to detect and discourage or otherwise address:

- Setting of fires;
- Parrot theft (and monitoring of nest-boxes and known yellow-headed parrot nesting holes);
- Local infestations of cogon grass and pine bark beetle.

At least two patrols per year are performed in areas of higher risk in the frontier area (including its approach through Aguas Turbias), Cacao, the northern Duck Ridge and lower Booth's River area, lower Irish Creek (where the ecotourism program also plays an important role in maintaining presence) and the south-eastern part of the boundary. Throughout, the general aim is to integrate protection and resource management more closely to make better use of available staff, equipment and transport. Annual and monthly planning is therefore a joint activity, with strong input from the Forester as the most senior staff member with direct responsibility for field operations.

As part of the monitoring, standard reports are produced that include date, time, personnel, route and specific objectives for the patrol. In forested areas, evidence of the following is recorded (see "Protection Reports"):

- Entry (e.g. vehicle and horse tracks, foot-prints, cut trails);
- Hunting (e.g. camps, torch batteries, cartridge cases);
- Logging (e.g. stumps, logs, extraction trails);
- NTFP extraction (e.g. cut sabal or palmetto, chicle slash-marks);
- Land clearance within the RBCMA boundaries.

The sustainable extraction of timber on the Rio Bravo is guided by a 5-year Sustainable Forest Management Plan (see “PfB SFMP 2022 -2026.docx”) legalized by a Long Term Private Forest Permit approved by the Belize Forest Department. Operations are based on the annual plan of operation approved by the Forest Department for the specific area within the project area chosen for the year.

In preparation for harvesting, each compartment’s boundary is demarcated and transect lines are cut every 400 meters to guide the process of stock survey. After all transects are cut, the forestry crew goes into the compartment and systematically measures and records every timber species from 25 cm DBH. Trees at and above minimum cutting diameter (MCD) are selected from the list. Some trees at and above MCD are retained as seed trees. The remaining trees are identified on a paper map, along with planned roads, skid trails, buffers and other features of High Conservation Value. The PfB forester and logging contractor are provided with the map so that selected trees can be cut and skid trails and logging decks (referred to as a barquadier) are created. The cut trees are tagged at the stump with a unique number after which the log is skidded to the logging deck. After scaling, the logs are loaded onto trucks and transported to the mill. A signed waybill is created for each load. This document is the basis for payment to the logger and for billing the buyers.

The forest harvest operations are legally authorized via a Long-term license approved by the Belize Forest Department. This license calls for the development of minimum 5-year management plans and annual operational plans. These management plans and annual operational plans are then vetted by the Forest Department.

The operation plans are detailed yearly plans that describe the stocking, methods of harvest and sustainable yield of the operations, the volume to be extracted is based on the approved Sustainable Yield Model developed by the Forest Department. Before the harvest, FD officers will visit the planned harvest area to verify that the stock reported is present and that the residual trees are on the ground as per the plan. During the harvest, FD officers will record the data on each log to be delivered and later will charge royalty fees based on the field measurements reported from the field to their office. All logs delivered have a unique number based on the compartment and transects they originated from and this information along with measurements and resulting volume are recorded in a triplicate waybill for billing and recording purposes.

3.2 Deviations

3.2.1 Methodology Deviations

A deviation from the methodology for calculating Logging Infrastructure emissions:

In the with-project scenario, it is more accurate to apply the Logging Infrastructure Factor (LIF) from Module VMD0011 LK-ME v1.0, Equation 4, than using Equation 12 in VMD0015 M-REDD to estimate emissions associated with logging roads, skid trails, and decks created for selective logging operations. The LIF applied in this equation is derived from data collected within the project area (see Annex I of VMD0011, page 14) and includes data from direct measurements of emissions associated with infrastructure constructed for selective logging at this site. Therefore, it is more accurate to apply the LIF for calculation of emissions associated with logging in the with-project scenario than it is to apply the global skid trail, logging road, and logging deck emission factors recommended in the M-REDD module. The expansion factor of 0.29 t C m⁻³, conservatively derived from the upper bound of the 95% confidence interval, is multiplied by volume extracted for legal FSC selective logging to determine the emissions resulting from skid trails, roads, and logging decks. Because this value constitutes a more direct measure of logging infrastructure emissions than Equation 4, the deviation does not negatively impact the conservativeness of the quantification of GHG emission reductions or removals. The deviation also does not relate to any other part of the methodology as it relates solely to emissions associated solely with construction of logging infrastructure due to selective logging that took place during this monitoring period.

3.2.2 Project Description Deviations

1. A deviation from the project description is being applied to account for enhancements. However, it is evident from the 2021 inventory that substantial growth of above-ground biomass has occurred in the project area during the crediting period, and it is accurate to account for emission removals that have taken place in absence of planned deforestation that would have occurred had the project activities not been implemented. Enhancements not only account for growth, but also for net stock change associated with emissions from disturbance and degradation.

Though the PD and the initial monitoring report conservatively excluded enhancements, inclusion of enhancements in this monitoring period does not impact the applicability of the methodology, additionality, or the appropriateness of the baseline scenario. The enhancements are based on the inventories conducted at the start of the project and at the end of the reporting period, incorporating the appropriate uncertainty estimates calculated based on the methodology. All enhancements are additional to the baseline which remained 0 during the reporting period. Enhancements can be credited to the project in years after baseline deforestation is expected to already have occurred. Because the planned deforestation in the baseline for this project was completed in 2008 (during the previous monitoring period) and baseline deforestation occurred across the entire project area, all acres of the project are eligible for crediting. Enhancements are conservatively credited only for this reporting period, from 2012 to 2021. The estimation of enhancements resulted in 203,073 t CO₂e emission removals during the monitoring period.

Enhancements are credited for this reporting period, to account for net stock change from 2012 through 2021. Stock change in the Upland and Lowland strata is calculated based on an annualized rate of change over 20 years and applied from 2012 to 2021. Stock change in the Upland-South stratum is calculated based on an annualized rate of change between the 2012 inventory and the 2021 inventory.

2. For this monitoring period, VM0007 v1.6 was used in place of VM0007 v1.1 which was applied during the last reporting. The new version of the methodology employs updated equations and methods for quantification of GHG emissions and reductions based on application of experience and the latest science. Application of the new methodology does not affect the applicability of the methodology, additionality, or the appropriateness of the baseline scenario because the baseline deforestation was completed during the previous monitoring period. Any changes due to the use of the newer version of the methodology had no impact on the baseline during this monitoring period because all baseline emissions remain 0.

The deviations from the monitoring plan were approved in the previous monitoring period. These deviations are listed below. Because no baseline deforestation takes place during this reporting period, the deviations related to estimation of baseline stocks are not relevant for reporting emission reductions and removals. Additionally, the deviation for quantifying degradation is not relevant during this reporting period as degradation is considered de minimis for this reporting period:

3.

VMD0001 “Estimation of carbon stocks in the above and belowground biomass in live tree and non-tree pools”.

‘II Procedures, Frequency of measurement for baseline above and belowground biomass stocks’

“Measurements of initial stocks employed in the baseline must take place within ± 5 years of the project start date, for simplicity referred to here as stocks at $t=0$ ”

“Above- and belowground biomass stock estimates are valid in the baseline (i.e. treated as constant) for 10 years, after which they must be re-estimated from new field measurements.”

It is requested that years since the project start date be allowed to be increased to ± 6 years. The project start is date: 15 Sept 1994, and although field measurements were taken in 1995, the measurement methods in 2000 are more consistent with other field measurement methods used elsewhere. In addition, additional field measurements were taken in the area surrounding the project area, providing a better estimate of carbon stocks.

4.

VMD0001 “Estimation of carbon stocks in the above and belowground biomass in live tree and non-tree pools”.

'II Procedures, Frequency of measurement for baseline above and belowground biomass stocks'

"Above- and belowground biomass stock estimates are valid in the baseline (i.e. treated as constant) for 10 years, after which they must be re-estimated from new field measurements. For each stratum, where the re-measured estimate is within the 90% confidence interval of the $t=0$ estimate, the $t=0$ stock takes precedence and is re-employed, and where the re-measured estimate is outside the 90% confidence interval of the $t=0$ estimate, the new stock estimate takes precedence and is used for the subsequent period."

The start date of the project is 15 Sept 1994. Field measurements were taken in 2000. No field measurements were at the 'baseline renewal period' in 2004 since this project took place prior to that rules existence. Therefore it is requested that the field measurement data taken in 2000 be allowed to be used for the second baseline period.

5.

VMD0015 V2 "Methods for Monitoring of GHG Emissions and Removals"

Section 5.2.2.1 Degradation through extraction of trees for illegal timber or fuelwood and charcoal

"ADeg,_i shall be sampled by surveying several transects of known length and width across the access-buffer area (equal in area to at least 1% of ADeg,_i) to check whether new tree stumps are evident or not. If there is little to no evidence that trees are being harvested (see next paragraph on how to estimate emissions and use tool T-SIG to determine if significant or not) then degradation can be assumed to be zero and no monitoring is needed. This limited sampling must to be repeated each time the PRA indicates a potential for degradation.

If the limited sampling does provide evidence that trees are being removed in the buffer area, then a more systematic sampling must be implemented. The sampling plan must be designed using plots systematically placed over the buffer zone so that they sample at least 3% of the area of the buffer zone (ADeg,_i). The diameter of all tree stumps will be measured and conservatively assumed to be the same as the DBH. If the stump is a large buttress, identify several individuals of the same species nearby and determine a ratio of the diameter at DBH to the diameter of buttress at the same height above ground as the measured stumps. This ratio will be applied to the measured stumps to estimate the likely DBH of the cut tree. The above and below ground carbon stock of each harvested tree must be estimated using the same allometric regression equation and root to shoot ratio used in the module for estimating the carbon pool in trees (CPAB) in the baseline scenario 1. The mean above and below ground carbon stock of the harvested trees is conservatively estimated to be the total emissions and to

all enter the atmosphere. This sampling procedure shall be repeated every 5 years and the results annualized by dividing the total emissions by five.”

Since incomplete sampling of illegal logging existing from the start of the project, it is requested that a more conservative approach be implemented. Under this approach, using the forest inventory data, the average biomass of mahogany and cedar is estimated. It is then assumed that the biomass of all the mahogany and cedar trees within A*De*_{g,i} are harvested and emitted in the first year of the project. This is clearly a strongly conservative approach as in reality, only a small portion of mahogany and cedar trees have been harvested through illegal logging. For example, within the current FSC selective logging taking place, over 50% of the volume removed is from mahogany trees.

3.3 Grouped Projects

This is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	A_i ,
Data unit	Ha
Description	Area of stratum <i>i</i>
Source of data	Sentinel 2 imagery
Value applied	See section 4.3
Justification of choice of data or description of measurement methods and procedures applied	Detailed description of classification in Section 4.3 - Deforestation
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	CF
Data unit	t C/t d.m.
Description	Carbon fraction of dry matter
Source of data	IPCC
Value applied	0.47
Justification of choice of	Default factor from IPCC ch4 AFOLU Guidance for GHG Inventories

data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	CF _j
Data unit	t C/t d.m.
Description	Carbon fraction of biomass for tree species j
Source of data	IPCC
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	Default factor from IPCC ch4 AFOLU Guidance for GHG Inventories
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	D _j
Data unit	t d.m./m ³
Description	Basic wood density
Source of data	Default value
Value applied	0.6
Justification of choice of data or description of measurement methods and procedures applied	Reyes et al 1992, basic wood density in the tropical Americas
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	D%planned,i,t
Data unit	% year ⁻¹
Description	Projected annual proportion of land that will be deforested in stratum i at year t
Source of data	Analysis of remote sensing data or legal records
Value applied	0

Justification of choice of data or description of measurement methods and procedures applied	Baseline stocks were depleted in 2008 and no forest stocks remain to be deforested during the most recent baseline.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	L-D _i
Data unit	%
Description	Likelihood of deforestation in stratum i
Source of data	N/A
Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	All areas not both under government control and zoned for deforestation L-D _i must be equal to 1.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	CP _{AB_tree,i}
Data unit	tCO ₂ -e ha ⁻¹
Description	Carbon stock in aboveground biomass in trees in the baseline in stratum i
Source of data	IPCC default value of post-deforestation land cover
Value applied	5
Justification of choice of data or description of measurement methods and procedures applied	Baseline stocks were depleted in 2008 and no forest stocks remain to be deforested during the most recent baseline.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	CP _{BB_tree,i}
Data unit	tCO ₂ -e ha ⁻¹
Description	Carbon stock in belowground biomass in trees in the baseline in stratum i

Source of data	IPCC default value of post-deforestation land cover
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Baseline stocks were depleted in 2008 and no forest stocks remain to be deforested during the most recent baseline.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$CP_{WP,i}$
Data unit	tCO ₂ -e ha ⁻¹
Description	Mean carbon stock entering the wood products pool at the time of deforestation from stratum i
Source of data	N/A
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Baseline stocks were depleted in 2008 and no harvesting took place during the baseline period.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$E_{FC,i,t}$
Data unit	tCO ₂ -e ha ⁻¹
Description	Carbon stock in aboveground biomass in trees in the baseline in stratum i
Source of data	IPCC default value of post-deforestation land cover
Value applied	5
Justification of choice of data or description of measurement methods and procedures applied	Baseline stocks were depleted in 2008 and no forest stocks remain to be deforested during the most recent baseline.
Purpose of Data	Calculation of baseline emissions
Comments	None

4.2 Data and Parameters Monitored

Data / Parameter	Project Forest Cover Monitoring Map
Data unit	N/A
Description	2021 Map of forested area in the project area
Source of data	Sentinel 2 Imagery
Description of measurement methods and procedures to be applied	See Section 4.3 - Deforestation
Frequency of monitoring/recording	Every 10 years
Value monitored	Forest – 6,235.8 ha Non-forest – 59.8 ha
Monitoring equipment	Sentinel 2 Imagery and TerrSet for classification analysis.
QA/QC procedures to be applied	See Accuracy Assessment in Section 4.3
Purpose of the data	Calculation of project emissions
Calculation method	See Section 4.3 - Deforestation
Comments	None

Data / Parameter	$\Delta C_{P,Enh,1,t}$			
Data unit	tCO _{2e} e			
Description	Net carbon stock changes as a result of forest carbon stock enhancement in stratum i in the project area in year t			
Source of data	Calculated			
Description of measurement methods and procedures to be applied	See section 5.2			
Frequency of monitoring/recording	This is the first reporting event for enhancements. See deviation from PD in Section 3.2			
Value monitored	Lowland	Upland	Upland-South	Total
	14,908.1	331,200.6	(143,036.0)	203,072.7

Monitoring equipment	NA
QA/QC procedures to be applied	See QA/QC procedures in "RioBravo_2021Monitoring_SOPs_*.docx"
Purpose of the data	Calculation of project emissions
Calculation method	See "RioBravo_MR_Calcs_*.xlsx"
Comments	None

Data / Parameter	$\Delta C_{BSL,planned}$
Data unit	tCO _{2e} e
Description	Net greenhouse gas emissions in the baseline from planned deforestation
Source of data	Module BL-PL Eq 3
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	At least every 10 years
Value monitored	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	Baseline deforestation completed in 2008

Data / Parameter	$A_{planned,i}$
Data unit	ha
Description	Total area of planned deforestation over the entire project lifetime for stratum i
Source of data	Module BL-PL Eq 26

Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	At least every 10 years
Value monitored	0
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of baseline emissions
Calculation method	N/A
Comments	The area of planned deforestation in the baseline scenario was exhausted in 2008.

Data / Parameter	$C_{BSL,i}$
Data unit	tCO ₂ -e ha ⁻¹
Description	Carbon stock in all pools in the baseline in stratum <i>i</i>
Source of data	Module BL-PL eq 5, 17, 18, 19, 24, 27
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	At least every 10 years
Value monitored	5
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of baseline emissions
Calculation method	The sum of C_{AB} , C_{BB} , and C_{WP} calculated at the initial baseline assessment. The IPCC default value of post-deforestation land cover were re-applied for baseline reassessment.
Comments	The area of planned deforestation in the baseline scenario was

	exhausted in 2008 and the total stock value is 0.
--	---

Data / Parameter	C _{P,i,t}			
Data unit	tCO _{2e} e			
Description	Carbon stock in all pools in the project case in stratum i in year t			
Source of data	2021 Forest Inventory and 2012 Forest Inventory			
Description of measurement methods and procedures to be applied	See “RioBravo_2021Monitoring_SOPs_*.docx”			
Frequency of monitoring/recording	Measured in 2000, 2012 and 2021			
Value monitored		Lowland	Upland	Upland-South
	total tCO _{2e}	342,807.7	2,860,887.2	505,908.8
Monitoring equipment	See “RioBravo_2021Monitoring_SOPs_*.docx”			
QA/QC procedures to be applied	See “RioBravo_2021Monitoring_SOPs_*.docx”			
Purpose of the data	Calculation of project emissions			
Calculation method	See “RioBravo_Carbon_Calcs_Inventory_*.xlsx”			
Comments	None			

Data / Parameter	$A_{Enh,PL,i,t}$
Data unit	Ha
Description	Project area in stratum i in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline in year t
Source of data	Project description; area of deforestation in the baseline that occurred between 1996 and 2008
Description of measurement methods and procedures to be applied	The baseline deforestation was completed in 2008 when all forest cover would have been removed, therefore the total area where carbon has been accumulating since the end of the last reporting period in 2011 is equal to the area of the included strata.
Frequency of	This is the first reporting event for enhancements. See deviation from

monitoring/recording	PD in Section 3.2
Value monitored	6,295.7
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of the data	Calculation of project emissions
Calculation method	Equal to the project area
Comments	Enhancement calculations include all strata, though some enhancements were negative due to emissions likely associated with storm damage in the Upland South Stratum.

Data / Parameter	Degradation Illegal Logging Survey
Data unit	Stem count
Description	Record of illegally harvested trees from the project area
Source of data	Monthly PfB ranger patrols
Description of measurement methods and procedures to be applied	PfB Forest Rangers patrol the project area looking for poaching and illegal removal of timber from the forest on a monthly basis. Where instances of illegal logging are found, rangers record a GPS point and identify the species of tree removed
Frequency of monitoring/recording	Instances of illegal harvesting are compiled annually
Value monitored	329 stems illegally harvested
Monitoring equipment	GPS and documentation stored on PfB computers to track illegal harvesting.
QA/QC procedures to be applied	Illegal harvesting records are reviewed by PfB staff and data is checked by PfB staff after it is entered into the system.
Purpose of the data	Calculation of project emissions
Calculation method	Sum stem count
Comments	None

Data / Parameter	A _{DefPA,i,u,t}
Data unit	Ha

Description	Area of recorded deforestation in the project area in stratum i converted to land use u at time t
Source of data	Sentinel 2 satellite imagery from February 2021
Description of measurement methods and procedures to be applied	See Section 4.3 - Deforestation
Frequency of monitoring/recording	Every 10 years
Value monitored	59.8
Monitoring equipment	TerrSet
QA/QC procedures to be applied	See Accuracy Assessment in Section 4.3 - Deforestation
Purpose of the data	Calculation of project emissions
Calculation method	See Section 4.3 - Deforestation
Comments	None

Data / Parameter	$A_{DistPA,q,i,t}$
Data unit	Ha
Description	Area impacted by natural disturbance in the project stratum i converted to natural disturbance stratum q at time t
Source of data	"HurEarlNarrative4Aug2016.docx"
Description of measurement methods and procedures to be applied	The 2016 Hurricane Earl impacted the entire project area (see "HurEarlNarrative4Aug2016.docx").
Frequency of monitoring/recording	At least every ≤ 5 years
Value monitored	0
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of the data	Calculation of project emissions
Calculation method	NA

Comments	Emissions associated with disturbances such as Hurricane Earl and wildfire are included with estimations of $\Delta C_{P,Enh,1,t}$ where stock changes as measured on re-inventoried plots are representative of the entire project area and includes changes associated with disturbance.																							
Data / Parameter	$C_{Deg,i,t}$																							
Data unit	tCO2e/ha																							
Description	Biomass carbon of trees cut and removed through illegal logging, fuelwood and charcoal extraction degradation process from plots measured in stratum i at time t																							
Source of data	Forest Inventory Data																							
Description of measurement methods and procedures to be applied	See Section 5.2 - Degradation																							
Frequency of monitoring/recording	Every 10 years																							
Value monitored	<table><tr><th>Year</th><th>Net carbon stock change as a result of degradation in the project area (tCO2e)</th></tr><tr><td>2012</td><td>-</td></tr><tr><td>2013</td><td>710.5</td></tr><tr><td>2014</td><td>1,968.2</td></tr><tr><td>2015</td><td>1,647.0</td></tr><tr><td>2016</td><td>1,615.9</td></tr><tr><td>2017</td><td>-</td></tr><tr><td>2018</td><td>447.7</td></tr><tr><td>2019</td><td>1,648.0</td></tr><tr><td>2020</td><td>676.5</td></tr><tr><td>2021</td><td>851.8</td></tr></table>		Year	Net carbon stock change as a result of degradation in the project area (tCO2e)	2012	-	2013	710.5	2014	1,968.2	2015	1,647.0	2016	1,615.9	2017	-	2018	447.7	2019	1,648.0	2020	676.5	2021	851.8
Year	Net carbon stock change as a result of degradation in the project area (tCO2e)																							
2012	-																							
2013	710.5																							
2014	1,968.2																							
2015	1,647.0																							
2016	1,615.9																							
2017	-																							
2018	447.7																							
2019	1,648.0																							
2020	676.5																							
2021	851.8																							
Monitoring equipment	Surveys are conducted annually to document incidents of illegal logging by PfB patrols through the project area. Data is collected using data loggers and tracked in a database held by PfB. This monitoring process is separate from the carbon inventory monitoring data collection and is complementary to the data in 'Degradation Illegal Logging Survey'.																							
QA/QC procedures to be applied	N/A																							
Purpose of the data	Calculate project emissions																							
Calculation method	See Section 5.2 – Degradation																							
Comments	None																							

Data / Parameter	$V_{EXT,z,i,t}$			
Data unit	m^3			
Description	Volume extracted from logging stratum z in stratum i at time t			
Source of data	Waybill receipts from mills			
Description of measurement methods and procedures to be applied	Receipts from the mill are tallied to calculate total volumes logged each year.			
Frequency of monitoring/recording	At least every ≤ 5 years			
Value monitored	Year	Lowland	Upland	Upland-South
	2012	-	-	-
	2013	1.2	361.4	9.5
	2014	3.4	1,001.2	26.3
	2015	2.8	837.8	22.0
	2016	2.8	822.0	21.6
	2017	-	-	-
	2018	0.8	227.7	6.0
	2019	2.8	838.3	22.0
	2020	1.2	344.1	9.0
	2021	1.5	433.3	11.4
Monitoring equipment	Waybill receipts from the sawmill in Orange Walk			
QA/QC procedures to be applied	Volumes harvested will be check against mill receipts.			
Purpose of the data	Calculation of project emissions			
Calculation method	See Section 5.2 - Degradation			
Comments	None			

Data / Parameter	$C_{XB,ty,i}$
Data unit	$tCO_2-e\ ha^{-1}$
Description	Mean stock of extracted biomass carbon by class of wood product ty from stratum i
Source of data	Calculated
Description of measurement methods and	The volume of timber extracted from each stratum is distributed into product classes using emission factors:

procedures to be applied	Prop - sawnwood			Proportion of total biomass going to sawnwood	0.89
	Prop - woodbase panels			Proportion of total biomass going to woodbase panels	0.09
	Prop - other ind roundwood			Proportion of total biomass going to other industrial roundwood	0.02
	The volumes are then converted to tCO ₂ e and summed to determine meant stocks of biomass in each stratum.				
Frequency of monitoring/recording	At least every ≤ 5 years				
Value monitored	Year	Lowland	Upland	Upland-South	
	2012	-	-	-	
	2013	0.2	0.2	0.2	
	2014	0.5	0.5	0.5	
	2015	0.4	0.4	0.4	
	2016	0.4	0.4	0.4	
	2017	-	-	-	
	2018	0.1	0.1	0.1	
	2019	0.4	0.4	0.4	
	2020	0.2	0.2	0.2	
	2021	0.2	0.2	0.2	
Monitoring equipment	N/A				
QA/QC procedures to be applied	N/A				
Purpose of the data	Calculation of project emissions				
Calculation method	See Section 5.2 - Degradation				
Comments	None				

Data / Parameter	C _{WP,i}
Data unit	tCO ₂ -e ha ⁻¹
Description	Carbon stock entering the wood products pool from stratum i

Source of data	Calculated			
Description of measurement methods and procedures to be applied	Carbon stocks remaining in wood products are calculated using wood waste mill efficiency factor of 0.24 for developing countries			
Frequency of monitoring/recording	At least every ≤ 5 years			
Value monitored	Year	Lowland	Upland	Upland-South
	2012	-	-	-
	2013	1.0	289.7	7.6
	2014	2.7	802.6	21.1
	2015	2.3	671.6	17.6
	2016	2.2	658.9	17.3
	2017	-	-	-
	2018	0.6	182.6	4.8
	2019	2.3	672.0	17.6
	2020	0.9	275.8	7.2
	2021	1.2	347.3	9.1
	Monitoring equipment	N/A		
QA/QC procedures to be applied	N/A			
Purpose of the data	Calculation of project emissions			
Calculation method	See Section 5.2 - Degradation			
Comments	None			

Data / Parameter	$E_{FC,j,t}$
Data unit	tCO ₂ e
Description	Net CO ₂ e emissions of Fuel consumption in stratum i in year t
Source of data	Calculated
Description of	Fossil fuels used for logging operations were calculated using fuel bills

measurement methods and procedures to be applied	from harvesting operations in 2021. The average fuel usage per m3 of timber was used to estimate fuel emissions.			
Frequency of monitoring/recording	At least every ≤ 5 years			
Value monitored		Lowland	Upland	Upland-South
	2012	-	-	-
	2013	0.01	2.20	0.06
	2014	0.02	6.09	0.16
	2015	0.02	5.09	0.13
	2016	0.02	5.00	0.13
	2017	-	-	-
	2018	0.00	1.38	0.04
	2019	0.02	5.10	0.13
	2020	0.01	2.09	0.05
	2021	0.01	2.63	0.07
Monitoring equipment	NA			
QA/QC procedures to be applied	NA			
Purpose of the data	Calculation of project emissions			
Calculation method	See module E-FFC Fossil Fuels v1			
Comments	None			

Data / Parameter	Fuel usage
Data unit	Liters/m ³
Description	Avg fuel use per volume timber harvested
Source of data	PfB fuel reports, see "Fuel Details November 2020 – October 2021.xlsx"
Description of measurement methods and procedures to be applied	Fuel usage tracked during timber harvest activities that occurred between November 2020 and October 2021.
Frequency of monitoring/recording	At least every ≤ 5 years
Value monitored	2.26
Monitoring equipment	NA
QA/QC procedures to be	NA

applied	
Purpose of the data	Calculation of project emissions
Calculation method	Monthly fuel costs were divided by the cost of fuel per gallon to calculate volume of fuel consumed in each month of the year. The fuel used for harvesting was predominantly diesel fuel. Gallons were then converted to liters. Total fuel consumption was summed for the year and then divided by the total m ³ of timber harvested to get liters/m ³ .
Comments	None

Data / Parameter	LIF
Data unit	t C m ⁻³
Description	Logging infrastructure factor
Source of data	Equation 4, Module VMD0011
Description of measurement methods and procedures to be applied	Default factor for estimating emissions associated with infrastructure such as skid trails, roads, and logging decks, built to harvest timber.
Frequency of monitoring/recording	At least every ≤ 5 years
Value monitored	0.29
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of the data	Calculation of project emissions
Calculation method	NA
Comments	None

Data / Parameter	LDF
Data unit	t C m ⁻³
Description	The logging damage factor (LDF) is a representation of the quantity of emissions that will ultimately arise per unit of extracted timber.
Source of data	Equation 11, VMD0015
Description of measurement methods	A default factor derived from VMD0015 for broadleaf and mixed forests.

and procedures to be applied	
Frequency of monitoring/recording	At least every ≤ 5 years
Value monitored	0.67
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of the data	Calculation of project emissions
Calculation method	NA
Comments	None

4.3 Monitoring Plan

4.3.1 Monitoring Organizational Structure

Programme for Belize (PfB) owns and manages the project area. It is responsible for monitoring of the project. Monitoring work is carried out by a team of rangers, based at Hill Bank who are responsible for manning the gates and mounting regular patrols. This work is backed by regular aerial flights to detect problems (use of trails, illicit logging) from the air. The team cooperates with the Belize Defense Force, the Police and Forest Departments when appropriate. Patrols are organized on a monthly basis to areas deemed to require oversight and the team responds to information of illicit activity as and when required.

PfB is governed by a board of directors that decides policy directions, approves the yearly budgets, and support fund raising activities. The immediate link between the staff and the board is the executive director. The executive director oversees the organization to ensure that the board policies are being followed.

The executive director is assisted by the financial controller, administrator and the technical coordinator. The financial controller manages the budget and ensures that services take place and employees' benefits and salaries are paid. The administrator oversees the supply of goods and services to the main office and the field stations. Two permanent field stations exist with permanent station managers and support staff: La Milpa and Hillbank. These field stations are located outside the carbon project boundary but within the wider Rio Bravo Conservation Management Area. The field-station managers report to the administrator.

The technical coordinator manages all forest related work including managing sustainable timber harvest, carbon sequestration activities and some research. The forestry crew, including the forester, field ecologist and assistant forester, all report to the technical coordinator. Any activity related to

sustainable timber harvest, carbon data collection, fire management, verification of areas and volume of illegal harvest is carried out by the three forestry staff and temporary assistants, the number of which changes depending on the need.

Two field-station managers, based at La Milpa and Hillbank field stations, report to the administrator and manage the field personnel including the rangers and support staff. The Hillbank station manager is directly responsible for the ranger patrols and reporting any findings to the administrator who will then liaise with the BDF, Police or Forest Department to set up more intense patrols as necessary. The administrator also plans over flights and other land management issues.

4.3.2 Monitoring data generation, recording and storage

Programme for Belize follows a set of standard procedures for the monitoring of the project area. Protective ground patrols are conducted regularly every month and increased during the dry season when threats such as wild fires and parrot theft increase.

Data collected is kept on file for the duration of the project. This includes inventory data on carbon stocks, monitoring plans, permanent plot names and locations (if any are used), and GIS data. Reports from protective patrols and aerial flights are entered into a computer and kept on file for review. The data is kept in commonly used formats such as Microsoft Office formats for reports and tables, and for GIS data, shapefile or .tif format. Metadata, especially for GIS data, is maintained and updated as needed.

PfB maintains monitoring records in both hard copies and digital formats. The main activities monitored include fires and illegal activities. The ranger crew (10 persons) is deployed by the Hillbank station manager to area of high risk. The rangers will report on a daily basis to the Hillbank station manager in hard copy format. The station manager will summarize these reports on a monthly basis and submit these to the administrator in digital format. These monthly reports are further summarized quarterly and presented to the PfB board of directors. These reports are discussed at board level and recommendations for further actions are documented in the minutes of the meeting. The executive director then passes the updated strategy to the PfB staff for action. All board papers are in hard copy and digital formats. All digital copies are housed in PfB offices in Belize City.

4.3.3 Procedures for handling internal auditing and non-conformities

PfB's management plan is based on "Adaptive Management" principles. This means that activities within the approved management plans can be deleted or new activities added based on the prevailing conditions. However, given PfB's experience in managing the Rio Bravo Conservation Management Area, most potential threats or opportunities are identified in the plan, at least from a global perspective. Any major change in management actions will be presented by the executive director to the PfB board of directors for approval.

This is necessary as the deviation from the approved plan can result in significant financial demands from the organization. The board will authorize the executive director to incur the expenses and will support the fund-raising efforts needed to do what needs to be done. PfB's staff, including the

administrator, field station manager or the technical coordinator will lead the new activities that became necessary.

Existing activities that simply require the redirection of temporal or special parameters are decided by PfB's staff, including the administrator, field station manager or the technical coordinator. From the Rio Bravo Climate Action Project perspective, project oversight is provided by a board of directors comprised of a representative from each financial participant, TNC and PfB. The board approves annual plans, including the annual budget. TNC acts as the fund's manager with PfB implementing the activities on the ground. Quarterly reports are presented to TNC by PfB who monitor fund use and activities being implemented. Any deviation from the annual plan is presented by PfB to TNC for approval by the project board through the two financial representatives.

4.3.4 Implementation of sampling approach

A new inventory to measure above and below-ground live tree biomass was implemented in the project area in 2021 to estimate carbon stocks for quantification of enhancements. An independent sample of biomass was derived from the 2021 inventory by randomly selecting a subsample of the plot points established in the 2000 inventory. The standard operating procedures for 2021 are available in "RioBravo_2021Monitoring_SOPs_2021-02-25". 44 plots were sampled in the 2021 inventory across 3 strata: Lowland, Upland, and Upland South (see Figure 3). The Upland-South stratum was last sampled in 2012, and stock estimates from these plots were used to calculate stock change during the monitoring period for enhancements. 21 plots were sampled in the Upland-South stratum in 2012 (see Figure 2). However, 4 of those plots fell outside of the stratum and were not included in the stock estimate for the stratum in 2012. The Upland South stratum was previously unsampled in the 2000 inventory.

The inventory targeted a precision of +/- 15% of the mean biomass value at a 95% confidence interval as required by Module VMD0017 X-UNC. The overall uncertainty from the inventory is 14.3% at a 95% confidence interval.

Results of the re-inventory show substantial stock change between 2000 and 2021.

	Lowland	Upland	Upland-South	
mean tCO ₂ e/ha	367.1	627.2	632.0	
total tCO ₂ e	342,807.7	2,860,887.2	505,908.8	
var	22525.2	73623.3	23734.4	
sd	150.1	271.3	154.1	
CV	41%	43%	24%	
SE	53.1	54.3	46.5	
sampling error	122.4	111.8	102.2	
sampling error %	33%	18%	16%	Total
Area	933.77	4,561.40	800.45	6,295.63

n	8	25	11	44
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Table 4-1. Inventory statistics from the 2021 re-inventory of the Rio Bravo project area.

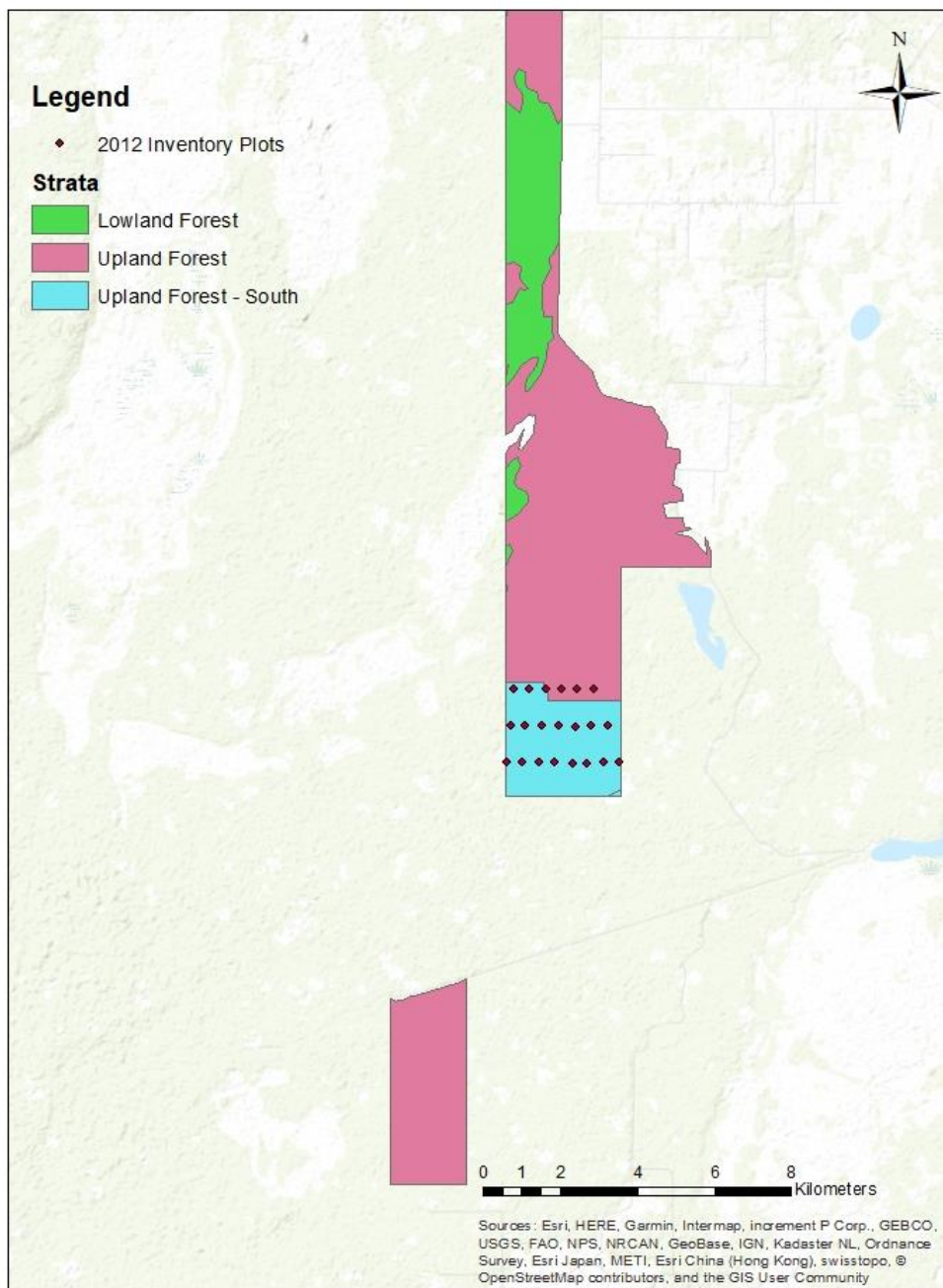


Figure 2. Map of 2012 inventory points located in the Upland-South stratum.

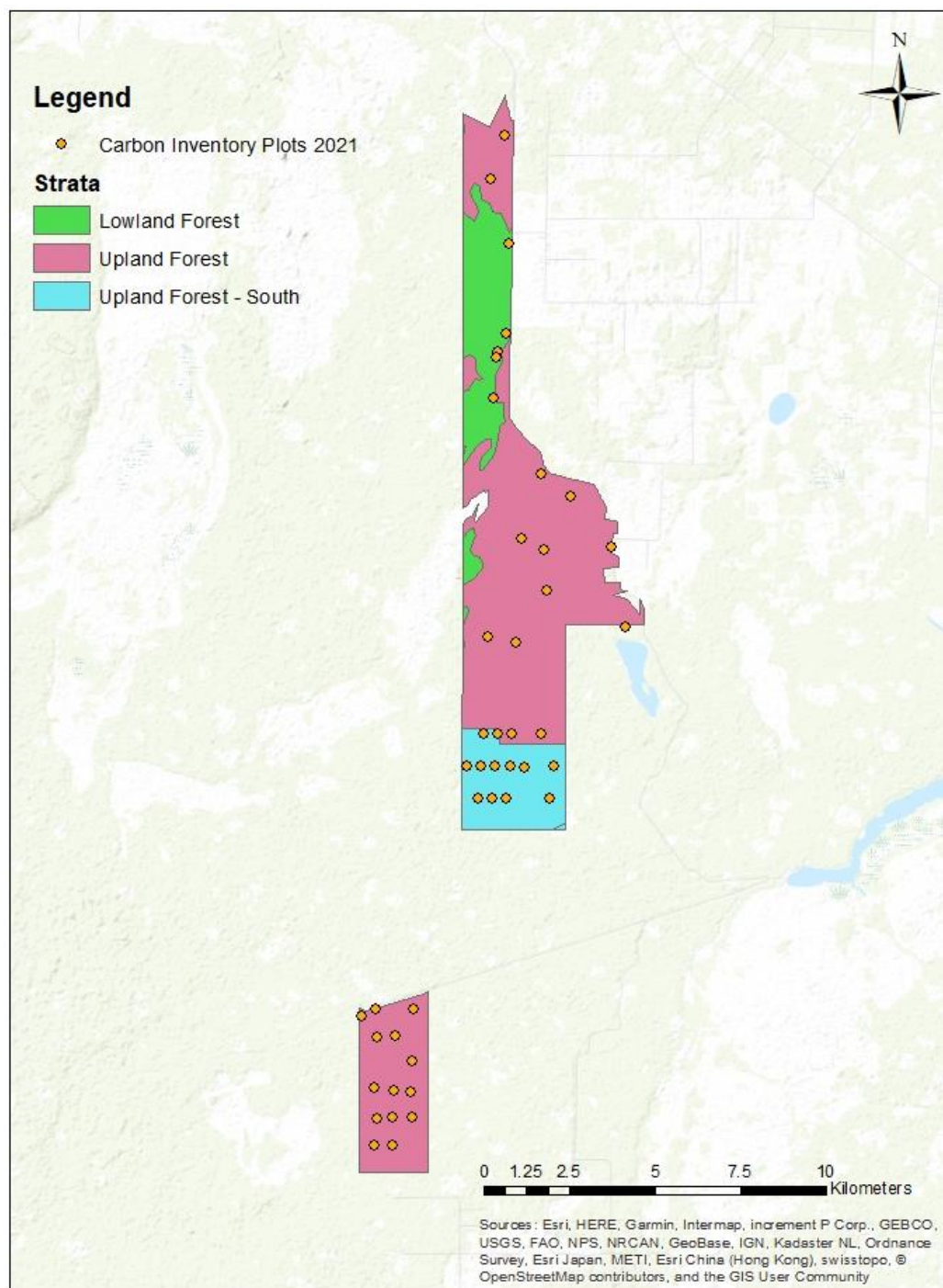


Figure 3. Map of Rio Bravo project area with sample points (n=44) from the 2021 inventory spread across 3 strata.

4.3.5 Monitoring of Baseline

The Baseline was reassessed at the last verification for the baseline period beginning January 2012, based on methods written in the Methodology Module VMD0006. According to VM0007 Section 6.2,

“For planned deforestation projects, the baseline must be revised every 10 years for *ongoing* planned deforestation”. The planned deforestation in the baseline was no longer ongoing at the beginning of the reporting period as it was completed in 2008.

The parameters that were reassessed include the projected annual proportion of land that was deforested in the stratum per year during that baseline period ($D_{\text{planned},i,t}$), the carbon stocks (C_{bsl}), and carbon stock change (ΔC_{bsl}), and the GHG emissions resulting from deforestation activities.

The planned deforestation that took place in the baseline was completed in 2008, during the first baseline period, and baseline stocks, based on post-deforestation stock values, were held constant through the end of the crediting period. Therefore, no baseline emissions were accounted during this monitoring period. Additionally, the project will not be renewing the crediting period and a new baseline will not be established for this project at the end of this baseline period.

4.3.6 Application of Monitoring Module (M-REDD)

4.3.6.1 Applicability

Emissions from logging are not omitted as *de minimis*. The program maintained the Forest Stewardship Council (FSC) certification throughout the entire monitoring period when selective logging occurred.

4.3.6.2 Monitoring deforestation

As dictated by the methodology modules used, this monitoring event only takes place within the project boundary.

Selection and analyses of sources of land-use and land cover (LU/LC) change data

Landcover change analysis was conducted to evaluate forest and non-forest classes in the project area. Due to high cloud contamination of all available Landsat imagery, Sentinel 2 imagery collected on 03 Feb 2021 was used. The imagery is collected at multiple spatial and spectral resolutions. The highest spatial resolution available is 10m, and all available bands (B2, B3, B4, and B8) were used for classification (see table 4-2).

Table 4-2. Spectral bands available from Sentinel 2 imagery available for classification analysis are highlighted in dark gray.

Band	Resolution	Central Wavelength	Description
B1	60 m	443 nm	Ultra blue (Coastal and Aerosol)
B2	10 m	490 nm	Blue
B3	10 m	560 nm	Green
B4	10 m	665 nm	Red
B5	20 m	705 nm	Visible and Near Infrared (VNIR)
B6	20 m	740 nm	Visible and Near Infrared (VNIR)
B7	20 m	783 nm	Visible and Near Infrared (VNIR)

B8	10 m	842 nm	Visible and Near Infrared (VNIR)
B8a	20 m	865 nm	Visible and Near Infrared (VNIR)
B9	60 m	940 nm	Short Wave Infrared (SWIR)
B10	60 m	1375 nm	Short Wave Infrared (SWIR)
B11	20 m	1610 nm	Short Wave Infrared (SWIR)
B12	20 m	2190 nm	Short Wave Infrared (SWIR)

Imagery was downloaded from USGS Earth Explorer and imported into TerrSet. An unsupervised clustering classification algorithm was used to group pixels into spectrally based classes. These were then grouped into information classes based on expert opinion to distinguish forest and non-forest (see Figure 3).



Figure 3. Results of the 2021 classification of the Rio Bravo project area showing forest cover (green) and non-forest (black).

An accuracy assessment of the classification maintained 92.9% accuracy, exceeding the 90% threshold required by VMD0015 (see Table 4-3). 700 random points were selected from the project area and were validated with high resolution Planet monthly composite data (5m) from November 2021 (see Figure 4).

Table 4-3. Accuracy assessment of forest/non-forest classification analysis.

Class	Points in class	Correct	% Correct
forest	681	633	92.95%
non-forest	19	17	89.47%

Overall accuracy	700	650	92.86%
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Figure 4. Map of accuracy assessment points in the project area.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The baseline was reassessed, based on the methods written in the Methodology Module VMD0006, at the end of the last monitoring period which was completed in 2011 and extends through the end of the current monitoring period, ending in 2021. As the crediting period will not be renewed, a new baseline will not be assessed.

Following VMD0006 for planned deforestation, the baseline was completed in 2008 when all eligible lands would have been deforested in the project area. Therefore, no further deforestation takes place in the baseline after 2008 and carbon stock change = 0, and all GHG emissions associated with deforestation in the baseline were equal to 0.

5.2 Project Emissions

Project emissions were calculated following the module M-REDD VMD0015. Emissions accounted for degradation due to FSC certified selective logging, disturbances, deforestation, fossil fuel usage, and enhancements. Once the emissions from each component was monitored and estimated, the total project emissions were summed together based on Equation 1 in VMD0015 (see “Rio_Bravo_MR_Calcs_*.xlsx”):

$$\Delta C_{WPS-REDD} = \sum_{t=1}^T \sum_{i=1}^M (\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + \Delta C_{P,DistPA,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t})$$

Equation 1, Module VMD0015

Estimating emissions resulting from deforestation within the project area

Analysis of landcover change data from 2021 Sentinel 2 imagery shows 59.8 hectares of forest loss during the monitoring period (2012-2021). The area found to have been deforested in each year in the project area is multiplied by the change in carbon stocks resulting from such deforestation, using equation 3 in Module VMD0015 (see Table 5-1 and 5-2):

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^U (A_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t})$$

Equation 3, Module VMD0015

	A _{DefPA,u,i,t}		
	Area of recorded deforestation in the project area (ha)		
Year	Lowland	Upland	Upland-South
2012	7.59	50.62	1.63
2013	-	-	-
2014	-	-	-

2015	-	-	-
2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	-	-	-
2020	-	-	-
2021	-	-	-

Table 5-1. Area of deforestation in the with-project case that occurred between 2012 and 2021.

	$\Delta C_{P,DefPA,i,t}$		
	Net carbon stock change as a result of deforestation (tCO2e)		
Year	Lowland	Upland	Upland-South
2012	4,060.7	39,972.2	1,026.3
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	-	-	-
2020	-	-	-
2021	-	-	-
Total	-	-	-

Table 5-2. Net carbon stock change as a result of deforestation during the 2012-2021 monitoring period.

The non-forest area detected in this monitoring period likely existed prior to 2012, based on review on forest cover data from the previous monitoring period. However, the area within the project boundaries were considered to be entirely forested in the last monitoring period. The non-forest areas being detected in this reporting period are conservatively being treated as forest loss. All deforestation is assumed to have occurred in 2012, the first year of monitoring for this period. Additionally, biomass removed due to deforestation is conservatively considered to be burned and GHG emissions associated with burning are accounted for based on Equation 1 in VMD0013:

$$E_{biomassburn,i,t} = \sum_{g=1}^G \left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i} \right) \times 10^{-3} \right) \times GWP_g \quad (1)$$

Equation 1, Module VMD0013

The emission per unit area is equal to the difference between the stocks before and after deforestation, applying Equation 5 in Module VMD0015:

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{WP,i}$$

Equation 5, Module VMD0015

Wood products produced from deforestation are conservatively excluded from this analysis and there is no baseline deforestation during this monitoring period. The emission associated with deforestation is based on the carbon stock estimates using Equation 6 in VMD0015, for only above-ground and below-ground tree biomass:

$$C_{post,u,i} = C_{AB_tree,i} + C_{BB_tree,i} + C_{AB_non-tree,i} + C_{BB_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,PD-BSL,i}$$

Equation 6, Module VMD0015

5.2.1 Monitoring degradation

For the project area, the net greenhouse gas emissions resulting from degradation is equal to the sum of stock changes due to degradation through extraction of trees for illegal timber or fuelwood and charcoal, and extraction of trees for selective logging from forest management areas possessing a FSC certificate as expressed in Equation 7 of Module VMD0015:

$$\Delta C_{P,Deg,i,t} = \Delta C_{P,DegW,i,t} + \Delta C_{P,SelLog,i,t}$$

Equation 7, Module VMD0015

In the previous monitoring period, degradation due to illegal logging was quantified by conservatively assuming that all mahogany and cedar biomass within 500m of the road network was emitted in the first two years. In this monitoring period, degradation from illegal logging is considered to be de minimis. PfB staff complete monthly patrols, aerially and by foot, of the reserve to identify illegal activity, focused around areas of highest risk including roads and property boundaries. Instances of illegal harvest are tracked using under the FSC program. The species of each illegally removed tree is identified where possible and a GPS point captured (see “IllegalLogging_2011_2020_OriginalArea.shp”). The GPS points allow PfB to determine where illegal logging occurred specifically within the project area. Between 2012 and 2020, 329 instances of illegal logging were recorded (see “IllegalLoggingData_2011_2020OriginalArea2.xlsx”).

To demonstrate that illegal harvests are de minimis, the maximum average volume (0.97 m³), derived from mill delivery of FSC certified logging, of commercial species was multiplied by the number of trees illegally removed between 2012 and 2020 to estimate the total volume removed. The volume removed was multiplied by the BCEF for Humid Tropical forests⁴ (2.05) to convert the volume to metric tons of

⁴ 2006 IPCC Guidelines for GHG Inventories. Vol 4. Ch 4: Forest Land.

above-ground biomass. The value was then multiplied by 0.47 and 44/12 to convert above-ground biomass to tCO₂e. It is conservatively assumed that all illegally logged timber is immediately emitted. The estimated emission from illegal logging in the reserve between 2012 and 2020 is 1,003 tCO₂e. By the end of the last reporting period, the project had generated 1,790,889 tCO₂e emission reductions. A conservative estimate of emissions related to illegal logging makes up 0.056% of emission reductions at the end of the last reporting, well below the 5% de minimis threshold. Therefore, emissions related to illegal logging will be accounted as 0 tCO₂e in this reporting period and Equation 8 of Module VMD0015 is applied where no degradation is occurring:

$$\Delta C_{P,DegW,i,t} = 0$$

Equation 8, Module VMD0015

5.2.2 Monitoring selective logging

Selective logging took place within the project boundary during this reporting period, which was certified under FSC standards.

The area logged is monitored using GPS systems. The geospatial data of timber management areas is available in the shapefile “ProjArea_Logged2011_2021.shp”. The data show that within the project area 2,176.8 hectares were logged between 2011 and 2021 (see Figure 5).

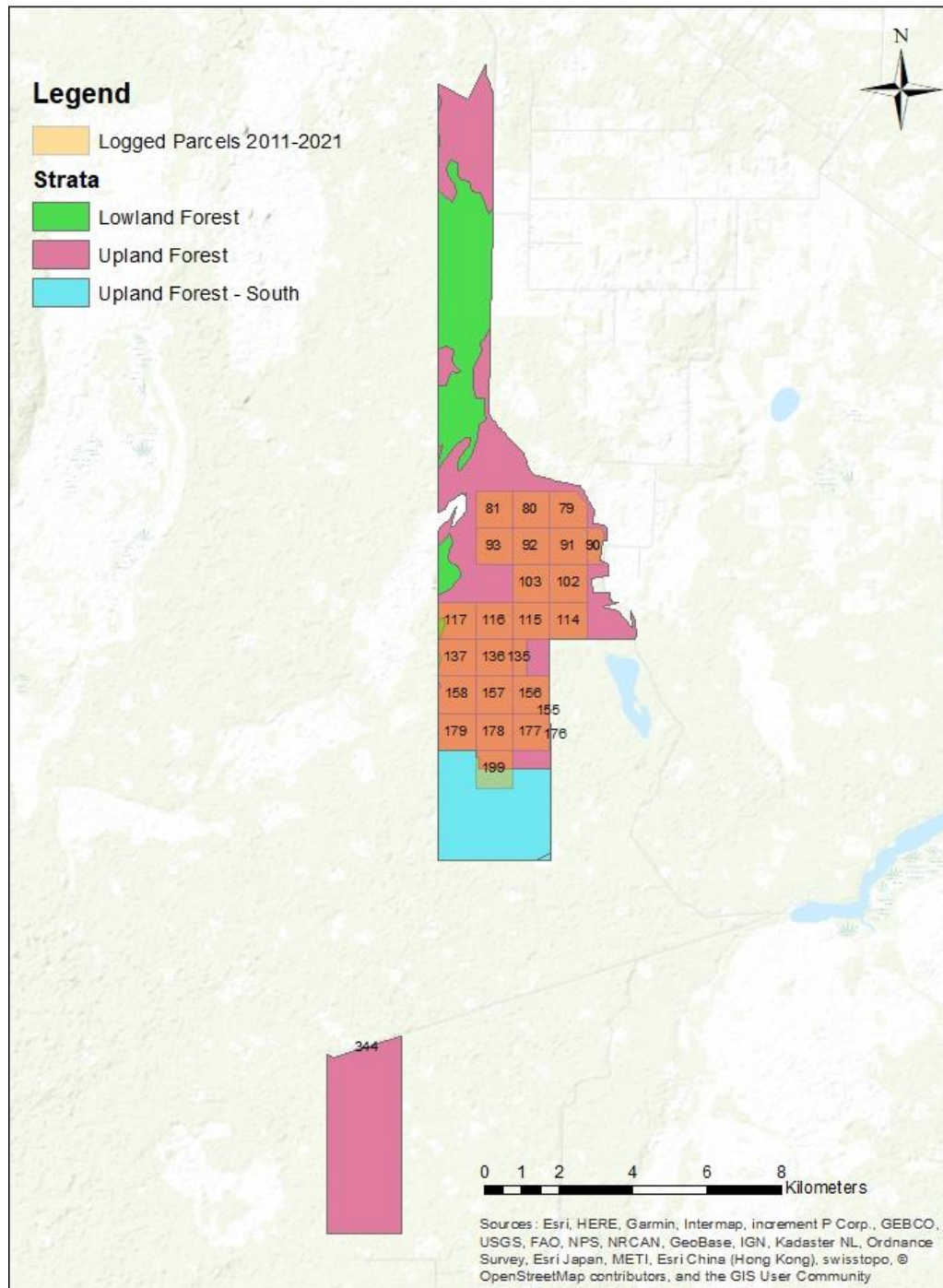


Figure 5. Map of Rio Bravo project area with parcels where selective FSC certified logging took place between 2012 and 2021.

The emissions from certified selective logging are monitored through wood volume delivered to mills by PfB and verified through audits conducted by FSC. Annual mill receipts track volume logged and are available in the supplemental data (see folder “Treesharvested_2011_2021_RBCAP”).

Through the application of VMD0015 Methods for Monitoring GHG Emissions and Removals, emissions arising in the logging gap and emissions from logging infrastructure were estimated annually. Annual timber volumes reported by PfB were used to estimate yearly emissions from degradation. The principle of conservativeness was taken into consideration when estimating emissions during monitoring. Equation 9 from VMD0015 was applied to calculate net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas:

$$\Delta C_{P, SelLog, i, t} = \sum_{t=1}^t (C_{LG, i, t} + C_{LR, i, t} - C_{WP, i, t})$$

Equation 9, Module VMD0015

Emissions arising in the logging gap

Emissions occurring in logging gaps as a direct result of the death of timber trees and due to death of trees killed when timber is felled are calculated using Equation 10 in VMD0015:

$$C_{LG, i, t} = \sum_{z=1}^Z (C_{EXT, z, i, t} + (LDF_{z, i} * V_{EXT, z, i, t} * \frac{44}{12}))$$

Equation 10, Module VMD0015

Biomass of commercial extracted logs is calculated using Equation 11 in VMD0015:

$$C_{EXT, z, i, t} = \sum_{j=1}^S (V_{EXT, j, z, i, t} * D_j * CF_j * \frac{44}{12})$$

Equation 11, Module VMD0015

The reported yearly volume was multiplied by the wood density following Equation 1 in the CP-W module. According to Reyes et al. (1992) the average wood density in the tropical Americas is 0.6 t m⁻³. It was then multiplied by the carbon fraction and converted to tons of CO₂-e.

$$C_{XB, ty, i} = \frac{1}{A_i} * \sum_{j=1}^S (V_{ex, ty, j, i} * D_j * CF_j * \frac{44}{12})$$

Equation 1, Module VMD0005

The remaining carbon stored in wood products was then calculated, using Equation 2 of the CP-W module, by subtracting the amount of wood waste emitted using the mill efficiency factor of 0.24, the default value for developing countries.

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} * (1 - WW_{ty})$$

Equation 2, Module VMD0005

Emissions arising through logging infrastructure

Emissions arising from logging infrastructure were estimated using the Logging Infrastructure Factor (LIF) applied in Equation 4 of VMD0011 LK-ME (See Methodology Deviations in Section 3.2), which is prescribed for estimating logging infrastructure emissions in the baseline scenario:

$$C_{BSL,XBT,i,t} = ([V_{BSL,XE,i,t} * D_{mn} * CF] + [V_{BSL,XE,i,t} * LDF] + [V_{BSL,XE,i,t} * LIF]) * \frac{44}{12}$$

Equation 4, Module VMD0011

LIF Logging infrastructure factor; t C m⁻³ (default 0.29 t C m⁻³)

The LIF, 0.29 tCO₂e/m³ was multiplied by the annual volume of wood extracted through legal FSC certified logging to calculate emissions related to logging infrastructure such as skid trails, road, and logging decks.

Net emissions in the project case are then equal to the sum of emissions resulting from skid trails, roads, and logging decks created for selective logging operations (see Equation 9, VMD0015).

Emissions from FSC certified legal logging operations are accounted for based on logging volumes delivered to mills based on mill receipts tracked by the FSC program (see Table 5-5; folder “2011_2021 Timber Delivery Data”). Equation 9 from VMD0015 was applied to calculate total emissions from selective logging, which includes emissions from logging gaps, logging infrastructure, and wood products (see Tables 5-4 to 5-11).

Year	Vol harvested (bdf t)				V _{EXT} (m ³)		
	Total	Lowland	Upland	Upland-South	Lowland	Upland	Upland-South
2012	-	-	-	-	-	-	-
2013	157,713.0	517.4	153,173.3	4,022.2	1.2	361.4	9.5
2014	436,881.0	1,433.4	424,305.6	11,142.0	3.4	1,001.2	26.3
2015	365,573.0	1,199.4	355,050.2	9,323.4	2.8	837.8	22.0
2016	358,667.0	1,176.8	348,343.0	9,147.3	2.8	822.0	21.6
2017	-	-	-	-	-	-	-
2018	99,374.0	326.0	96,513.6	2,534.4	0.8	227.7	6.0
2019	365,802.0	1,200.2	355,272.6	9,329.3	2.8	838.3	22.0
2020	150,155.0	492.6	145,832.9	3,829.5	1.2	344.1	9.0
2021	189,080.0	620.4	183,637.4	4,822.2	1.5	433.3	11.4

Table 5-4. Total board foot volumes were reported annually from mill receipts for harvesting from each stratum in 2012-2021 and converted to cubic meters volume.

Lowland	$C_{EXT,i,t}$	$C_{LG,i,t}$	$C_{LR,i,t}$	$\Delta C_{P, SelLog,i,t}$
Year	Biomass of carbon stock extracted (tCO ₂ e)	Actual net emissions from logging (tCO ₂ e)	Logging infrastructure (tCO ₂ e)	Net emissions from logging + Logging infrastructure (tCO ₂ e)
2012	-	-	-	-
2013	1.3	2.1	1.3	2.4
2014	3.5	5.8	3.6	6.6
2015	2.9	4.8	3.0	5.6
2016	2.9	4.7	3.0	5.5
2017	-	-	-	-
2018	0.8	1.3	0.8	1.5
2019	2.9	4.8	3.0	5.6
2020	1.2	2.0	1.2	2.3
2021	1.5	2.5	1.6	2.9

Table 5-5. Calculation of carbon emissions due to logging infrastructure and logging gaps in the lowland stratum from 2012-2021.

Lowland	$V_{sawnwood}$	$V_{woodpanels}$	$V_{roundwood}$	V_{paper}	$C_{XB,ty,i}$	$C_{WP,i}$
Year	Volume of sawnwood (m ³)	Volume of wood panels (m ³)	Volume of round wood (m ³)	Volume of paper (m ³)	Mean stock of extracted biomass (tCO ₂ e/ha)	Carbon in wood products pool (tCO ₂ e)
2012	-	-	-	-	-	-
2013	1.1	0.1	0.0	0.0	0.2	1.0
2014	3.0	0.3	0.1	0.1	0.5	2.7
2015	2.5	0.3	0.1	0.1	0.4	2.3
2016	2.5	0.2	0.1	0.1	0.4	2.2
2017	-	-	-	-	-	-
2018	0.7	0.1	0.0	0.0	0.1	0.6
2019	2.5	0.3	0.1	0.1	0.4	2.3
2020	1.0	0.1	0.0	0.0	0.2	0.9
2021	1.3	0.1	0.0	0.0	0.2	1.2

Table 5-6. Calculation of emissions associated with wood products in the Lowland stratum.

Upland	$C_{EXT,i,t}$	$C_{LG,i,t}$	$C_{LR,i,t}$	$\Delta C_{P, SelLog,i,t}$
Year	Biomass of carbon stock extracted (tCO ₂ e)	Actual net emissions from logging (tCO ₂ e)	Logging infrastructure (tCO ₂ e)	Net emissions from logging + Logging infrastructure (tCO ₂ e)
2012	-	-	-	-
2013	373.7	615.9	384.3	710.5
2014	1,035.3	1,706.1	1,064.7	1,968.2

2015	866.3	1,427.7	890.9	1,647.0
2016	849.9	1,400.7	874.1	1,615.9
2017	-	-	-	-
2018	235.5	388.1	242.2	447.7
2019	866.9	1,428.5	891.4	1,648.0
2020	355.8	586.4	365.9	676.5
2021	448.1	738.4	460.8	851.8

Table 5-7. Calculation of carbon emissions due to logging infrastructure and logging gaps in the Upland stratum from 2012-2021.

Upland	V _{sawnwood}	V _{woodpanels}	V _{roundwood}	V _{paper}	C _{xB,ty,i}	C _{WP,i}
Year	Volume of sawnwood (m ³)	Volume of wood panels (m ³)	Volume of round wood (m ³)	Volume of paper (m ³)	Mean stock of extracted biomass (tCO ₂ e/ha)	Carbon in wood products pool (tCO ₂ e)
2012	-	-	-	-	-	-
2013	321.7	32.5	7.2	7.2	0.2	289.7
2014	891.1	90.1	20.0	20.0	0.5	802.6
2015	745.7	75.4	16.8	16.8	0.4	671.6
2016	731.6	74.0	16.4	16.4	0.4	658.9
2017	-	-	-	-	-	-
2018	202.7	20.5	4.6	4.6	0.1	182.6
2019	746.1	75.5	16.8	16.8	0.4	672.0
2020	306.3	31.0	6.9	6.9	0.2	275.8
2021	385.7	39.0	8.7	8.7	0.2	347.3

Table 5-8. Calculation of emissions associated with wood products in the Upland stratum.

Upland-South	C _{EXT,i,t}	C _{LG,i,t}	C _{LR,i,t}	ΔC _{P,SelLog,i,t}
Year	Biomass of carbon stock extracted (tCO ₂ e)	Actual net emissions from logging (tCO ₂ e)	Logging infrastructure (tCO ₂ e)	Net emissions from logging + Logging infrastructure (tCO ₂ e)
2012	-	-	-	-
2013	9.8	16.2	10.1	18.7
2014	27.2	44.8	28.0	51.7
2015	22.7	37.5	23.4	43.2
2016	22.3	36.8	23.0	42.4
2017	-	-	-	-
2018	6.2	10.2	6.4	11.8
2019	22.8	37.5	23.4	43.3

2020	9.3	15.4	9.6	17.8
2021	11.8	19.4	12.1	22.4

Table 5-9. Calculation of carbon emissions due to logging infrastructure and logging gaps in the Upland-South stratum from 2012-2021.

Upland-South	V _{sawnwood}	V _{woodpanels}	V _{roundwood}	V _{paper}	C _{xB,ty,i}	C _{WP,i}
Year	Volume of sawnwood (m ³)	Volume of wood panels (m ³)	Volume of round wood (m ³)	Volume of paper (m ³)	Mean stock of extracted biomass (tCO ₂ e/ha)	Carbon in wood products pool (tCO ₂ e)
2012	-	-	-	-	-	-
2013	8.4	0.9	0.2	0.2	0.2	7.6
2014	23.4	2.4	0.5	0.5	0.5	21.1
2015	19.6	2.0	0.4	0.4	0.4	17.6
2016	19.2	1.9	0.4	0.4	0.4	17.3
2017	-	-	-	-	-	-
2018	5.3	0.5	0.1	0.1	0.1	4.8
2019	19.6	2.0	0.4	0.4	0.4	17.6
2020	8.0	0.8	0.2	0.2	0.2	7.2
2021	10.1	1.0	0.2	0.2	0.2	9.1

Table 5-10. Calculation of emissions associated with wood products in the Upland-South stratum.

	$\Delta C_{P,Deg,i,t}$		
	Net carbon stock change as a result of degradation (tCO ₂ e)		
Year	Lowland	Upland	Upland-South
2012	-	-	-
2013	2.4	710.5	18.7
2014	6.6	1,968.2	51.7
2015	5.6	1,647.0	43.2
2016	5.5	1,615.9	42.4
2017	-	-	-
2018	1.5	447.7	11.8
2019	5.6	1,648.0	43.3
2020	2.3	676.5	17.8
2021	2.9	851.8	22.4
Total	32.3	9,565.6	251.2

Table 5-11. Net carbon stock change from degradation caused by FSC certified selective logging operations between 2012-2021.

5.2.3 Monitoring areas undergoing natural disturbance

Hurricane Earl affected the project area in August 2016. A report estimating damage relating to the hurricane impact estimated that the entire project area experienced some level of damage from the storm (see “HurEarlNarrative4Aug2016.docs”). No loss event was reported during this period because the event did not result in an emission of more than 5% (128,904 tCO₂e) of the VCU_s issued to date for the project (“see RioBravo_LossReportAssess_2022-12-01.xlsx”). If a loss event of 5% of carbon stocks issued at the end of the last reporting period (~128,900 tCO₂/ha), the minimum loss that would trigger a loss event report, had occurred due to the hurricane in 2016, the growth rate of the forest would have had to double to reach the stocks inventoried at the end of the reporting period in 2021, which is highly unlikely in a mature tropical moist forest. Additionally, review of aerial imagery before and directly following the storm also reveals that the forest canopy cover remained intact (see Figures 6 and 7). The full inventory that was implemented in 2021 and used for calculation of enhancements in this reporting period quantifies the net stock change from the previous reporting period, covering the hurricane event. Sample frame of the 2021 forest inventory covers the entire project area and biomass loss related to the storm that occurred in 2016 is incorporated into the estimate of stock change since the last reporting period. Therefore, emissions related to storm damage in the Upland, Upland-South, and Lowland strata are not estimated separately using Equation 20 in Module VMD0015, where $\Delta C_{DistPA} = 0$.

Figure 6. Landsat imagery from December 2014 of the project area, pre-hurricane.

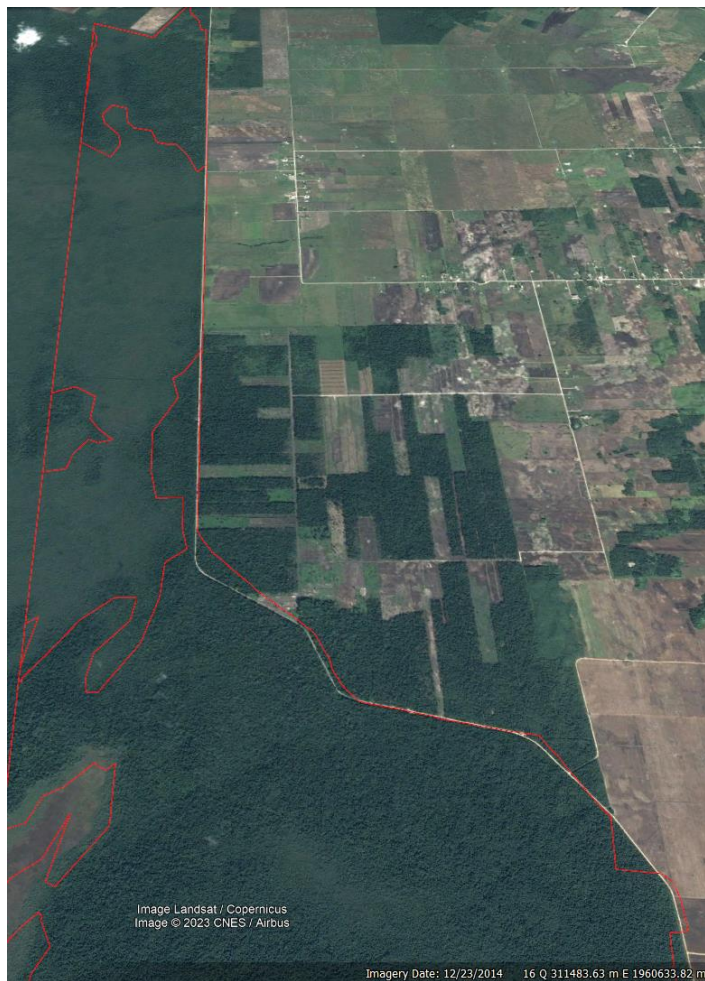
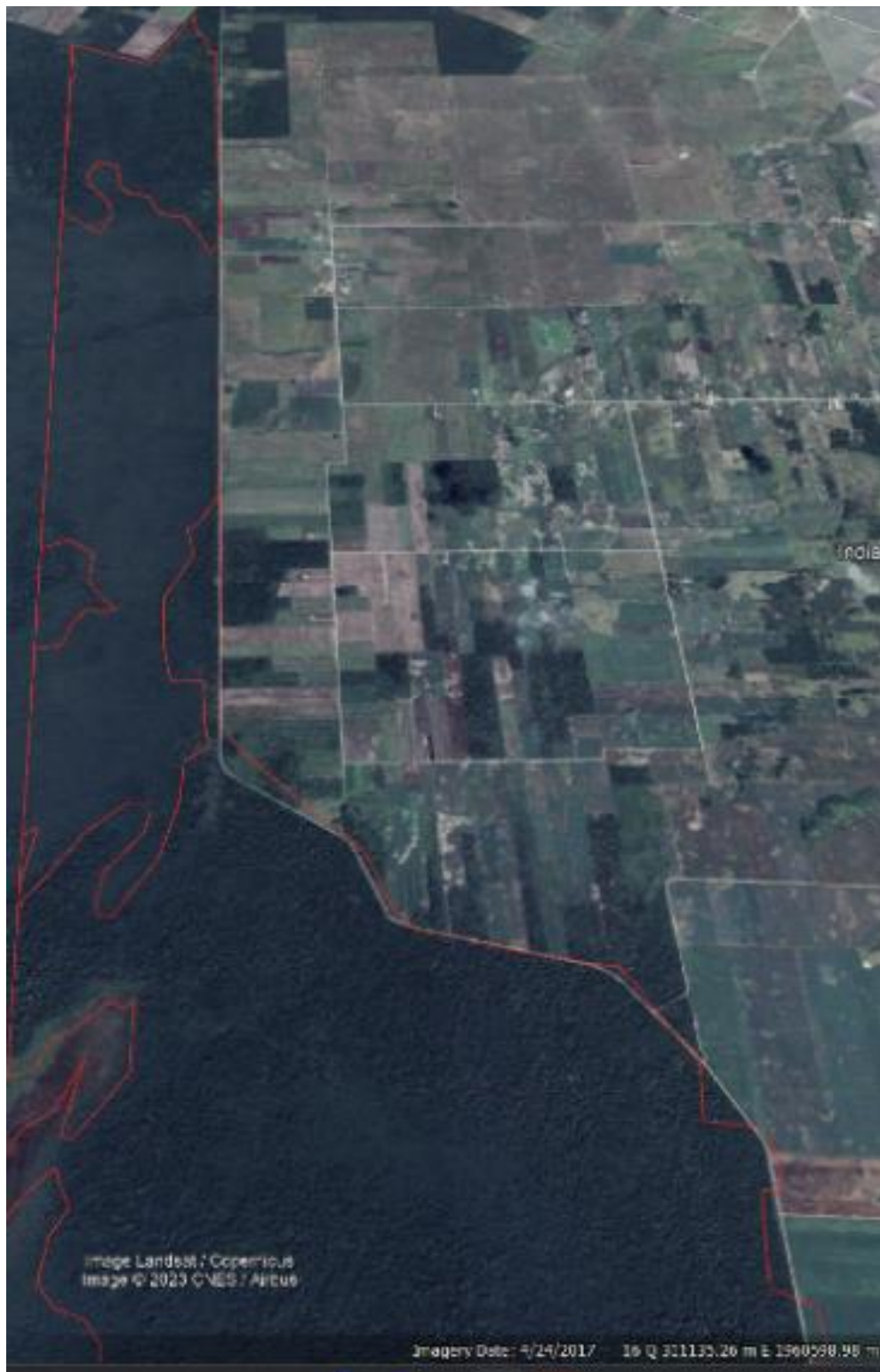


Figure 7. Landsat imagery from April 2017, less than 1 year after the hurricane.



$$\Delta C_{P,DistPA,i,t} = \sum_{q=1}^Q (A_{DisPA,q,i,t} * \Delta C_{P,Dist,q,i,t})$$

Equation 20, Module VMD0015

One fire took place during the monitoring period in April 2019. About 313 hectares of forest were subject to burning along the western edge of the project boundary. The fire did not result in heavy mortality of the area as the 2021 classification of forest cover does not show any forest loss in the areas affected by the fire, and is therefore, considered *de minimis*.

5.2.4 Monitoring areas undergoing carbon stock enhancement

Forest carbon has been increasing in the Rio Bravo forest since the initiation of the project in 1996. Though the project initially, conservatively, excluded enhancements from emissions calculations, the 2021 re-inventory revealed that a substantial increase in carbon stocks occurred over 20-years due to effective conservation activities. Accounting for enhancements is, therefore, an accurate accounting of emissions during the project crediting period. Enhancements are accounted for this period between 2012 and 2021.

Equation 25 from VMD0015 is applied to determine the net carbon stock changes as a result of forest carbon stock enhancements for years 0-20 of the project:

$$\Delta C_{P,Enh,i,t} = \sum_{t=1}^t \sum_{i=1}^M ((C_{P,i,t} - C_{BSL,i}) * A_{Enh,PL,i,t})$$

Equation 25, Module VMD0015

Enhancements due to forest growth are credited to areas within the project only after it would have been deforested in the baseline. The area of the project determined to be deforested in each year of the baseline was calculated using Equation 26 for a planned REDD project:

$$A_{Enh,PL,i,t} = D\%_{planned,i,t} * A_{planned,i,t}$$

Baseline deforestation took place between 1996 and 2008, which means that at the start of this monitoring period, in 2012, baseline deforestation was completed and all growth could be attributed to project activities. Enhancements are only credited during the crediting period from 2012-2021. It should be noted that stocks decreased in the Upland-South stratum and the loss is being accounted here as an emission, likely reflective of hurricane damage.

An annualized net stock change was calculated using the difference in mean carbon stock values for each stratum from the 2000 and 2021 inventories of the project area and divided by 20 (see table 5-12).

	Lowland	Upland	Upland-South
Ann net stock change tCO2e/ha/yr	1.6	7.8	-12.9

Table 5-12. Annual net stock change for the Lowland and Upland strata based on inventories from 2000 and 2021.

Because baseline deforestation was completed in 2008, all hectares in the project area underwent stock changes that would not have otherwise occurred in the baseline. Carbon stocks generally increased across the project site. The annual net stock change was multiplied against the total area of each stratum in each year of the monitoring period to calculate the overall emissions from enhancements (see Table 5-13).

	Lowland		Upland		Upland-South	
	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
Year	$\Delta C_{PA,Enh}$ (tCO ₂ e)	$\Delta C_{PA,Enh}$ (tCO ₂ e)	$\Delta C_{PA,Enh}$ (tCO ₂ e)	$\Delta C_{PA,Enh}$ (tCO ₂ e)	$\Delta C_{PA,Enh}$ (tCO ₂ e)	$\Delta C_{PA,Enh}$ (tCO ₂ e)
2012	1,490.8	1,490.8	33,120.1	33,120.1	(14,303.6)	(14,303.6)
2013	1,490.8	2,981.6	33,120.1	66,240.1	(14,303.6)	(28,607.2)
2014	1,490.8	4,472.4	33,120.1	99,360.2	(14,303.6)	(42,910.8)
2015	1,490.8	5,963.2	33,120.1	132,480.2	(14,303.6)	(57,214.4)
2016	1,490.8	7,454.0	33,120.1	165,600.3	(14,303.6)	(71,518.0)
2017	1,490.8	8,944.8	33,120.1	198,720.4	(14,303.6)	(85,821.6)
2018	1,490.8	10,435.7	33,120.1	231,840.4	(14,303.6)	(100,125.2)
2019	1,490.8	11,926.5	33,120.1	264,960.5	(14,303.6)	(114,428.8)
2020	1,490.8	13,417.3	33,120.1	298,080.5	(14,303.6)	(128,732.4)
2021	1,490.8	14,908.1	33,120.1	331,200.6	(14,303.6)	(143,036.0)

Table 5-13. Net emissions due to enhancements during the monitoring period 2012-2021.

5.2.5 Monitoring project emissions

Carbon emissions are also generated in the project scenario through usage of machineries that consume fossil fuels, potential biomass burning occurring within the project boundaries, and fertilizers used within the project boundary.

Monitoring of emissions from fossil fuel consumption was conducted by keeping track of the annual amount of fuel consumed by PfB and by logging contractors to conduct operations in the project area and applying Equation 30 in VMD0015:

$$GHG_{P,E,i,t} = E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Fuel consumption was estimated from logging activity in 2021 (see “Fuel Details November 2020 – October 2021.xlsx”). Monthly fuel costs were divided by the cost of fuel per gallon to calculate volume of fuel consumed in each month of the year. The fuel used for harvesting was predominantly diesel fuel. Gallons were then converted to liters. Total fuel consumption was summed for the year and then divided by the total m³ of timber harvested to get liters/m³. This annual average was then applied across all years of the monitoring period by multiplying the total volume harvested in each year by the average fuel consumption value.

Module E-FFC, VMD0014, for fossil fuels was then applied to convert fuel consumption to tCO₂e as a contribution to project emissions. Using Equation 2 in VMD0014 to convert the amount of fuel

consumed to terrejoules (TJ), we multiplied total liters of fuel by the default density (DensityFuel) of 0.8439 kg/ltr, and the default of 43.0 TJ/Gg for Net Caloric Value (NCV):

$$Fuel_{a,i,t} = Liters_{Fuel_{a,i,t}} \times Density_{Fuel_a} \times NCV_{Fuel} \div 10^6$$

Equation 2, VMD0014

Applying Equation 1 in VMD0014, we then multiplied terre-joules of fuel consumed in each year and each stratum by the default emission factor (EF) for diesel of 74.1 tCO₂/TJ (see Table 4-3):

$$E_{FC,i,t} = \sum_{a=1}^A (Fuel_{a,i,t} \times EF_a)$$

Equation 1, VMD0014

Year	Emission from fossil fuel combustion (tCO ₂)		
	Lowland	Upland	Upland-South
2012	-	-	-
2013	0.01	2.20	0.06
2014	0.02	6.09	0.16
2015	0.02	5.09	0.13
2016	0.02	5.00	0.13
2017	-	-	-
2018	0.00	1.38	0.04
2019	0.02	5.10	0.13
2020	0.01	2.09	0.05
2021	0.01	2.63	0.07

Table 5-14. Total emissions from fossil fuel consumption related to harvesting activity between Jan 2012 and Dec 2021.

Fires within the project boundary have been monitored over time by both field crews and satellite imagery. One fire occurred during the monitoring period, in 2019, burning about 313 ha of forest area in the Upland stratum (see “April 2019 Fire Report to TNC.docx”).

The occurrence of fires has also been monitored using the MODIS Burned Area Monthly L3 Global 500m (MCD45A1) was used to investigate the risk of wildfire inside the project boundary. The MCD45A1 is a monthly Level-3 gridded 500-meter satellite imagery product, which contains burning and date information at a pixel level. The monthly MCD45A1 product is based on three months of atmospherically and geometrically corrected, cloud-screened daily reflectance data. The algorithm that creates the product analyzes daily imagery of surface reflectance dynamics to locate changes, uses that information to detect the approximate date of burning, and maps the spatial extent.

The fire that took place in 2019 did not cause substantial mortality area and based on the 2021 inventory and 2021 satellite imagery analysis, this forest area has maintained its canopy cover. As Rio Bravo Climate Action Project plans do not include fertilization of remnant forest, no emissions from fertilization took place during this monitoring period.

The Programme for Belize keeps records of fuel purchased for maintaining the project, such as utilizing vehicles including trucks, all terrain vehicles (ATV), and tractors, generators, lawnmowers. Additionally, a survey was applied to the logging contractor to identify fuel consumption for conducting logging practices (e.g. chainsaw, skidder, loaders and trucks). PFB fuel purchase records and results of the survey were compiled and the annual fuel consumption within Rio Bravo Climate Action Project area was estimated. Emissions from fossil fuels are calculated using Equation 30 in VMD0015.

No biomass burning took place in the project area. However, the above-ground biomass from areas deforested during the monitoring period is conservatively considered to be burned. Emissions from biomass burning were calculated using Equation 1 in VMD013 by multiplying stocks by area deforested and converting the standing stocks to non-CO2 emissions using the following emission factors:

Parameter	Description	Value
COMF	Combustion Factor	0.45
G_CO2	Emission Factor for CO2	1580
GWP_CO2	Global Warming Potential	1
G_CH4	Emission Factor for CH4	6.8
GWP_CH4	Global Warming Potential	21
G_N2O	Emission Factor for N2O	0.2

GWP_N2O	Global Warming Potential	310
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$$E_{biomassburn, n, i, t} = \sum_{g=1}^G \left(\left(A_{burn, i, t} \times B_{i, t} \times COMF_i \times G_{g, t} \right) \times 10^{-3} \right) \times GWP_g$$

Equation 1, VMD0013

No fertilizer was applied in the project area and no N2O emissions occurred during the monitoring period. The only GHG emissions associated with the project during the reporting period are emissions from fossil fuel burning during logging operations and patrols. The volume of fuel usage annually is reported through the FSC system and calculations of emissions are in Table 5-15 and 5-16.

	E _{FC,i,t}			E _{BiomassBurn,i,t}		
Year	Emission from fossil fuel combustion (tCO2e)			Non-CO2 emissions due to biomass burning (tCO2e)		
	Lowland	Upland	Upland-South	Lowland	Upland	Upland-South
2012	-	-	-	1,647.63	15,459.12	397.57
2013	0.01	2.20	0.06	-	-	-
2014	0.02	6.09	0.16	-	-	-
2015	0.02	5.09	0.13	-	-	-
2016	0.02	5.00	0.13	-	-	-
2017	-	-	-	-	-	-
2018	0.00	1.38	0.04	-	-	-
2019	0.02	5.10	0.13	-	-	-
2020	0.01	2.09	0.05	-	-	-
2021	0.01	2.63	0.07	-	-	-

Table 5-15. Fossil fuel and biomass burning emissions in the with-project scenario during the monitoring period from 2012-2021.

	N ₂ O _{direct-N,i,t}			GHG _{P,E,i,t}		
	Direct N2O emission as a result of nitrogen application on the alternative land use (tCO2e)			Greenhouse gas emissions as a result of deforestation activities within the project area (tCO2e)		
Year	Lowland	Upland	Upland-South	Lowland	Upland	Upland-South
2012	-	-	-	1,647.6	15,459.1	397.6
2013	-	-	-	-	2.2	0.1
2014	-	-	-	-	6.1	0.2
2015	-	-	-	-	5.1	0.1

5						
2016	-	-	-	-	5.0	0.1
2017	-	-	-	-	-	-
2018	-	-	-	-	1.4	0.0
2019	-	-	-	-	5.1	0.1
2020	-	-	-	-	2.1	0.1
2021	-	-	-	-	2.6	0.1

Table 5-16. N2O and GHG emission associated with deforestation activities taking place between 2012-2021

5.3 Leakage

No baseline deforestation took place during this reporting period, therefore no market effects leakage or activity shifting leakage would have taken place during this period and are accounted as 0.

5.4 Net GHG Emission Reductions and Removals

Net GHG emissions and VCU are calculated using Equation 2 in the REDD-Framework, where $\Delta C_{BSL-REDD} = 0$ and $\Delta C_{LK-REDD} = 0$ (see "RioBravo_MR_Calcs_*.xlsx"):

$$NER_{REDD} = \Delta C_{BSL-REDD} - \Delta C_{WPS-REDD} - \Delta C_{LK-REDD}$$

Equation 2, VM0007

The buffer pool contribution is the minimum 10% (see "Rio_Bravo_REDD_VCS-Risk-Report-Calculation-*.xlsx"). The buffer contribution was calculated using Equations 13 and 14 from VM0007:

$$Buffer_{Total} = Buffer_{Planned} + Buffer_{Unplanned} + Buffer_{Degrad-FWIC} + Buffer_{WRC} + Buffer_{ARR}$$

Equation 13, VM0007

$$Buffer_{Planned} = \left(\frac{\Delta C_{BSL,Planned} - \sum_{t=1}^{t^*} \sum_{i=1}^M (E_{FC,j,t} + N_2O_{direct,j,t})}{\Delta C_{P,Planned} - \sum_{t=1}^{t^*} \sum_{i=1}^M (E_{FC,j,t} + N_2O_{direct,j,t})} \right) \times Buffer\%$$

Equation 14, VM0007

Uncertainty was calculated using Equation 21 in Module X-UNC, VM0017:

$$NER_{REDD+ERROR} = \frac{\sqrt{(Uncertainty_{REDD_{BSL,t}} \times \Delta C_{BSL-REDD,t})^2 + (Uncertainty_{REDD_{WPS}} \times \Delta C_{WPS-REDD,t})^2 + (Uncertainty_{WRC_{BSL,t}} \times GHG_{BSL-WRC,t})^2 + (Uncertainty_{WRC_{WPS,t}} \times \Delta C_{WPS-REDD,t})^2}}{\Delta C_{BSL-REDD,t} + \Delta C_{WPS-REDD,t} + GHG_{BSL-WRC,t} + GHG_{WPS-WRC,t}}$$

Equation 21, VM0007

Net emission reductions were adjusted for uncertainty using Equation 22 in VM0007:

$$Adjusted_NER_{REDD+} = NGR_{ARR} + (NER_{REDD} + NER_{WRC}) \times (100\% - NER_{REDD+ERROR} + 15\%)$$

Equation 22, VM0007

Because the overall uncertainty is, 7.2%, below the 15% threshold, there is no required adjustment to NERs for this monitoring period.

To estimate total verified carbon units (VCUs) for this reporting period, Equation 19 of VM0007 was applied:

$$VCU_t = (Adjusted_NER_{REDD+,t_2} - Adjusted_NER_{REDD+,t_1}) - Buffer_{Total}$$

Equation 19, VM0007

	Adj_NER _{REDD+}				
	Total net GHG emission reductions of the REDD+ project activities (tCO ₂ e)				
Year	Lowland	Upland	Upland-South	Total	Total Cumulative
2012	(4,218)	(22,311)	(15,728)	(42,256)	(42,256)
2013	1,488	32,407	(14,322)	19,573	(22,683)
2014	1,484	31,146	(14,355)	18,274	(4,408)
2015	1,485	31,468	(14,347)	18,606	14,198
2016	1,485	31,499	(14,346)	18,638	32,836
2017	1,491	33,120	(14,304)	20,307	53,143
2018	1,489	32,671	(14,315)	19,845	72,988
2019	1,485	31,467	(14,347)	18,605	91,593

2020	1,489	32,441	(14,321)	19,609	111,202
2021	1,488	32,266	(14,326)	19,427	130,629
Total	9,167	266,174	(144,712)	130,629	

Table 5-17. Net emission reductions adjusted for uncertainty.

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)	Buffer pool allocation	VCUs eligible for issuance
2012	0	(42,256)	0	(42,256)	-	(42,256)
2013	0	19,573	0	19,573	-	19,573
2014	0	18,274	0	18,274	-	18,274
2015	0	18,606	0	18,606	1,420	17,186
2016	0	18,638	0	18,638	1,864	16,775
2017	0	20,307	0	20,307	2,031	18,277
2018	0	19,845	0	19,845	1,984	17,860
2019	0	18,605	0	18,605	1,861	16,745
2020	0	19,609	0	19,609	1,961	17,648
2021	0	19,427	0	19,427	1,943	17,485
Total	0	130,629	0	130,629	13,063	117,566

Table 5-18. Total VCUs available for the monitoring period for the Rio Bravo REDD Project, 2012-2021.